NUMBERS & NEEDS

Addressing imbalances in the civil engineering profession

Allyson Lawless

saice

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Contents

Foreword

The report on 'Addressing imbalances in the civil engineering profession' is a valuable contribution to our national debate on skills. The South African Institution of Civil Engineering (SAICE) should be commended for its extensive work in researching the 'numbers and needs' involved in this profession which are absolutely crucial to our country's further development.

The research is also in line with the National Research and Development (R&D) Strategy which was approved by Cabinet in 2002 and became a cornerstone of economic development. Key operational elements of the strategy are:

- Achieving mastery of technological change in our economy and society
- Increasing investment in South Africa's science base
- Straightening the government science and technology system

Of critical importance for South Africa is wealth creation in the context of globalisation. To achieve this human resource development remains a big focus. Science and technology here are considered central in creating wealth and an improved quality of life for all.

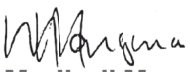
This SAICE report presents statistics which highlight bottlenecks in the field and expose skills gaps. It also makes practical recommendations in terms of the education, training, coaching and mentoring that may be required. The report points out how the attraction and retention of staff can be facilitated in order to develop and maintain civil engineering capacity in South Africa.

The statistics provide a good starting point for addressing equity and inclusiveness in the engineering sector without which there will be no sustainable successes. The need to address mathematics, science and English among schoolchildren is also highlighted and confirms the need to plan for the youth as the future drivers of the economy and leaders of the country. To date, the Department of Science and Technology, together with Education, has developed strategies and monitoring mechanisms for increasing the participation of young people in mathematics, science and technology careers.

One of the Millennium Development Goals (MDG) adopted in the General Assembly of the United Nations is cooperation with the private sector to make available the benefits of new technologies. These goals can be better served by growing the engineering sector and by fighting the declining status of the field. For South Africa to maintain its competitive edge and to bolster its role both within NEPAD and globally it has to develop its social and economic infrastructure. Engineering professionals play a crucial role in this context.

The recommendations and interventions proposed in the report lay a sound foundation for private and public institutions to join hands and work together. It also calls for a critical review of offerings in the engineering field, including practical components offered in industries. I congratulate the South African Institution of Civil Engineering on publishing this book

I thank you



Mosibudi Mangena
Minister of Science and Technology

Mosibudi Mangena
(Minister of Science and Technology)

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A report covering this amount of detail cannot be prepared in isolation. Many have made significant contributions in terms of data collection and preparation of the document, not least of which is the civil engineering industry as whole, without whose cooperation this could never have been achieved.

Special thanks must go to the following:

ORGANISATIONS WHO PROVIDED DATASETS

- South African Institution of Civil Engineering (SAICE)
- Engineering Council of South Africa (ECSA)
- South African Association of Consulting Engineers (SAACE)
- South African Federation of Civil Engineering Contractors (SAFCEC)
- South African Black Technical and Allied Careers Organisation (SABTACO)
- Master Builders South Africa (MBSA)
- National Home Builders Registration Council (NHBRC)
- South African Women in Construction (SAWiC)
- Women for Housing (WFH)
- Department of Education (DOE)

Input was also given by many other stakeholders, including the African Builders Assocation (ABA), the National Federation for the Building Industry (NAFBI) and the National Association of Black Contractors and Allied Trades (NABCAT).

THE RESEARCH TEAM

Thanks to the research team for all your hard work – particularly Margaret Constantaras for all the advice; Marthelene Buckle and Elaine Orpen, who never stopped phoning until all the required returns were received; and to all who drove great distances to carry out interviews: Rob du Preez, Willie Potgieter, Hannes de Kok, Wayne Schäfer and Tony Murray. Thanks also to SAICE leaders and staff for assistance with the development of the various instruments and organising of functions.

THE PRODUCTION TEAM

The hours spent capturing data and preparing graphs were immense. Thank you to Natasha Niemandt for burning the midnight oil and a big thank you to Johann Seidel and Marketing Support Services for the layout work.

THE REVIEWERS

A document is not complete until it has been read and re-read. Thank you to all the reviewers, who are too numerous to list here, but special mention must be made of the many hours spent by the SAICE president, Mike Deeks, and the executive director, Dawie Botha.

'You cannot hope to build a better world without improving the individuals. ... our particular duty being to aid those to whom we think we can be most useful …'

– Marie Curie

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Last, but by no means least, thanks go to the companies who sponsored the collection of material presented in this book as follows:

- Construction Education Training Authority (CETA)
- Construction Transformation Charter Group (CTCG)
- Construction Industry Development Board (CIDB)
- South African Association of Consulting Engineers (SAACE)
- South African Federation of Civil Engineering Contractors (SAFCEC)
- Allyson Lawless and Associates (Pty) Ltd (ALA)
- Department of Water Affairs and Forestry (DWAF)

Glossary

Built environment professions	A term used to describe all professions within the construction sector including architecture, building science, civil engineering, construction management and economics, quantity survey, survey and town and regional planning as regulated by the Professions Act
BEng or BSc (Eng)	Bachelor of Engineering or Bachelor of Science in Engineering. These are designated engineering degrees awarded by South African universities. The length of study is a minimum of four years full time
BTech	Bachelor of Technology. A technical degree offered by universities of technology (the former technikons). This is a one-year postgraduate qualification which may only be commenced after completing a national diploma and gaining some workplace experience
Broad based black economic empowerment	Codes of good practice for Broad Based Black Economic Empowerment have been developed to ensure that transformation takes place at all levels and black economic empowerment is promoted countrywide
Endorsement	The minimum condition for entry to a degree programme at a university. Learners who pass the Senior Certificate Examination with endorsement are qualified to enter university. The conditions for a senior certificate with endorsement are established by the South African Universities Vice-Chancellors Association (SAUVCA)
Higher education	A level of education defined by the National Qualifications Framework (NQF) in South Africa, including all NQF qualifications from Levels 5 to 9. Defined differently, higher education includes all education programmes at the post-school, pre-degree level, including certificates, diplomas and higher diplomas (Level 5 programmes), as well as all undergraduate degree and postgraduate degree programmes, from bachelor degrees to doctoral level (Level 6-8 programmes)
Historically advantaged institutions	This term refers to institutions that, under apartheid, were designated to serve white students. These institutions enjoyed relative advantage through preferential resource allocation and better facilities, infrastructure and access to developmental opportunities
Historically disadvantaged institutions	Institutions that, under apartheid, were designated to serve the various groups of the black (African, Indian and Coloured) population through a restricted range of teaching programmes and limited research
Gender mainstreaming	Gender mainstreaming has been defined by the UN Economic and Social Council (ECOSOC) as the process of assessing the implications for women and men of any planned action, including legislation, policies or programmes, in any area and at all levels. It is a strategy for making concerns and experiences of women as well as of men an integral part of the design, implemen

	tation, monitoring and evaluation of policies and programmes in all political, economic and societal spheres, so that women and men benefit equally, and inequality in not perpetuated. The ultimate goal of mainstreaming is to achieve gender equality
Grouping, ethnic group, demographic group, race	Terms currently used to denote these groups require further definition:
African	Black African people
Indian	Indian and other groups of Southeast Asian origin
Black	A comprehensive term including African, Indian and Coloured
Learner	The term 'learner' is now widely used in South Africa, in Education Department legislation and policy documents, in preference to 'student', to reflect a more active, inclusive and life-long process of learning
Learnerships	Learnerships are aimed at providing workplace learning in a structured and systematic form through the provision of both formalised learning and structured work experience. Learnership contracts are signed in a three-way agreement between the employer, education and training provider, and learner
National diploma	An engineering diploma offered by universities of technology. This is a three-year undergraduate qualification consisting of four semesters (S1, S2, S3 and S4) and one year workplace experience (termed work integrated learning), which should be undertaken after S2, but is often only undertaken after S3 or S4
National skills development	The National Skills Development Plan was put in place to ■ develop a culture of high quality life-long learning ■ foster skills development in the formal economy for productivity and employment growth ■ stimulate and support skills development in small business ■ promote skills development for employability and sustainable livelihoods through social development initiatives ■ assist new entrants into employment
NSFAS	The National Student Financial Aid Scheme is a loan scheme for academically deserving and financially needy students. On completion of their studies and starting work they are expected to repay the loan over a set period
PDIs	Previously disadvantaged individuals, that is, all black people and all females
Professional registration	After obtaining the required qualifications and experience, the Engineering Council of South Africa registers engineering practitioners in the following registration categories: ■ Professional Engineer (Pr Eng) ■ Professional Engineering Technologist (Pr Eng Tech) ■ Professional Engineering Technician (Pr Eng Techni)

Rote learning Knowledge gained by repetition typical of the process of learning tables, spelling and verses

SETA Sectoral education and training authorities were put in place to address training and skills development per sector in a structured manner. Accredited training and learnerships required in each industry are developed through the SETAs and member companies are able to claim for training of their staff

SMME Small, micro and medium-sized enterprises which combine formal and informal sector activities. According to the Department of Trade and Industry (DTI) 95% of all enterprises in South Africa are SMMEs, accounting for almost 75% of the employment in the country. In 2004 they contributed approximately 56% to the country's GDP

Swedish rating system A rating system for entry into tertiary education. Each subject scores points according to the symbol/mark achieved on the national certificate or other qualification

	HG	SG
A	8	6
B	7	5
C	6	4
D	5	3
E	4	2
F	2	1
G	0	0

The total number of points determines whether a student has enough points to be admitted to a course

Work integrated (experiential) learning As part of the national diploma the practical training for students in the workplace must be planned, structured and controlled so that they derive maximum advantage from it and it enriches and amplifies their academic knowledge

Workplace training (candidate phase) In the candidate phase applicants for professional registration (who have already attained a recognised qualification in engineering) are trained in the application of engineering principles and methods and are given progressively more responsibility until they can accept professional responsibility and make engineering decisions at an appropriate level in their category

List of figures

EXECUTIVE SUMMARY

CHAPTER 1 – SCOPE AND DEFINITIONS

CHAPTER 2 – THE PRIVATE SECTOR

CHAPTER 3 – THE PUBLIC SECTOR

CHAPTER 4 – SECONDARY EDUCATION

CHAPTER 5 – TERTIARY EDUCATION

CHAPTER 6 – GRADUATES

CHAPTER 7 – PROFESSIONALS

CHAPTER 8 – THE PRIVATE SECTOR

CHAPTER 9 – THE PUBLIC SECTOR

CHAPTER 10 – NUMBERS AND NEEDS

List of tables

CHAPTER 9 – THE PUBLIC SECTOR

CHAPTER 10 – NUMBERS AND NEEDS

Acronyms

ABA	African Builders Association
ABET	Adult Basic Education and Training
ACSA	Airports Company of South Africa
AEF	Africa Engineers Forum
ANC	African National Congress
ASCE	American Society of Civil Engineers
BBBEE	Broad-Based Black Economic Empowerment
BCEA	Basic Conditions of Employment Act
BE	Built Environment
BEE	Black Economic Empowerment
BEP	Built Environment Professional
BITB	Building Industries Training Board
BMR	Bureau for Market Research
CAD	Computer Aided Drawing
CBD	Central Business District
CDE	Centre for Development and Enterprise
CEO	Chief Executive Officer
CETA	Construction Education Training Authority
CFA	Critical Functional Area
CHE	Council on Higher Education
CIDB	Construction Industry Development Board
CIETS	Construction Industry Education and Training Services
CIPRO	Companies and Intellectual Property Registration Office
CITB	Civil Industries Training Board
CMIP	Consolidated Municipal Infrastructure Programme
CPD	Continuous Professional Development
CSI	Corporate Social Investment
CSIR	Council for Scientific and Industrial Research
CTCG	Construction Transformation Charter Group
DBSA	Development Bank of Southern Africa
DOE	Department of Education
DOL	Department of Labour
DPLG	Department of Provincial and Local Government
DPW	Department of Public Works
DST	Department of Science and Technology
DTI	Department of Trade and Industry
DWAF	Department of Water Affairs and Forestry
EC	Eastern Cape
ECOSOC	United Nations Economic and Social Council
ECSA	Engineering Council of South Africa
EE	Employment Equity
EPC	Engineering Procurement Construction
EPCM	Engineering Procurement Construction Management
EPWP	Expanded Public Works Programme
ESKOM	Electricity Supply Commission
ETQA	Education and Training Quality Assurance
EU	European Union
FDI	Foreign Direct Investment
FET	Further Education and Training
FIDIC	International Federation of Consulting Engineers
FMCG	Fast Moving Consumer Goods
FTE	Full-time Equivalent
GDP	Gross Domestic Product
GIS	Geographic Information Systems
HDI	Historically Disadvantaged Institution
HEQC	Higher Education Quality Committee
HESA	Higher Education Statistics Agency
HG	Higher Grade
HIV/Aids	Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome
HND	Higher National Diploma
HOD	Head of Department
HR	Human Resources
HRD	Human Resources Development
HSRC	Human Sciences Research Council
ICE	Institution of Civil Engineers
ICT	Information and Communication Technology
IDP	Integrated Development Plan
IDZ	Industrial Development Zone
IEB	Independent Examination Board
IMD	Institute for Management and Development
IMESA	Institution of Municipal Engineering of Southern Africa

IMIESA	Institution of Muncipal Ingenieurswese/ Engineering of South Africa
INCA	Infrastructure Finance Corporation
ILO	International Labour Office
IPET	Institution of Professional Engineering Technologists
IStructE	Institution of Structural Engineers
IT	Information Technology
ITS	Intelligent Transport System
JSE	Johannesburg Stock Exchange
KZN	KwaZulu-Natal
LDC	Limited Duration Contract
LED	Local Economic Development
LGWSETA	Local Government and Water Sector Education and Training Authority
LOSC	Labour Only Sub-contractors
MBSA	Master Builders of South Africa
MDG	Millennium Development Goals
MIG	Municipal Infrastructure Grant
MIIU	Municipal Infrastructure Investment Unit
NACI	National Advisory Council for Innovation
NABCAT	National Association of Black Contractors and Allied Trades
NAFBI	National Federation for the Building Industry
ND	National Diploma
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organisation
NHBRC	National Home Builders Registration Council
NPA	National Ports Authority
NQF	National Qualifications Framework
NSFAS	National Student Financial Aid Scheme
NU	Natal University
PAYE	Pay As You Earn
PDI	Previously Disadvantaged Individual
PFMA	Public Finance Management Act
PMU	Project Management Unit
PPP	Public Private Partnership
PR	Public Relations
R&D	Research and Development
RAU	Rand Afrikaans University (now University of Johannesburg)
RDP	Reconstruction and Development Programme
RPL	Recognition of Prior Learning
SAACE	South African Association of Consulting Engineers
SABS	South African Bureau of Standards
SABTACO	South African Black Technical and Allied Careers Organisation
SACAP	South African Council for Architectural Professionals
SACPE	South African Council for Professional Engineers
SADC	Southern African Development Community
SAFCEC	South African Federation of Civil Engineering Contractors
SAICA	South African Institute of Chartered Accountants
SAICE	South African Institution of Civil Engineering
SAISC	South African Institute of Steel Construction
SALGA	South African Local Government Association
SANRAL	South African National Roads Agency Limited
SAQA	South African Qualifications Authority
SAR&H	South African Railways and Harbours
SAWiC	South African Women in Construction
SC	Senior Certificate
SD	Skills Development
SET	Science, Engineering and Technology
SETA	Sector Education and Training Authority
SG	Standard Grade
SGB	Standards Generating Body
SIC	Standard Industrial Classification
SMMEs	Small, Medium and Micro Enterprises
SOAR	Stress on Analytical Reasoning
SOC	Standard Occupational Classification
SOE	State Owned Enterprise
SSP	Sector Skills Plan
SAUVCA	South African Universities Vice-Chancellors Association
TRB	Transportation Research Board
TSA	Technikon South Africa
TUT	Tshwane University of Technology
TWR	Technikon Witwatersrand
UCT	University of Cape Town
UDW	University of Durban Westville
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UJ	University of Johannesburg
UP	University of Pretoria
USA	United States of America
VA	Voluntary Associations
VAT	Value Added Tax
WITS	University of the Witwatersrand
WSP	Workplace Skills Plan
www	World Wide Web

EXECUTIVE SUMMARY

Contents

Executive summary

ABSTRACT

A great deal has been said about the lack of capacity in relation to civil engineering professionals. The nation's economy and the quality of life of its citizens depend heavily on the supply and efficient operation of infrastructure. Yet the civil engineering industry faces unprecedented challenges in attracting, recruiting and retaining the staff needed to design, manage and deliver this infrastructure, without which poverty alleviation, and ultimately its eradication, is not possible.

Transformation is also a major challenge, and concerns have been raised at national level about the limited numbers of black people in senior positions. For South Africa to be globally and technologically competitive, positive steps must be taken to create a diverse, well-trained and multicultural workforce.

Fast tracking of young graduates has been suggested, but herein lies a conundrum: it is only possible to develop capacity if there is sufficient capacity to develop this capacity! Fast tracking can only be a solution if it does not mean reduced experience and, consequently, a reduced level of competence. Alternatively, placing non-engineering staff in engineering management roles results in an inadequate understanding of the levels of service, maintenance, systems and finances required.

This document presents statistics and bottlenecks identified from 24 months of detailed research. It seeks to make practical recommendations in terms of education, learnerships, training, coaching and mentoring, as well as suggesting how to attract and retain professionals to develop sufficient civil engineering capacity to unblock bottlenecks.

INTRODUCTION

There has been a slow decline in the number of civil engineering professionals (engineers, technologists and technicians) since the infrastructure development heydays of the sixties and seventies. Reduced industry demand, reduced numbers of graduations, emigration, low rewards and engineering graduates being highly sought after by other economic sectors have meant that personnel have left the market at a higher rate than those entering through tertiary institutions and immigration.

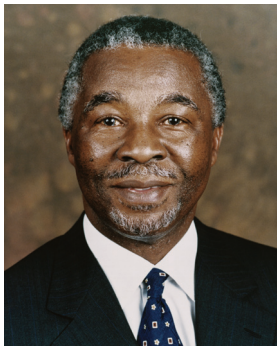
South Africa is not unique in this situation. The trend is evident worldwide. In the developing world, lack of engineering capacity is hampering development. In particular Africa and South Africa are experiencing frustrations in fulfilling their commitment to NEPAD. The New Partnership for Africa's Development (NEPAD) is a pledge by African leaders, based on a common vision and a firm, shared conviction, to eradicate poverty and place their countries, individually and collectively, on a path of sustainable growth and development, and at the same time to participate actively in the world economy. South Africa sees its role as one of leadership in the continent's recovery.

To play its role effectively the economy needs to be sound and growing, and first world economic infrastructure is a requisite to support the growth. Engineering professionals are fundamental to the development of both social and economic infrastructure. Apart from

'… Civil engineers are the Leonardo Da Vincis of the 21st Century …'

– Thabo Mbeki, 2003

Thabo Mbeki
(President of the Republic of South Africa)



electricity and communications, all infrastructure identified in the Millennium Development Goals (MDG) is the domain of the construction industry and civil engineering professionals. Their competence comes from education, training, experience and knowledge transfer through coaching.

'Scarce skills' and 'skills gaps' are the current buzz words while the country grapples with capacity issues. As with the Chernobyl and Challenger disasters, and indeed most major calamities, '*… a number of things combined to cause …*'[1] the problems. The research indicates that many fundamental activities relating to the attraction, education and training of professionals are no longer in place or are inadequate. No long-term capacity planning has been carried out. Furthermore, solid workplace training and the value of experience have been disregarded as a result of the 'lean-mean' business model of the nineties and this century.

Unless the standard of education and training from kindergarten to retirement is adequate, competence in engineering and decision making can never be achieved or maintained. Worldwide, changes in lifestyle and approaches to education and training have brought about declining results and diminishing numbers of people in the industry. Several aspects require attention, from English and mathematics in schools all the way through to tertiary education, graduate training, working conditions and continuing professional development.

The challenges facing South Africa are exacerbated by the legacy of Bantu Education and apartheid, the brain drain, and the need for rapid transformation.

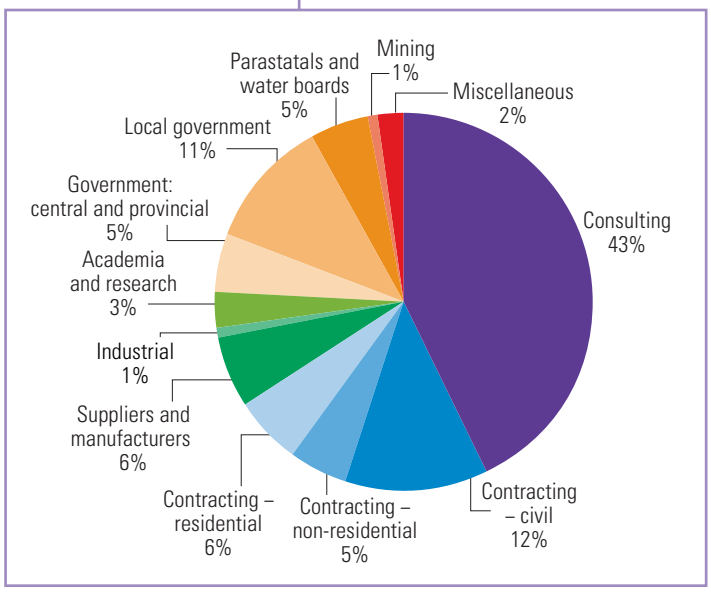
THE STATUS QUO

1.1 Demand

Civil professionals are employed in many sectors (see Figure 1). All sectors reported staff shortages, particularly of experienced mid-career professionals who are required to execute major projects and transfer knowledge to junior staff.

Further, the current ratio of university to technikon graduates does not match the number absorbed in industry and points to a need to produce more university graduates.

Figure 1 Distribution of civil professionals per sector



It was found that across the board experienced and mid-career professionals regularly worked extremely long hours, with 15% regularly working more than sixty hours per week. These staff are generally highly qualified with 40% holding postgraduate technical qualifications and 30% holding postgraduate business or project management qualifications.

1.1.1 The private sector

The consulting sector reports that the current workload and continual reduction in staff has meant that capacity utilisation is now over 90% on average and in excess of 100% in many practices. Over 80% of the consulting practices were seeking experienced engineers. In terms of equity goals, all were searching for black engineers. Fifty per cent were also looking for technicians and technologists.

In considering the viability of the huge investments required to develop and upgrade the transport network, the Department of Transport estimates than an additional 945 to 1 890 staff will be required by consulting practices in the private sector within the next few years. This translates roughly to a 7,5% to 15% increase, that is, 450 to 900 more engineers, technologists and technicians will be required. They also suggest that an additional 310 to 3 060 highly skilled staff would be required by contracting companies in the private sector. In terms of civil engineering this could mean 100 to 1 000 more engineers, technologists and technicians, a 5% to 50% increase in the number currently employed in civil engineering contracting.

1.1.2 The public sector

Shortages in all tiers of government are even more acute

Local government has been particularly hard hit as a result of a number of factors including budget constraints, restructuring, increased bureaucracy and pursuing equity targets.

A census of all local and district municipalities and metros yielded the following statistics:

- **No civil professionals**
  - Of the 231 local municipalities 79 have no civil engineers, technologists or technicians
  - Of the 47 district municipalities 4 have no civil engineers, technologists or technicians
- **Only one civil technician**
  - Of the 231 local municipalities 42 have only one civil technician
  - Of the 47 district municipalities 4 have only one civil technician
- **Only young staff**
  - Of the 231 local municipalities 38 employ only technologists and technicians under the age of 35
  - Of the 47 district municipalities 6 employ only technologists and technicians under the age of 35
- **Only 70 with civil engineers**
  - Only 45 of the 231 local municipalities have any civil engineers
  - Only 25 of the 47 district municipalities have any civil engineers

Those municipalities that have civil engineering staff report 35% vacancies, the freezing of many posts owing to budget constraints, and little or no capacity for the project management units (PMUs) that have been set up to handle the Municipal Infrastructure Grant (MIG). Metros on average reported 45% vacancies. These vacancies mean that at least 1 000 civil engineers, technologists and technicians are required in local government

Shortages in provincial and central government are no less acute. Provincial structures reported posts that have been vacant for seven years and more. The Department of Transport suggests that an additional 70 to 710 highly skilled staff will be required to support their increased expenditure.

The increased investment and activities to address the water and sanitation Millennium Development Goals (MDGs) will also require a great deal of increased capacity.

Parastatals reported significant vacancies. Transnet is particularly concerned about its capacity to deliver the new and upgraded infrastructure that is required. The total number of technical staff currently employed by Spoornet is less than half the number that was employed on the construction of the Witbank-Richards Bay Coal Line alone.

Adding up these estimates, it can be concluded that between 3 000 and 6 000 additional civil engineers, technologists and technicians may be needed in the next few years.

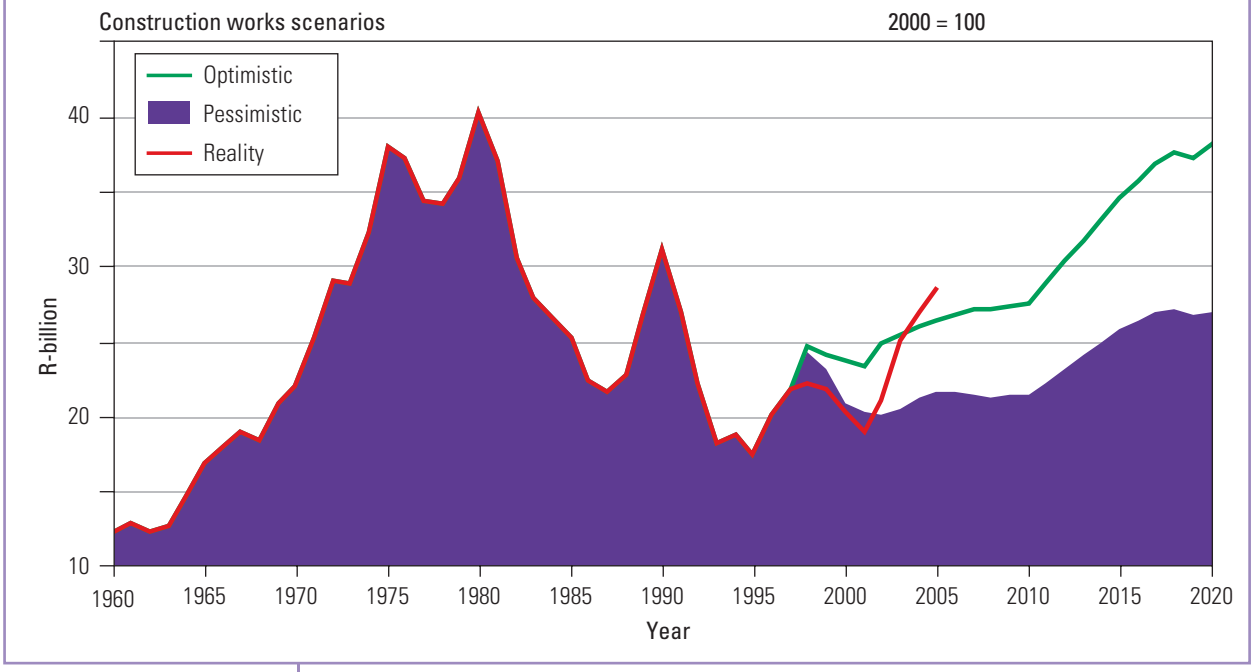


Figure 2 Spending in civil engineering construction, actual and projected, 1960–2020

1.1.3 Growth and capacity

Given that R200 billion or more is to be spent on infrastructure in the next five to seven years, the view is that the civil engineering industry is entering a long-term growth phase. This growth will continue beyond 2010 because an expansion of infrastructure, upgrading of basic services and maintenance of the much extended network will be required.

This growth was predicted as far back as 1998 by a study commissioned by Pretoria Portland Cement, to predict the long-term demand for cement. (See Figure 2.)

The actual performance plotted in Figure 2 shows that the predicted turnaround has

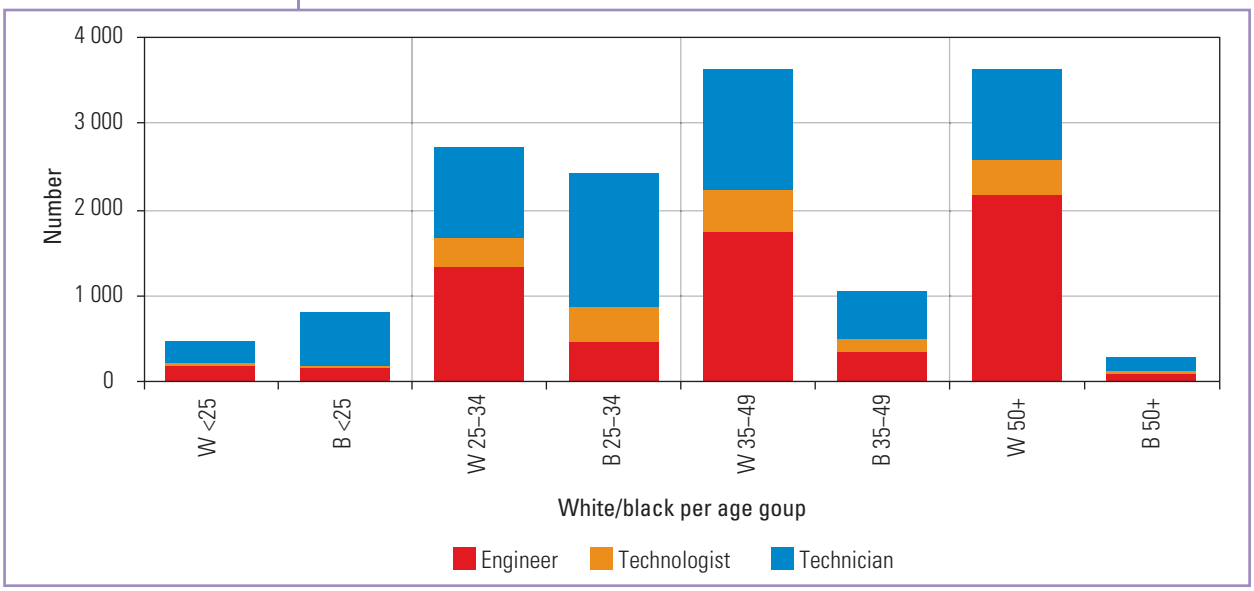
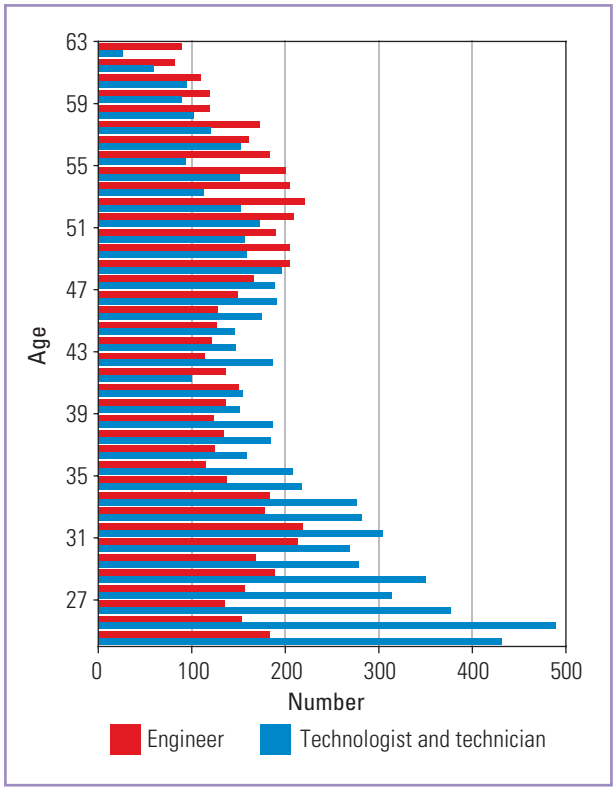
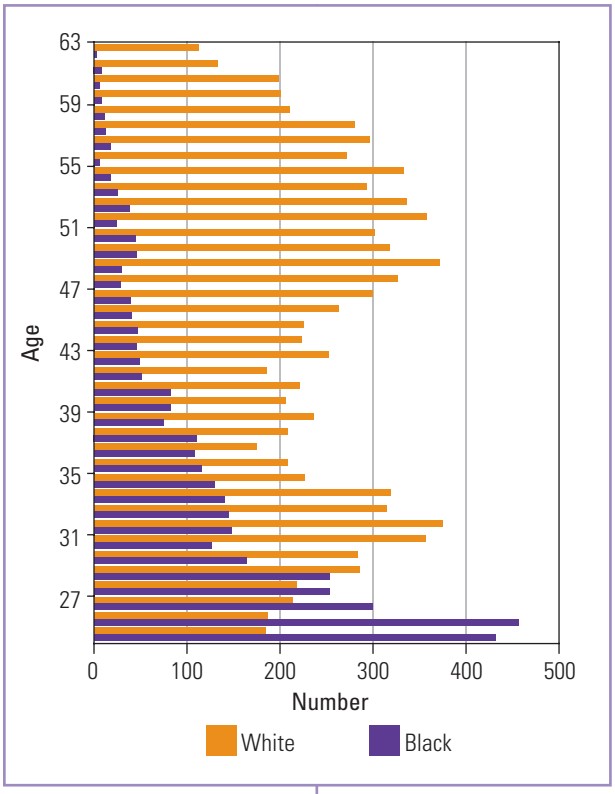


Figure 3 Civil engineering professionals employed in South Africa, by age, group and qualification, 2004





Left *Figure 4 Distribution of civil professionals by age and qualification*
Above *Figure 5 Distribution of civil professionals by age and race*

begun. The challenge is to ensure that there is sufficient capacity to cope with the dramatically increased workload, because achieving these optimistic predictions is not possible with the current number of professionals.

If appropriate interventions are not made now, the projected growth will not be achieved and, worse still, continued vacancies in local government will mean that existing infrastructure will be rendered worthless. Protests relating to lack of service delivery as have been witnessed in 2005 could become commonplace.

1.2 Supply

Around 15 000 civil engineering professionals are currently practising in South Africa. The profile is presented in Figure 3. The model is easier to understand from Figures 4, 5 and 6, by considering qualification, group and gender separately.

The profiles show three major trends as follows:

1.2.1 Transformation

The first trend is the dramatic transformation in the demographic and, recently, the gender profile of the profession. Black students represented 78% of the civil engineering student profile in 2004. Twenty five per cent of the student population were female. These young people must receive the necessary training to become experienced senior professionals in time.

1.2.2 Qualifications

The second change has been the reduction in the number of university-educated professionals in favour of technikon education.

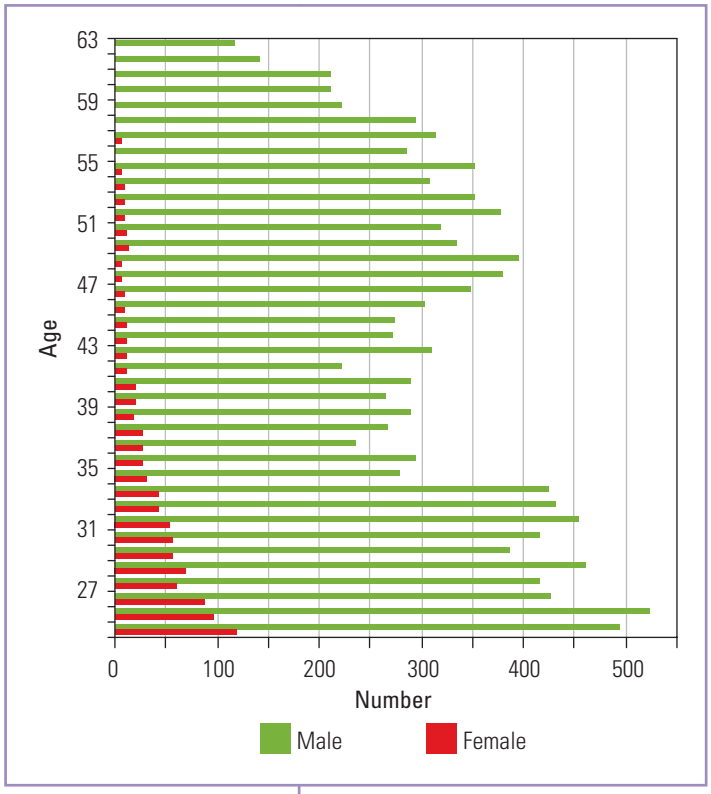


Figure 6 Distribution of civil professionals by age and gender

In many countries engineering degrees are being extended by one year to address increasingly advanced technology and the complexity of service delivery. It is incongruous that South Africa should be expected to compete globally and deliver appropriate solutions locally, with a reducing number of highly qualified professionals.

1.2.3 The age gap

The third concern is age distribution. The current profile does not represent the normal distribution, but shows a large group of experienced engineers in their late forties and older, and a large group of young technicians, with limited numbers in between. This presents many problems:

- There are insufficient mid-career staff to carry out production work
- Senior staff, rather than attending to strategic issues, continue to carry out production work and do not have time to train or supervise young professionals
- A large percentage will be retiring in the next ten years, further reducing capacity in the industry

The age profile problem is not unique to South Africa. A Canadian report on capacity in the transport sector[2] states that '*… the bad news is that a lot of senior experience will be lost in the short term …*'. However, elsewhere in the world retirement ages are being raised to retain the expertise, while increasing numbers of young people are being trained. By contrast, in South Africa this expert group is being retired early mainly owing to equity targets.

THE CHALLENGES

1.3 Bottlenecks – capacity supply chain

It takes many years and a rigorous process before a civil professional reaches the level of competence currently required in the industry. To address the shortages, actions urgently need to be taken to ensure an adequate flow of entrants into the industry. Unfortunately there are bottlenecks at every step of the way, as outlined below:

1.3.1 Matric maths, science and English

Many professions, including civil engineering, require competence in these three subjects. To qualify for university entry, matriculants are expected to attain an A, B or C in higher grade maths. Few achieve this (see Figure 7) and competition for this select group is fierce from many other engineering disciplines as well as medicine, accounting and the natural sciences.

A great deal of work needs to be done to increase the numbers passing with better results, particularly black learners.

Interventions are proposed in Chapter 4, such as selecting and nurturing learners in Grades 11 and 12; instituting a well-coordinated nationwide career guidance campaign

aimed at all schools in which learners are successful in maths; improving teacher skills; and in the long term reviewing the curricula and re-introducing some of the teaching methods used before the introduction of outcomes based education.

1.3.2 Tertiary education

Having achieved the results required for tertiary education, students still face many hurdles before graduating. The drop-out rate is very high – up to 70% at some institutions. The most pressing problems are as follows:

- Students are ill prepared for tertiary education, particularly those from disadvantaged schools and rural communities
- Bursaries are very limited, particularly for first-year students and in many cases funds are insufficient to cover all the student's expenses or are available only halfway through the year.
- The volume of work is excessive considering the time frame for all but the top students
- Student to staff ratios are extremely high in some departments
- At universities, second year also appears to be a major challenge, and students require substantial dedicated support
- Many technikon students are unable to gain experiential training owing to a lack of workplace opportunities. They therefore cannot graduate
- Industry complains about the poor quality of technikon graduates. It appears that the entrance criteria at some technikons are too low and students graduating with low marks cannot be utilised by industry

Interventions are suggested in Chapter 5, including the introduction of entrance testing; career counselling; better structured bursaries; more funding and energy being applied to foundation courses; increased numbers of lecturers; lecturer training; curricula reform; monitoring and mentoring of students; and linking students with industry from the beginning of their studies.

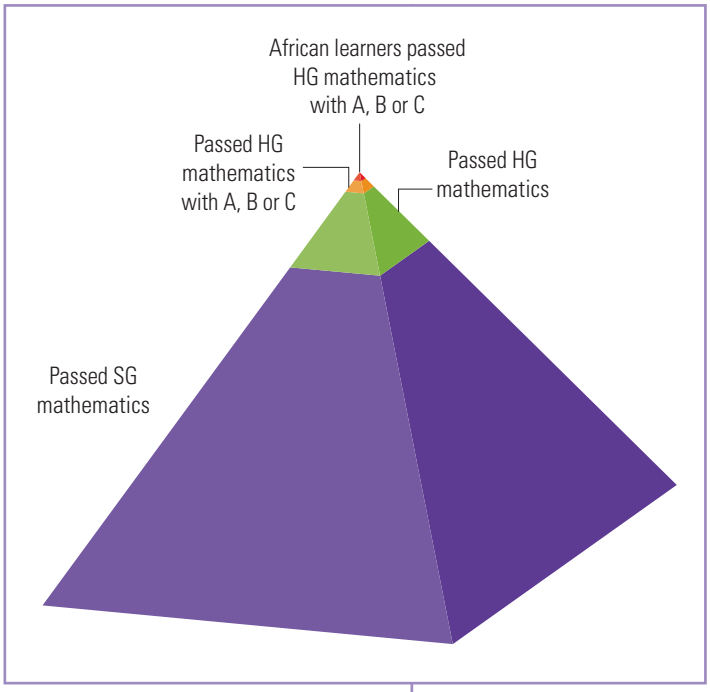


Figure 7 Percentage passing matric maths in 2003

1.3.3 Challenges facing graduates in the workplace

Having graduated, new entrants to the workplace face many more challenges before they can become technically competent and progress in their careers.

The lean-mean approach to business and the shortage of mid-career production staff has meant that young graduates are seen from the outset as resources to assist with production. As a result, in many companies they are taught one particular skill. They are then locked into production, using only that skill for months or even years and make no progress to maturity in the profession.

(a) Workplace training

The recommended ECSA process requires exposing graduates to a range of experiences to develop competence in the project cycle. This guideline is rarely followed, which means

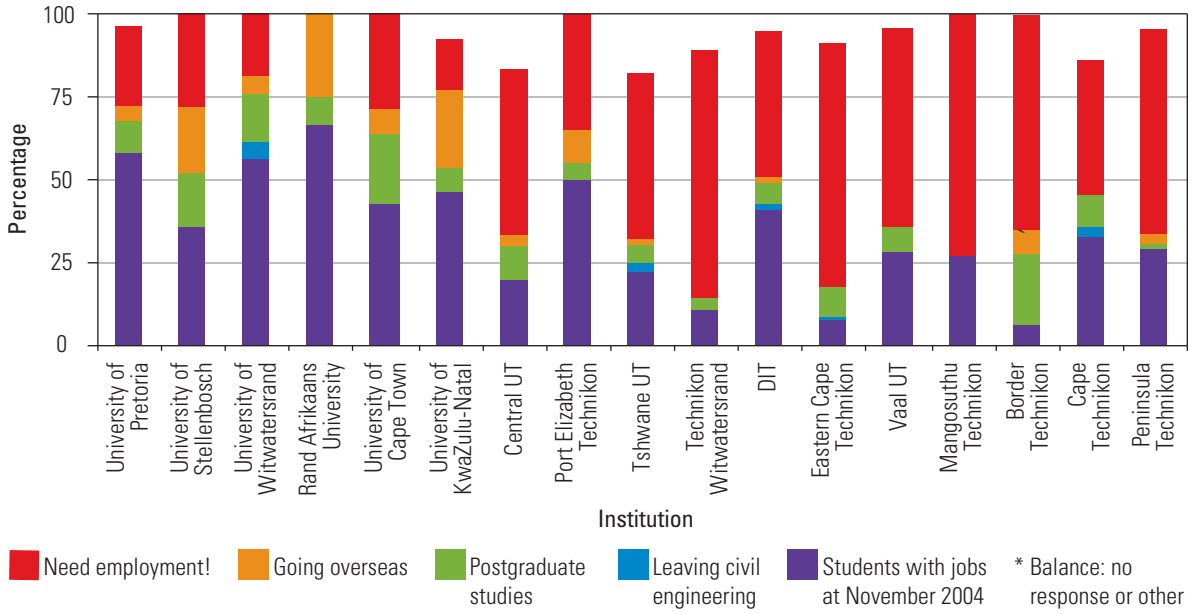


Figure 8 Success in finding employment for 2005 – final-year civil engineering students, October 2004

that graduates have difficulty in obtaining professional registration, cannot progress and often leave the industry.

Of particular importance is the number of graduate technicians who are unable to find work because there are too many technicians to train in relation to the number of senior staff to supervise or coach them. (See Figure 8.) Because there are so many vacancies in state organisations, it is recommended that posts should be filled by teams consisting of a recently retired senior and two or three young graduates. The senior should be tasked with training the graduates, as well as initiating and managing the many projects for which there is currently no capacity. If these graduates are trained against learnerships, employers would be able to claim some of the cost of training from the Sector Education and Training Authorities (SETAs).

(b) SETAs and ECSA

One of the major frustrations is the lack of understanding of NQF 6 and higher demonstrated by the SETAS and the lack progress made by the various SETAs and ECSA regarding the development of candidate engineer, technologist and technician learnerships. Learnerships would go a long way to addressing industry's resistance to funding graduate training.

The Skills Development Levy is viewed as a tax because it is felt that little support has been given to the professions. Rigid application of the South African Qualifications Authority (SAQA) requirements for qualifications and learnerships does not suit the training of tertiary graduates or continuing professional development.

Chapter 6 is devoted to workplace training and retention strategies for young graduates.

1.3.4 Retention in the workplace

The conditions of employment of professional staff have deteriorated over the years and have now reached crisis situation. Staff retention has become a major problem. The more serious aspects are outlined below:

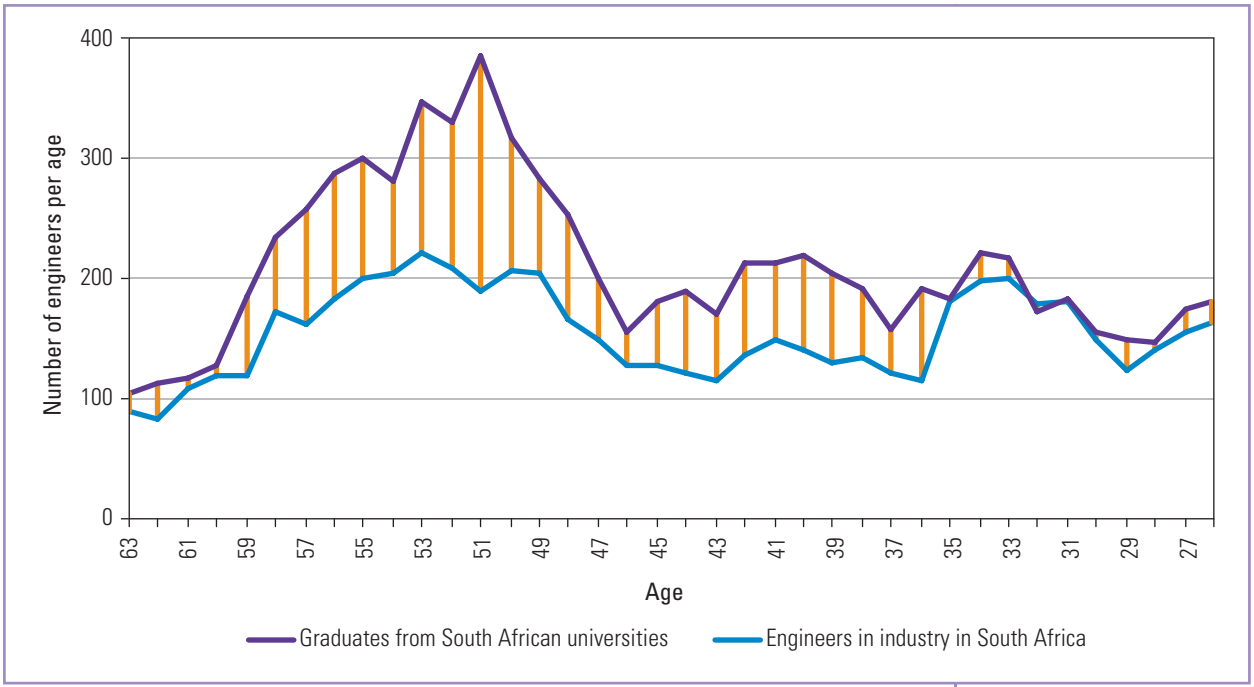


Figure 9 Civil engineering graduates versus civil engineers active in the industry, by age

- Salaries are well below those earned by other engineering disciplines and other employers of graduates, for example legal and financial
- The average working week is 53,5 hours with a significant number of staff working in excess of 60 hours a week without additional compensation. Civil professionals therefore contributed a complimentary R 1,1 billion to the South African economy in 2004
- Globalisation and emigration are growing problems. By 2002 the number of civil engineers emigrating annually matched the number graduating
- Senior staff in all organs of state continue to be offered early retirement packages, in order to address the equity challenge. Since black students began to enter tertiary institutions in significant numbers only from the mid-nineties, there are few experienced black professionals to fill these posts. The posts remain empty, or are filled by inexperienced young graduates or non-technical staff who are unable to train juniors, or drive the roll-out of projects. This 'social' engineering is having a detrimental effect on service delivery.

Succession planning is essential to ensure that protégés are developed to take over from those retiring.

(a) Losses and job creation

Figures 9 and 10 indicate the number of civil engineers, technologists and technicians educated in South Africa and the number employed in all sectors of the civil engineering industry at the end of 2004. At least 6 000 educated and trained staff who have graduated since 1963 have been lost to the industry. A large percentage have emigrated, and the balance have taken early retirement, or moved into other, more lucrative sectors. This number is similar to the estimates given in the Demand section for additional staff which may be required.

The construction industry employs some 400 000 people. In local government and water boards a further 125 000 or so are involved in civil engineering infrastructure. The ratio of civil engineers and technologists to the workforce is therefore roughly 1:60. For every

civil engineer or technologist who leaves the industry, ultimately 60 jobs are lost.

Government has identified job creation in the construction industry as one of the saviours of the economy. But as long as the bleeding of civil engineering skills is allowed to continue, jobs will be lost. The opposite is also true. Increasing the number of engineers and technologists will support the creation of more jobs.

South Africa cannot afford to lose any more civil engineering professionals. Chapter 7 explores retention strategies, including scarce skill and regional allowances, salary increases, overtime payment and other interventions. Every technique possible must be used to retain, attract and train. The current skills base and more are needed to address the huge development challenges facing the country.

1.4 Bottlenecks – infrastructure delivery

For consistent levels of development, and hence spending, to take place, a number of factors must be in place. These include:

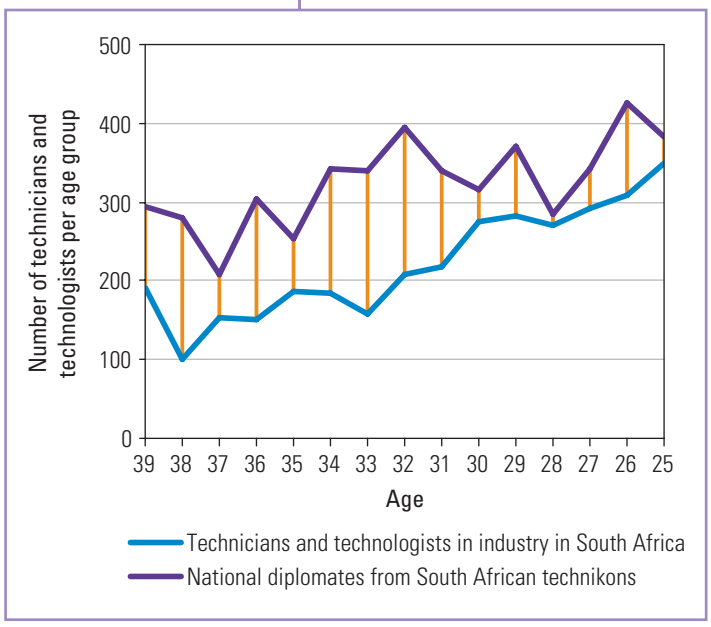
- Growth
- Availability of finance
- Policy conducive to development
- Institutional capacity
- Favourable interest and exchange rates

Private sector development is buoyant as low interest rates and the availability of finance have fuelled consumer spending.

Public sector development is governed by the availability of finance, policy and the availability of capacity.

South Africa boasts a model constitution, progressive legislation and has taken the lead role in developing a master plan to combat poverty on the African continent. Although government has published many ambitious development plans and has assigned funds accordingly, they are not being spent. Infrastructure development is not taking place at the required rate as massive and ongoing restructuring within state organs, complex and extensive legislation and a lack of capacity give rise to bottlenecks that hamper these developments.

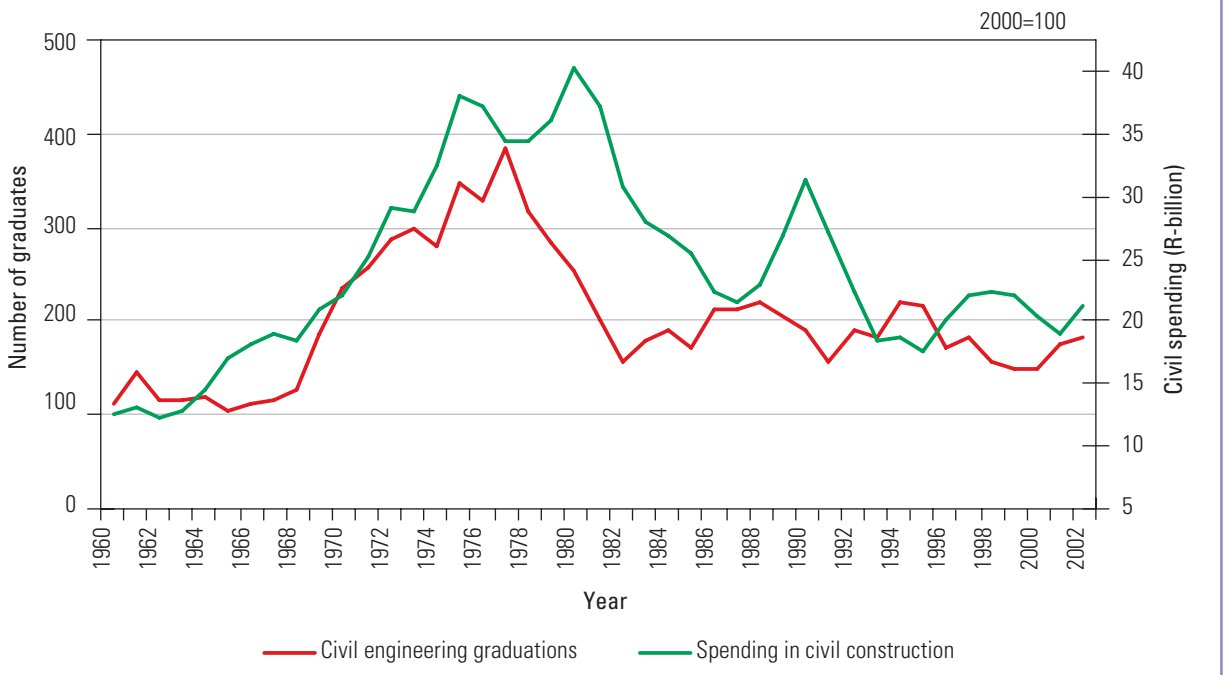
Figure 10 Civil diplomates versus civil technicians active in the industry, by age



1.5 Bottlenecks – Black Economic Empowerment

The need to create opportunities for previously disadvantaged individuals (PDIs) of the past has been addressed by affirmative procurement. This gave rise to fronting and little broad-based empowerment. The new Broad Based Black Economic Empowerment (BBBEE) strategy represents a maturing approach to empowerment that actively engages the private sector to develop black people at all levels and across all disciplines so that they may take their places as owners and experienced senior management. In terms of developing experienced capacity, transformation will be achieved through targets set for:

- Skills development
- Enterprise development



SAFCEC, DOE and universities

Figure 11 Civil engineering graduations compared with civil spending, 1960–2002

- Corporate social investment

The public sector should review the education supply chain and also set targets per age group rather than try to force transformation at all levels, whether skills are available or not. Graduation profiles over 43 years were collected for engineers and graduation figures for technicians are available over a 17-year period from the DOE. These can be used as a basis for setting realistic targets for professional placements.

1.6 The numbers required

Civil engineering graduations in the past closely tracked civil spending (see Figure 11). Since civil spending is on the increase once more, it is essential that there should be a commensurate increase in the number of graduates. Further, to compensate for the disproportionate number of retirements expected to take place in the next 5–10 years, additional graduates are required.

Unfortunately mounting career awareness campaigns now will not yield experienced professionals in fewer than seven years (four years to graduate and a minimum of three years to register with ECSA). While numbers entering universities must be increased, and more technikon students must be offered employment, the short-term solution will be to:

- Retain existing staff and entice those who have left the industry to return by improving remuneration
- Encourage experienced mid-career South Africans living abroad to return to carry out the production functions
- Extend rather than reduce retirement age
- Encourage retired capacity back into the profession to train young graduates and manage projects
- Set realistic equity targets

1.7 International trends

Many of the frustrations experienced in terms of capacity are not uniquely South African.

Challenges that are witnessed all over the world include the ageing profile, school-leavers not being tertiary ready, reducing numbers entering civil engineering faculties and urbanisation placing great demands on local government.

However, South Africa is unique in that the majority, rather than minorities, were excluded from economic activity, so there is a massive backlog in schooling, housing, community services and infrastructure for the majority. The dual economy further complicates matters as the requirement for economic infrastructure to be globally competitive adds to the demands for development.

In many instances new approaches adopted have been based on changes that were made in the Western world. But because these are developed countries, their models are not necessarily a good fit with South Africa. In other instances South Africa adopted inappropriate models or international reforms and structures before they were tried and tested. South Africa cannot afford to be part of the guinea pig process, and should wait to ensure that reforms elsewhere produce solid results or benefits.

South Africa is unique and must develop its own unique solutions.

In the words of President Mbeki,[3]

'… the African renaissance can only succeed … if its programmes are designed by ourselves …'

CONCLUSIONS

There is a critical shortage of experienced civil professionals, particularly mid-career civil engineers responsible for production work. Technicians, and to a greater extent technologists, may be used to fill some of the gaps, provided that the quality of technikon graduates improves and industry plays a bigger role in training all young graduates. Further, loss of experience and knowledge must be reversed at senior levels.

Training is an imperative. Significant effort must be put into education and training from kindergarten to retirement to ensure and maintain an adequate supply of high-calibre professionals. Retired professionals should be harnessed to assist with workplace training to develop the rapidly transforming pool of graduates. South Africans abroad or who have left the industry need to be encouraged to return to address the increasing shortages identified.

From a desktop survey in support of the field research it was distressing to note that all the problems outlined have been raised over and over again, over many years, but little attention has been paid to the millions of rand's worth of reports that are simply gathering dust. It is encouraging to observe a new-found interest and will by leadership at the highest levels to address these issues.

What will happen if the interventions are not made and the status quo is perpetuated into the future?

- Delivery will not be possible and poverty will be endemic in South Africa
- If adequate water and sanitation infrastructure services are not supplied, waterborne diseases will reach epidemic proportions
- An increase in transportation gridlock and congestion in ports will hamper trade
- Political instability will occur, because the growth rate of 6% and job creation will be not be achievable
- Engineering will become a career of last choice for adequately qualified matriculants

- Continual loss of skilled capacity through early retirement, emigration, and moving to other sectors will require South Africa to become a nett importer of engineering skills to the detriment of the rand, investor confidence, the economy and the infrastructure since local knowledge and understanding is imperative in civil engineering

It is hoped that by having quantitative data to back up the many recommendations, interventions may be implemented with confidence, and that the country will start to see a reversal of the looming capacity crisis. To succeed will require a collective effort involving political will and the cooperation of all tiers of government, the private sector, academic institutions and the civil engineering workforce. In the words of Dr Shirley Malcolm of AAAS in Washington, when addressing the CSIR[4] recently,

'*… we need … to understand that none of us will move forward unless all of us move forward …*'

Let us all move forward, together!

Building blocks

Before considering the actions needed to address the shortages identified, the supply and associated constraints covered in Chapters 4 to 7 must be understood. A prerequisite is an adequate supply of well-trained professionals. This requires an adequate supply of:

- High-calibre matriculants
- High-calibre graduates from tertiary institutions
- Entrants into the profession
- Employment opportunities and workplace training
- Projects to sustain employment of the human capital in civil engineering
- Continuing professional development

RECOMMENDATIONS

The much-debated skills shortage in terms of civil engineering professionals is real and requires immediate action, which includes increased funding to address the many issues listed below.

Reconstruction required

Interventions required to ensure that the building blocks are in place are discussed in detail under each chapter. A summary follows of the most important short, medium- and long-term interventions that must be initiated immediately:

Short term

- Retain senior professionals and appoint retired professionals to supervise and train young graduates and initiate and manage projects
- Review conditions of employment including remuneration, qualifications, grading, responsibility, authority and employment equity targets
- Attract people back into the industry
- Re-introduce structured workplace training throughout the industry

Medium term

- Increase the number of technologists
- Improve the employability of national diploma graduates
- Implement comprehensive succession planning and associated training

Long term

- Increase the number of graduate civil engineers

Suggested Construction Charter activities

The Construction Charter scorecard covers BBBEE in a holistic way. The charter will therefore be an effective vehicle to guide and inform the process of transformation. By attending to each of the points above, employers would have addressed:

- Employment equity by developing young black professionals
- Skills development by providing training
- Enterprise development by supporting fledgling companies
- Corporate social investment by providing bursaries, mentoring young graduates, carrying out career guidance and assisting with the development of schools.

NOTES

1 What actually happened at Chernobyl, http://www.dne.bnl.gov/atd-mag/chernobyl.html

2 S L Tighe, A Jeffrey and R Haas, *Managing our knowledge assets in pavement and transport engineering* 6th International Conference on Managing Pavements, 2004 Australia p 5.

3 Mbeki T, *Africa, the time has come,* Tafelberg, Cape Town, 1998.

4 S Malcolm, Science and technology: meeting human needs, presentation to the CSIR, Pretoria, 2005.

PART I
INTRODUCTION

Contents

CHAPTER 1

Scope and definitions

INTRODUCTION

Too few, too many
No experience – can't get a job
No job – can't get experience

Debates rage over the number civil engineering professionals that are required and available to design, manage and deliver the infrastructure so desperately needed to address poverty alleviation and eradication. In her role as president of the South African Institution of Civil Engineering (SAICE) in 2000 the writer was made aware of the heart-rending problems facing many technikon students who could not find experiential training or work after graduation. Those who participate most vociferously in debate tend to quote single anecdotes, which they generalise across the industry.

To deliver the appropriate services, the Construction Education Training Authority (CETA), being responsible for skills development, and the South African Institution of Civil Engineering (SAICE), for technology transfer, needed to understand the dynamics in the sector. In the words of Maria Ramos:

> *'… Unless you measure, you do not know where you are going or how you are going to get there …'*[1]

The project was initiated to gain a clear understanding of the numbers available and need for civil engineering professionals in South Africa.

The study began early in 2003 as a SAICE centenary initiative, and was expanded as more and more problem areas were identified. The bulk of the data was collected in 2004. The results provide essential information for developing national strategies and interventions to address the gaps.

The document was initially intended as an internal report to inform CETA and SAICE. Hence the style of the document is somewhat informal. Having become so extensive, it was decided to publish the material to provide guidance for all in the industry. The findings and recommendations will be of value to management, HR practitioners, educators, trainers, decision maker, politicians and civil engineering employees. The document is structured and colour coded as follows:

Executive summary

Part I: Introduction	Chapter 1 Scope and definitions
Part II: Demand	Chapter 2 The private sector Chapter 3 The public sector

'… Unless you measure, you do not know where you are going or how you are going to get there …'

– Maria Ramos

saice

Part III: Supply	Chapter 4 Secondary education
	Chapter 5 Tertiary education
	Chapter 6 Graduates
	Chapter 7 Professionals
Part IV: Drivers and inhibitors	Chapter 8 The private sector
	Chapter 9 The public sector
Part V: Conclusions	Chapter 10 Numbers and needs
	Chapter 11 The way forward

OUTCOMES

Implementing the many recommendations in this document will result in:

- Improved education
- Improved training opportunities and procedures
- Improved attraction and retention of staff, hence improved capacity
- Improved salary levels
- Significant transformation
- Improved infrastructure delivery, operation and maintenance

SCOPE OF THE PROJECT

1.1 The civil engineering professional

The professional team in the construction sector comprises many disciplines. These include architecture, building science, civil, environmental, electrical and mechanical engineering, construction and project management, land survey, quantity survey, social science and town planning.

Although this study looks only at civil engineering, the findings generally apply to all professions in the built environment and other engineering disciplines such as agricultural, chemical, electrical, mechanical, and mining engineering. Integrated solutions to these problems must be urgently implemented. All fields are facing problems with numbers, transformation and new ways of doing business.

Civil engineering professionals are classified according to their academic qualifications and/or their status with the Engineering Council of South Africa (ECSA), they comprise the following:

- **Civil engineers:** Those with a BSc or BEng degree or higher, and/or registered as Pr Eng
- **Civil technologists:** Those with a BTech, M Dip Tech or higher, and/or registered as Pr Tech Eng
- **Civil technicians:** Those with a national diploma or equivalent from one of the universities of technology (previously known as technikons) and/or registered as Pr Techni

A number of senior professionals achieved ECSA registration through other courses of study and experience, and recognition of prior learning (RPL). For instance, by continuing with supplementary theoretical studies, artisans who worked their way up through the ranks are registered with ECSA and bring valuable experience to the professional team.

Although head counts of other technical staff were captured, such as artisans, draughtsmen and tracers, those with certificates and short-course qualifications were not studied in

depth unless they subsequently registered with ECSA or qualified as engineers, technologists or technicians.

1.2 Education and training

To understand demand and supply it was necessary to consider the entire civil engineering career path, literally from cradle to grave. The terms 'education' and 'training' are taken to mean the following:

- **Education:** Studies in any Department of Education institution, such as primary, secondary and tertiary institutions, including universities and universities of technology. Since much of the research work was carried out prior to the formation of universities of technology, institutions educating technicians and technologists are referred to as technikons in this document.
- **Training:** Practical development after graduating. This can take the form of workplace training or attending some of the many practical courses offered in industry to improve proficiency in the workplace.

1.3 The infrastructure development industry

Before describing the current supply and demand status, an understanding of the whole infrastructure environment is required. Many sectors employ civil engineering professionals (see Figure 1).

In the past, research was generally focused on members of the South African Association of Consulting Engineers (SAACE) and the South African Federation of Civil Engineering Contractors (SAFCEC), ignoring 40–45% of the civil professionals in the country.

Contracting activities are not limited to civil engineering earthworks and infrastructure development, but extend to residential and non-residential development, as well as structures for the industrial, chemical and mining industries.

The state, acting in a variety of roles as client, consultant and contractor, also employs significant numbers of civil engineering professionals. The overall numbers and needs have never been investigated in detail and documented, although they impact significantly on skills development and the country's ability to deliver infrastructure.

1.4 Other disciplines

The scope of the project was to understand the supply and distribution of civil engineering professionals, but it was hoped that the HR questionnaire would provide an understanding of all employed in the sector (see separate methodology report, which is available on request from the author). This covered all engineers, technologists, technicians, draughting and administrative staff, as well as trade workers and site staff. Industry appeared to find this amount of data too onerous to report and the response was extremely poor. When the questionnaire was shortened, data became readily available. The full sets of data from some of the major organisations, however, give insight into the other disciplines working in the sector.

1.5 The Construction Charter

As far back as 1995, Minister Stella Sigcau, then Minister of Public Enterprises, challenged the reputedly shocked grey-haired men at Denel to transform or else …! Today, as Minister of Public Works, she is still issuing challenges as she drives the Construction Charter process.

The industry is currently polarised into fragmented black and white groups with a proliferation of fronting, which resulted because ownership has been the main criterion of empowerment since 1994. The development of knowledge, skills, business expertise and financial muscle has been neglected. This situation should be rectified by the balanced scorecard approach. The construction industry is a national asset that is essential for growth in gross domestic product (GDP) and employment, as well as for poverty alleviation. It must become a strong, cohesive sector able to achieve speedy delivery of basic services.

By the time the charter is complete, industry stakeholders, including consultants, contractors, labour and government, from all disciplines in the built environment will have spent two years defining the indicators and negotiating the targets and weightings. To help develop realistic targets, the parameters were incorporated into the research.

1.5.1 The company size

The sizes of enterprises for the purposes of the charter are defined in Table 1.1.

The challenge that faced the negotiating team was to address the needs of all sizes and types of companies. Nationally, only about 3% of companies employ 50 or more staff. Much of the attention of the charter has been focused on these companies. They employ 50% of the permanent staff in the sector.

The national and construction sector company profiles are similar for micro and large companies (see Figures 1.1 and 1.2). The many micro and small companies require relaxation in terms of the inordinate amount of paperwork required, and the inability of white micro organisations to comply with ownership and executive management targets and of emerging companies to meet the proposed level of skills development.

1.5.2 The indicators

The Construction Charter highlights the need for skills development and training in the sector, as well as mechanisms for facilitating the growth of small black-owned businesses. Ignatius Jacobs, Gauteng MEC for Public Transport, Roads and Works, stated:

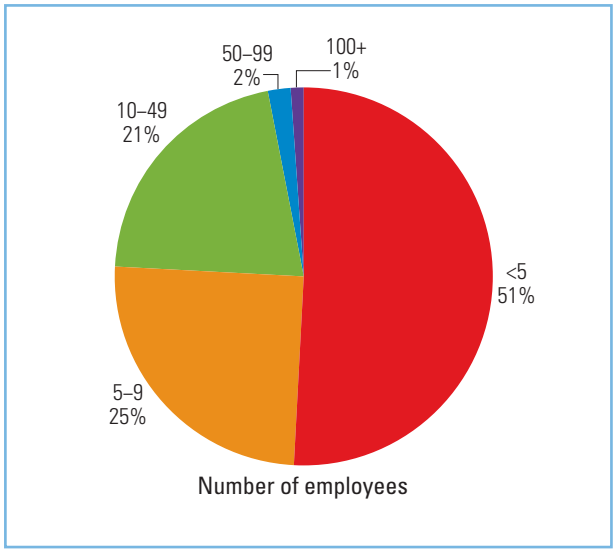
> *'… my goal is that when my term ends, there will be four or five major black players in the construction industry …'*

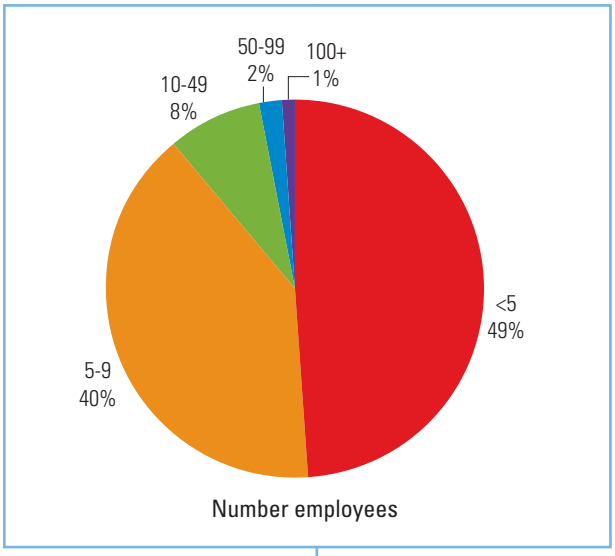
Owing to the limited numbers of experienced black professionals, it has been recognised that the black economic empowerment (BEE) efforts of the past did not encourage the systematic development of a transformed workforce. Over and above ownership and control, the Construction Charter is being developed in line with the Broad-Based Black

Table 1.1 Company categories for consideration by the Construction Charter technical teams

BUILT ENVIRONMENT CONSULTANTS		
Type	**Turnover**	**Staff**
Micro	<R300 000	<3
Small	R300 000–R3 million	3-9
Medium	R3 million–R36 million	10-100
Large	> R36 million	>100

CONTRACTORS		
Type	**Turnover**	**Staff**
Micro	<R1 million	<6
Small	R1 million–R12 million	6-60
Medium	R12 million–R60 million	61-300
Large	>R60 million	>300





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Left Figure 1.1 Size of companies in the construction sector, 2004
Above Figure 1.2 DTI estimates of all active companies by size in South Africa, 2004

Economic Empowerment (BBBEE) Act (Act 53 of 2003) to reward companies for their efforts in:

- **Skills development:** Including the provision of bursaries, support of learnerships, experiential and workplace training, and continuing professional development
- **Employment equity:** Dealing with the development of black people (including black women) into junior, middle and senior management roles. This capacity would enable them to assume ownership and control with the necessary experience and authority to be successful
- **Mentorship:** Points will be given if a recognised mentorship programme is in place to ensure the career path planning and development of black staff
- **Enterprise development:** Including coaching, management and financial support, to develop fledgling black-owned consulting and contracting companies
- **Procurement:** Companies will be encouraged to ensure that their suppliers subscribe to the principles of BBBEE
- **Corporate social investment:** Non-marketing investments aimed at black groups, communities and individuals that contribute towards transformation, for instance development of schools, clinics, water supplies, housing, sport facilities, career guidance, support of arts, culture, literacy, school maths and science, support of students (over and above bursaries), support of tertiary institutions, and HIV/Aids programmes.

Four to eleven indicators per element, totalling some 35 indicators, will be measured annually and rated in terms of the scorecard. Scoring will be low if skills development does not take place. Progress will be monitored and the targets will be revisited in three years from the effective date. With so many indicators that ensure broad-based development, the MEC may find that the major black companies he dreams of may not have had to start from scratch, but are existing companies which have been empowered through major transformation.

The charter will have the added benefit that a uniform set of criteria will be applied to all contracts. (Currently each client imposes its own empowerment and procurement criteria.) This should prevent fraudulent assessment of compliance and awarding of contracts by manipulation, a problem that recently hit the headlines.

RESEARCH COMPONENTS

This report examines the current status in education, training and capacity in the construction sector. The following areas were investigated:

1.6 Demand

- HR statistics covering civil engineering professionals and, where possible, supporting staff

1.7 Supply

- Matriculation statistics
- Tertiary enrolments and graduations
- Graduate Retention
- Attraction and retention of professionals

1.8 Drivers and inhibitors

- Private and public development and spending

1.9 Methodology

The method included an initial review of background documents in the industry, in-depth interviews with key players and leaders in consulting, contracting, local, provincial and national government, and workshops nationwide. Push and pull factors, organisational, institutional, cultural and personal factors were probed for.

Additional surveys were carried out to address gaps in the initial interviews and workshops. Many surveys were undertaken to gather quantitative and qualitative information to build a comprehensive model. These included:

1.9.1 SAICE/CETA Built Environment Survey for input into the Sector Skills Plan (SSP), March 2004

- Corporate profiles
- Personal profiles
- Student profiles

1.9.2 SAICE/CETA project, 2004–2005

- HR composition of companies including contract staff currently on the books
- Management views on a number of aspects of capacity and skills development
- Personal views on success factors and problems within the industry, including education parameters
- First-year and final-year civil engineering student status, problems and views
- Employment opportunities

1.9.3 Construction Charter research, 2004–2005

- Ownership, equity, control, skills development and CSI in built environment consultants and major contractors
- Contractor and sub-contractor size and ownership

1.9.4 Additional surveys, 2004–2005

- Under 35s' views on their aspirations and challenges
- Female views on their aspirations and challenges

Table 1.2 Research activities undertaken

Subject/questionnaire	Number issued, requested or sent	Number of responses
Face to face interviews	60	60
Telephone interviews	150	150
Management survey	1 000	328
Personal survey	1 200	395
First-year survey	2 075	990
Final-year survey	982	540
Fifty plus, planning the future survey	991	356
Civil professionals outside SA survey	213	176
Civil professionals outside SAICE survey	1 665	314
SAICE under-35 members' survey	459	128
SAICE female members' survey	94	39
Salary survey	7 200	559
Employment agency survey	10	5
HR survey	958	348*
Local government HR census	251	251*
Total	**17 308**	**4 639**

* Responses included nil returns

- Emigrant views covering reasons for emigration and the possibility of returning
- Over 50s' views on their plans for the future
- Views of civil engineering professionals who do not belong to SAICE
- Salary survey
- Local government census
- Municipal PMU capacity and vacancies
- Identification of work survey
- Engineer to population ratios in a number of countries

Seventeen instruments (questionnaires) were developed in the period July 2004 to March 2005. A large number of people were involved in the surveys of 2004/2005 (see Table 1.2).

Where responses from various sectors were considered inadequate, the total number employed per company was established and the number of professionals was determined by imputation, using the profile developed from the detailed responses. The detailed approach and copies of all the questionnaires are included in a separate methodology report, which is available on request.

Excluding the personal interviews and the local government census, these figures represent a 26% response. This reflects the high level of interest in the project and the level of concern industry has over the skills shortages and pressures to deliver.

The various tables and figures paint a comprehensive picture of the current status and challenges in the industry. Much of the text is based on the qualitative responses received from the many open questions.

Table 1.3 Reference datasets made available for the project

Organisation	Number of members or records
Building Industries Training Board (BITB)	2 500
Construction Education Training Authority (CETA)	1 500
Civil Industries Training Board (CITB)	18 000
Engineering Council of South Africa (ECSA)	9 200
Master Builders South Africa (MBSA)	2 500
National Home Builders Registration Council (NHBRC)	11 500
South African Association of Consulting Engineers (SAACE)	472
South African Black Technical and Allied Careers Organisation (SABTACO)	250
South African Federation of Civil Engineering Contractors (SAFCEC)	250
South African Institution of Civil Engineering (SAICE)	7 200
South African Institute of Steel Construction (SAISC)	350
Department of Education (DOE)	Matriculation results, 1995–2004
Department of Education (DOE)	Tertiary enrolments and graduations, 1986–2003

REFERENCE DATASETS

Detailed datasets from various organisations gave further perspective and depth to the study (Table 1.3).

Input on member numbers and profiles was also received from the African Builders Association (ABA), the National Association of Black Contractors and Allied Trades (NABCAT), the National Federation for the Building Industry (NAFBI), South African Women in Construction (SAWiC) and Women for Housing (WFH).

DESKTOP RESEARCH

A comprehensive desktop study was carried out to put the South African civil professional experience into context. South Africa is not alone in many of the problems facing the industry. Much of the Western world has suffered reducing numbers of entrants into the field and faces shortages because of an ageing workforce nearing retirement.

SOURCES

Sources are quoted next to the relevant figures and tables or in notes at the end of each chapter. Tables and graphs prepared from the research projects listed above are not referenced.

NOTES

1 M Ramos, in Businesswomen's Association (BWA) in association with Catalyst 2004, South African Women in Corporate Leadership Census, 2004, Johannesburg p 12.

PART II
DEMAND

Contents

CHAPTER 2

The private sector

INTRODUCTION

The South African Association of Consulting Engineers (SAACE) has carried out regular surveys among its member companies for a number of years. The data has proven very useful for indicating trends in employment profiles, confidence indices and transformation.

However, in the private sector civil professionals are employed in many fields other than consulting, and a more complete understanding of qualifications and the age/gender/transformation demographics and trends was required. (See Figure 2.1.)

Therefore the various institutions involved in the construction sector canvassed their members, using the detailed HR questionnaire (see separate methodology report).

Responses covered the current demographics, qualifications and registration status, giving an indication of the type of staff required by each sector and the demand for civil professionals over the next two- and five-year periods.

'... we need more engineers ... they are problem solvers ...'

– Cyril Ramaphosa

THE STATUS QUO

Each discipline in the private sector will be examined separately under similar headings. There are many common activities; hence it may seem that information is being repeated. However, activities are detailed per sector for comparison.

2.1 Consulting

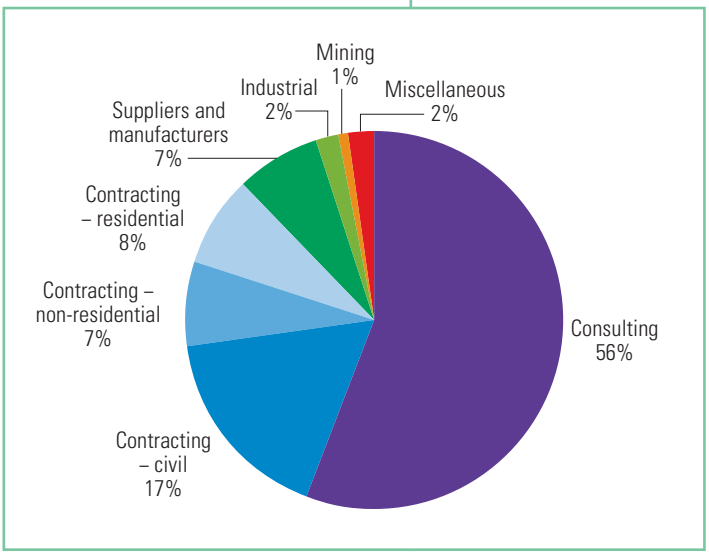
Some 500 civil engineering consulting practices are members of SAACE and SABTACO. In addition, several hundred one- and two-man entities operate from homes and small offices, and handle small projects, or offer specialist consulting services. The total employment in this sector is approximately 13 000, of which 46% are civil professionals.

2.1.1 A decline

There has been a gradual decline in the number employed in consulting practices since the seventies and early eighties. Many large practices have downsized.

One often hears the argument that with the introduction of technology fewer engineers are required as they can do their work in a fraction of the time. This type of statement can only be made by those who are not familiar with the structure of the production team in the pre-IT days. The tracers, draughting staff and detailers spent long periods converting the engineer's designs into working drawings. Today's design software produces a significant proportion of the final drawings and details automatically as a by-product of the design process.

Figure 2.1 Distribution of civil professionals in the private sector



Research results

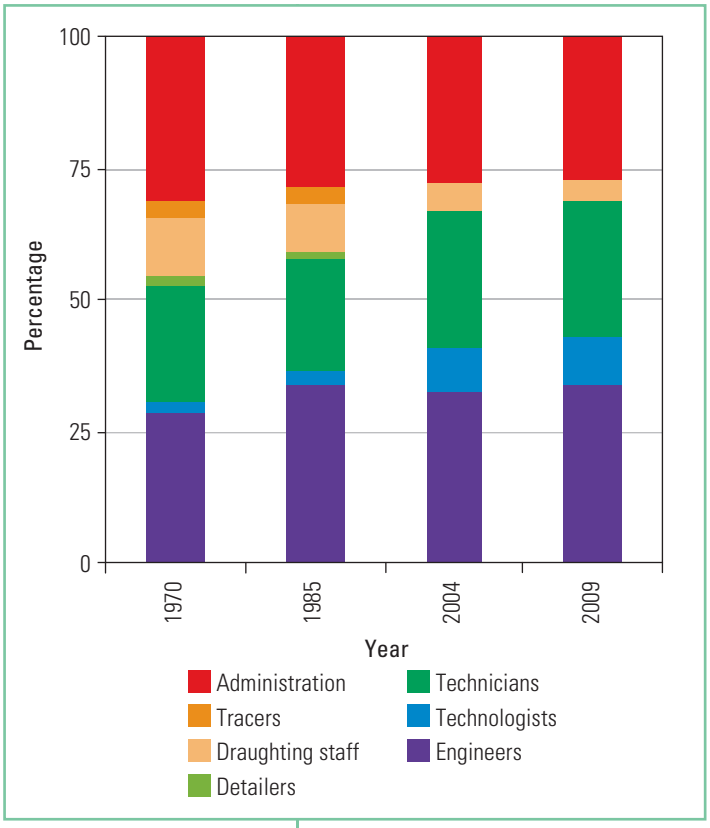


Figure 2.2 The changing profile of the consulting team, 1970–2009

Increasing use of technology, including IT and electronic equipment, has meant that the numbers of semi-skilled and certificated production staff have declined – particularly at the level of tracer and draughting staff. (See Figure 2.2.) Companies are now employing proportionally more tertiary-trained personnel (technicians, technologists and engineers).

The ever-increasing workload and reduction in staff mean that the average capacity utilisation in the consulting sector is now over 90%. While a few companies report that they do not have sufficient work, most describe capacity utilisation as well over 100%, with experienced and production staff regularly working significantly longer hours. (See Figure 7.10.)

2.1.2 The professional profile

The mix of professionals varies according to the type of organisation. Broadly speaking there are three company profiles in terms of staff usage:

(a) Traditional consultants

Traditional consultants are the long-established consulting companies that are involved in traditional civil and structural engineering consulting. On average their profile is as follows:

- 26% of all staff are civil engineers (22% in companies larger than 50 staff and 28% in companies of 50 staff and fewer)
- 6% are civil technologists (although this ranged from 0% in many companies to as high as 23% in others)
- 17% are civil technicians

(b) Specialist consultants

Specialist consultants are involved in mining, heavy industrial, geotechnical and soils, etc; and in GIS, IT, training and capacity development. On average their profile is as follows:

- 36% of all staff are civil engineers and specialist professionals
- 6% are civil technologists
- 6% are civil technicians

(c) Emerging consultants

Emerging consultants are companies formed in the past five to ten years that are predominantly black owned. On average their profile is as follows:

- 23% of all staff are civil engineers
- 12% are civil technologists
- 21% are civil technicians

The total number of professionals employed in consulting are as follows

- 2 977 or 23% of all staff are civil engineers

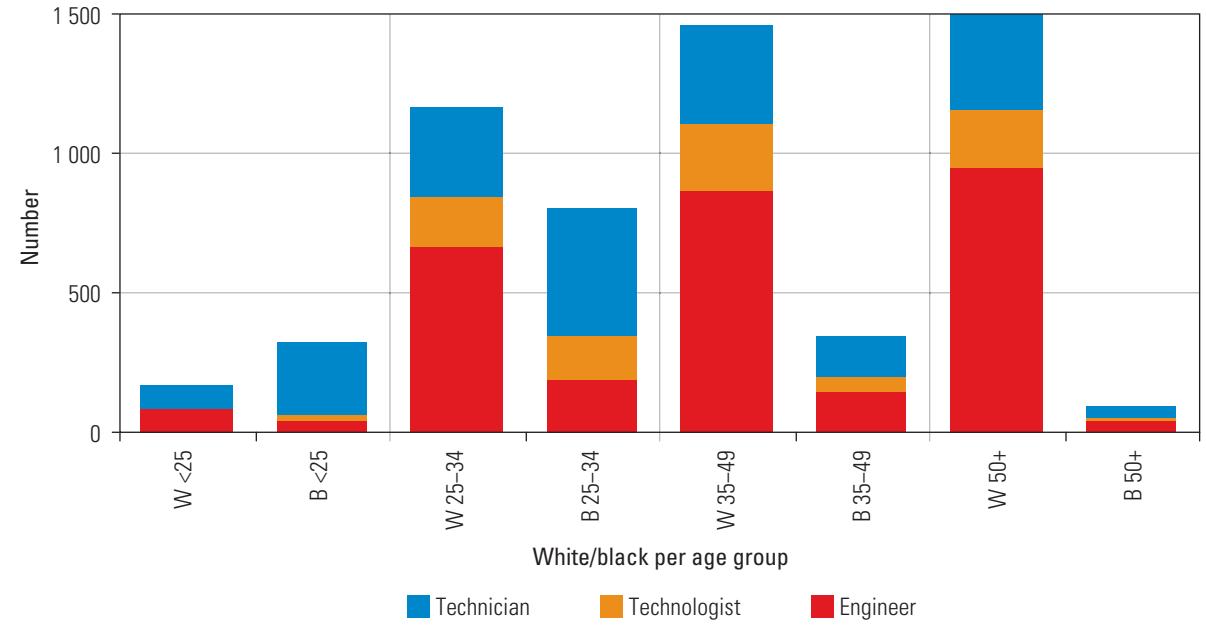


Figure 2.3 The profile of civil engineering professionals in all consulting practices, 2004

- 865 or 7% are civil technologists
- 2 024 or 16% are civil technicians

(See Figure 2.3.)

Considering the whole sector, the ratio of university-graduated to technikon-graduated staff is 1:1 (that is, 23%:23%). Civil professionals comprise 46% of all staff.

Utilisation of technikon graduates varies in the groups of consultants.

The major consulting firms use national diploma graduates as CAD operators, technologists for design and production work, and engineers for strategic activities, including planning, marketing and general management.

Emerging companies use technicians in both CAD and technical roles, and encourage technicians to continue with their BTech degrees.

In most companies technologists are increasingly being utilised in specialist fields as designer/draughting staff, and in many companies are being groomed for senior management posts, and to become associates, partners and directors. The BTech degree has at last given technicians an opportunity to break through the glass ceiling and assume senior management roles.

Transformation is taking place in the younger generation

2.1.3 The ownership profile

The South African Association of Consulting Engineers (SAACE) State of the Consulting Engineering Industry Report (SAACE CEIR),[1] published in September 2004, showed the distribution of owners, engineers and technologists as depicted in Table 2.1.

The current survey was carried out a few months later and found that 2 977 engineers and 865 technologists were employed in consulting. The SAACE survey did not ask for the qualification details of owners, which explains the greatly reduced numbers of engineers and technologists reported in Table 2.1.

The difference would seem to suggest that the 2 977 engineers minus 639 and some of the 956 are partners and associates and the 865 technologists minus 321 and some of the

Table 2.1 Distribution of owners and senior technical staff in the consulting sector

Description	Male	Female	Total
Partners / Directors	1 046	43	**1 089**
Associates	652	56	**707**
Pr. Eng / Pr. Tech. Eng	910	46	**956**
Engineers	544	95	**639**
Technologists	264	57	**321**
Total*	**3 416**	**297**	**3 712**

* Table 2.1 does not include technicians who are generally not owners in consulting practices.

956 are partners and associates. That is, most of the 1 796 associates, partners and directors are engineers or technologists.

Many of these associates, partners and directors have worked for their companies for long periods. Often the term of employment for staff over the age of 45 is 25 years and more! The managers and directors are experienced professionals who understand their businesses very well.

Most partners and directors are engineers or technologists

Unlike architects and quantity surveyors, there is no council controlling the structure of consulting practices. The South African Council for Architectural Professionals (SACAP) calls for ownership and management of architectural practices to be in the hands of registered professionals. Even in the absence of legislation, consulting firms have been similarly constituted for sustainability.

This recipe for stability of successful established companies should be borne in mind by those starting new businesses, and those looking to change the composition of management for whatever reasons. Technical competence and experience are essential ingredients.

2.1.4 Draughting staff

The use of tracers and draughting staff has declined (indicated in Figure 2.2). Many consulting companies prefer to employ staff who have tertiary qualifications, such as engineers, technologists and technicians.

However, many commented on the shortage of experienced draughting and detailing staff. In the past draughting staff started as tracers, were trained in-house and gained experience over the years. In addition, many extended their ability by attending technical colleges part time, or by going to night school while working during the day.

Since the advent of CAD, industry no longer employs and trains young tracers. The part-time and night-school approach to technical training has been replaced by the national diploma. Many so trained have higher aspirations than to remain behind a drawing board or CAD station for the rest of their lives, hence the growing shortage.

CAD courses are seen as the new method of training draughting staff, but emphasis is placed on use of the software rather than the principles of engineering and the associated drawings procedures and standards. With insufficient technical background, those trained through CAD courses are effectively tracers and not draughting staff, and require a great deal of supervision.

A draughting learnership is urgently needed and draughting should be included as a career prospect when carrying out career guidance. Not only will this address the shortage of draughting staff, but with the technical training so received, these people will be the feedstock for other functions, including estimating, supervisors and site agents.

2.1.5 ECSA recognition

Consulting practices of all sizes from the one-man-band to those employing several hundred responded to the survey. Seventy-four per cent indicated that they offered training that would enable young graduates to gain sufficient experience of and exposure to the various facets of industry to become professionally registered with ECSA. This response was consistent across all sizes of companies.

Those who did not offer training listed their main reasons as:

- being too small (although only 3% of all respondents cited this problem)
- being too busy
- not having sufficient volume or scope of work to offer training
- not having the cash flow
- not having graduates to train

Responses from employees yielded a different picture. Many said that they were not receiving training or being given support to register with ECSA! This is consistent with a similar survey carried out in 1975,[2] in which 73% of employers rated themselves highly on workplace training, but two thirds of the trainees responded that they were not being given much support at all! At the time there were complaints that graduates were often given 'repetitive and minor work', 'were not allowed to try new solutions', and after mastering a particular skill there was 'exploitation of engineers-in-training'.

There are therefore vast gaps in perception and expectation that will affect employer/employee relationships and the propensity of trainees to remain with a company, or indeed in the industry!

Management's responses to various aspects of training may cast light on the graduates' frustrations. Although 74% said their companies provided workplace training, they do not appear to offer a well-structured approach to this training as indicated by the following:

- 54% regularly supervised the graduate's work
- 67% regularly checked the graduate's work before being issued
- 61% regularly provided a more senior staff member to assist young graduates at site meetings
- 45% provided a mentor
- 19% moved graduates from one department to another to gain all-round experience

Many engineering failures worldwide have been traced to lack of checking, particularly the work of young graduates. The lack of supervision plus the 33% above who do not check work are cause for concern.

Graduates in consulting, however, seem to have the best deal in terms of registration. Sixty-six per cent of companies said that they gave increases or promotion once graduates had become professionally registered. This contrasts with the mere 30% of those in local government and state departments who receive additional benefits after registration.

2.1.6 Contract employees

As a result of the boom and bust cycles experienced by the construction industry, contract and part-time employees make up 18% of the total staff in consulting practices. By

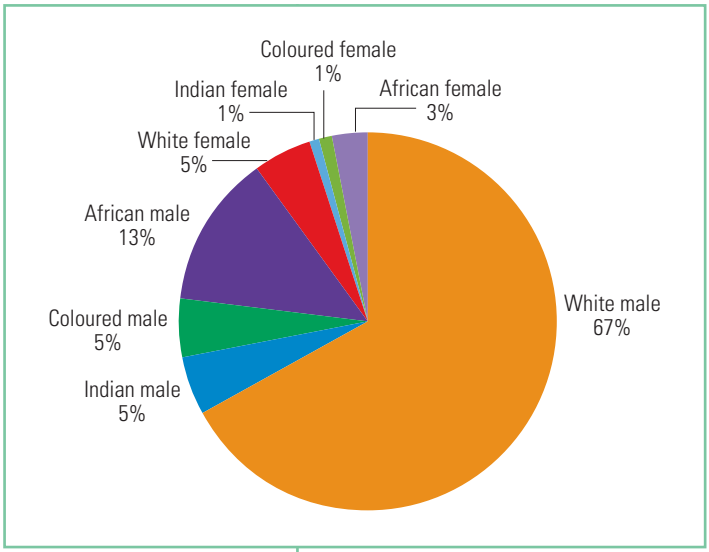


Figure 2.4 Transformation of civil professionals in consulting, 2004

structuring their staff in this way, organisations can reduce staff without major financial or labour law implications when projects come to an end, and no further work is available for the 'excess' staff.

This can be an efficient way of re-allocating scarce resources, but when there is insufficient work for the pool of contract workers, they often turn to other employment, and do not return to the industry. Consequently the industry risks losing some of the 1 000 professionals unless there is a consistent flow of project work. This does not include all contract employees because companies were not asked to record inactive professionals waiting for the next contract.

2.1.7 Regional distribution

Of the 500 to 600 companies, many have branches throughout South Africa and beyond. As work slows down in South Africa, companies work harder to supplement their incomes elsewhere and move staff out of South Africa. Many may not return unless positions, salaries and benefits and the situation in South Africa are more appealing than abroad.

2.1.8 Specialist consulting firms

Because of these boom and bust cycles, many consulting firms have moved beyond traditional consulting roles to offer specialised services.

The development of IT systems such as GIS (geographic information systems), knowledge management systems, document management, vehicle tracking, metering, water loss systems and ITS (intelligent transport systems) has resulted in companies replacing civil engineers with IT staff.

The other main areas of specialisation are mining, geotechnical and environmental. In these companies civil engineers are supported by other professionals such as geologists, surveyors and environmentalists.

2.1.9 Transformation

(a) Staff composition

Since this survey was focused on professional capacity, administration staff have not been included in the staff composition.

Figure 2.4 shows that the white male still dominates, but his share is reduced to 67%. Of greater interest is transformation when measured by age. (See Figure 2.5.)

There is a marked change in the profile of the professional team below age 30. This appears to bode well for the longer-term equity targets being set in the construction charter process.

However, transformation is most marked at technician level. A limited number of PDI engineers are older than 30. Before the mid-nineties few black learners could achieve the matric results required to enter universities or to source the necessary funding.

Those aged 45 and over who achieved the requisite maths results followed an arduous process to prove themselves and obtain permission from the government of the day to study

engineering at an established university.

These issues will be explored in Chapters 4 and 5, 'Supply – secondary education' and 'Supply – tertiary education'.

Since most senior managers and owners at this stage are engineers, a great deal of work must be done to address the shortfall if the current ownership profile is to be maintained.

Many PDI and female graduates are currently in training and there will be significant transformation in the next five to ten years if these graduates remain in the industry. (See Figure 2.5.)

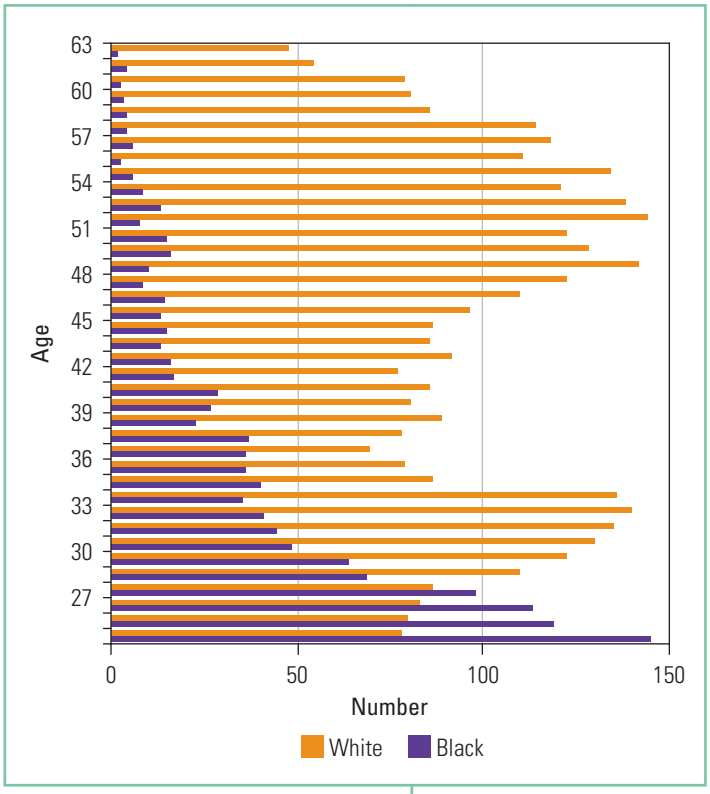


Figure 2.5 Distribution of civil professionals in consulting by race and age, 2004

(b) Types of company

Although many categories have been suggested for grouping companies for the Construction Charter, for example micro, small, medium, large; or A, B, C or D; in essence there are only three types of company structure in the consulting field in terms of company culture and ownership. They are:

- Medium and large
- Small established
- Small emerging

(i) Medium and large

In medium and large companies, experienced professional management staff are recruited for non-engineering functions including HR, financial and legal. Technical management and owners are largely experienced engineers who have worked for their companies for many years or, in emerging companies, are experienced engineers and businessmen. This type of structure is generally found in companies with 30 to 40 staff and more.

(ii)Small

Small companies form two groups: small established and small emerging companies. While they are quite different in character, operating conditions are tougher for all small companies. Research[3] has shown that red tape severely hampers their advancement.

Typically SMMEs that turn over less than R1 million per annum spend between 8 and 9% of their annual turnover to comply with regulations, while larger businesses turning over R5 million or more are spending less than 1%, and those turning over R1 billion or more are spending 0,2% of their turnover to comply with the plethora of regulations that have been promulgated. The two types of small company are:

- *Small established*

  Long established companies are typically owned by one to four white male professional engineers, who have many years of experience, and are now aged 50 or older.

  The owners are not too sure when, or even how, to retire. The companies generally provide high levels of delivery and customer satisfaction, as the experienced engineers are hands on. They usually manage all aspects of the business themselves, including HR and finances. Bookkeepers and perhaps junior HR and administration staff manage the

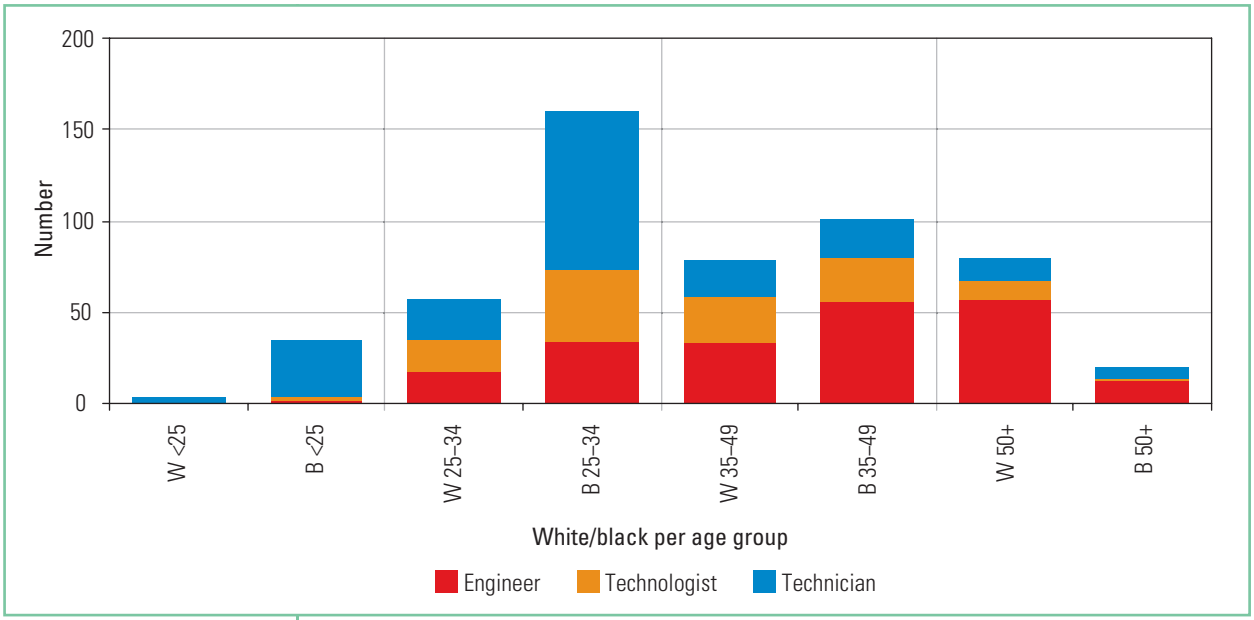


Figure 2.6 Civil profile of emerging consulting practices

day-to-day paper work. The owners have little or no desire to grow the business much beyond its current size.

They are typical entrepreneurial, small established owner-managed businesses and have all the characteristics of this type of company in any industry.

- *Small emerging*

The small emerging consultancies are owned largely by young technicians and technologists, who have limited workplace training or experience, and started their companies shortly after registering as Pr Techni or Pr Tech Eng.

Entrepreneurial companies have significant differences from those above as they seldom have adequate engineering or management experience, and are owned by a category of employee who would rarely reach management or ownership level in any industry.

This type of company is usually exploiting a marketing opportunity. Hired professional skills are utilised for engineering and management functions because the owners do not have the qualifications, training or experience for the level of input required in a consulting company. Many of these companies have requested assistance with enterprise development and mentorship.

No one- or two-man emerging companies responded to the survey. Micro consulting businesses appear to be the domain of the older white male and female specialists.

(c) Transformation in established and emerging consulting practices

There are marked differences in culture between established and emerging companies (see Figures 2.6 and 2.7). There are only about 900 to 1 000 black civil engineers in South Africa. Some 600 graduated from South African universities. The remainder are South African engineers who studied abroad and Asian and African engineers from further north who are now working in South Africa.

About 450 black engineers are currently in consulting (30% in emerging companies), 100 in contracting, 280 in the public sector, and the balance mostly in academia and research. They are also thinly spread through industrial, manufacturing, mining and the supply chain.

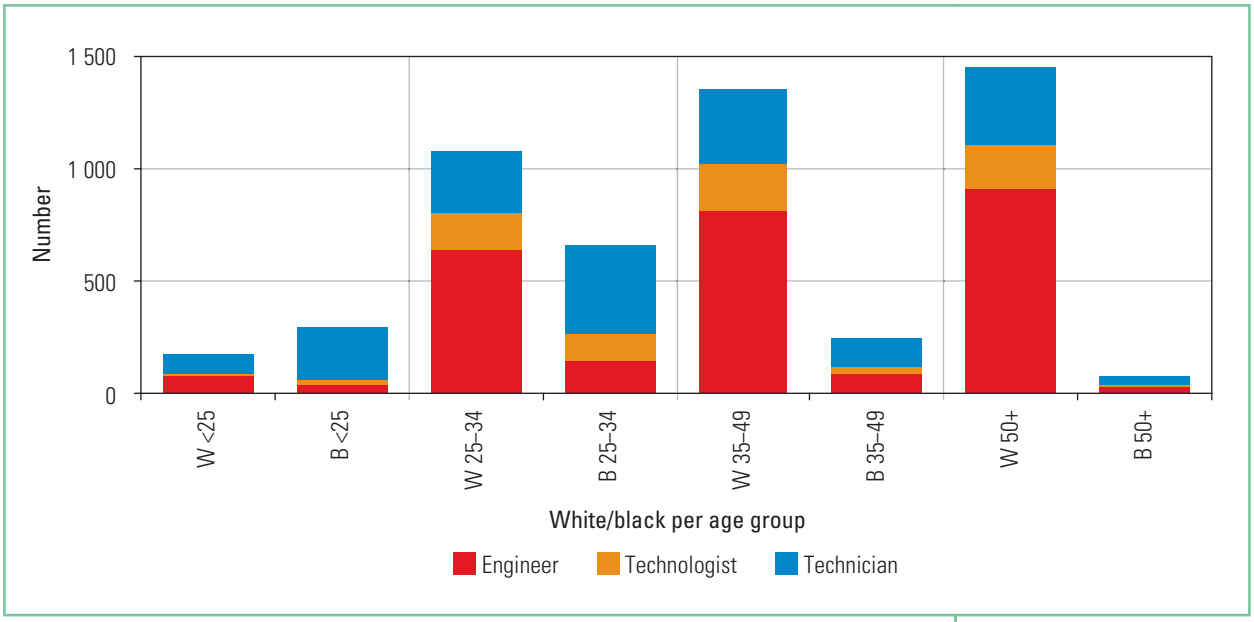


Figure 2.7 Civil profile of established consulting practices

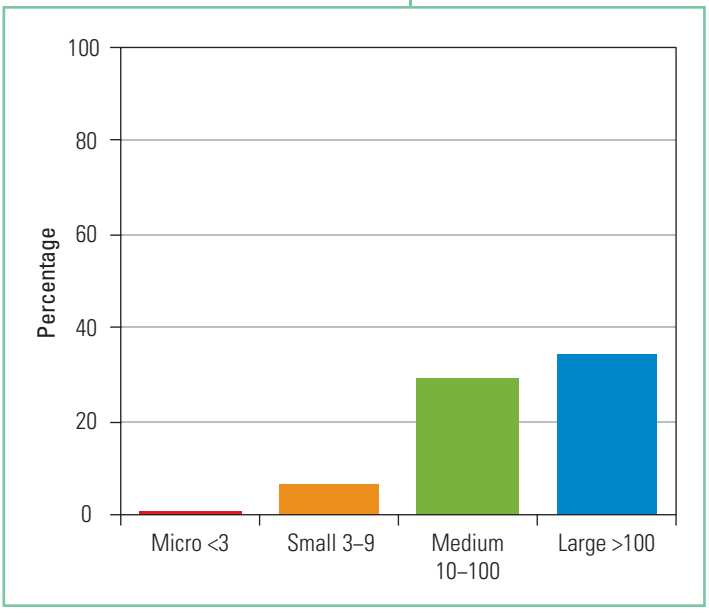
There is therefore limited scope for dramatically improving the equity profile in the consulting team sector in the immediate future, unless those working in the public sector could be enticed to move into the private sector.

(d) Ownership and the Construction Charter

There have been two marked changes in ownership in the consulting sector over the past ten years. (See Figure 2.8.)

The first has been the slow but consistent acquisition of shares in established, large, previously totally white-owned companies. This accounts for 30% of current black ownership in large and medium companies.

Figure 2.8 Percentage black ownership in consulting, based on company size, 2004.



CTCG transformation survey

The second is through the opening of many emerging, mostly small consulting practices, which now account for 13% of all consulting practices, although in terms of the number of employees in the sector, they represent 9% of engineering personnel.

Medium, large and emerging firms should have no difficulty with the ownership targets envisaged in the Construction Charter scorecards. (See Figure 2.9.)

The companies that are unlikely to achieve these targets are the established companies with 30 staff or fewer, particularly micro and small family-owned consulting practices, which together account for over 50% of the companies, and 8% of the employees. Micro and small firms typically involve the owner, some family members and no more than four employees.

Hundreds of one- and two-man and slightly

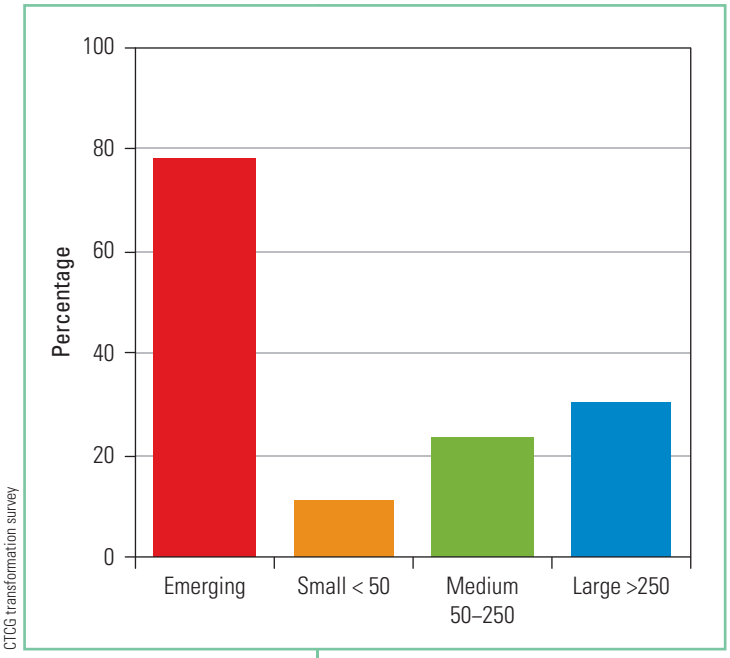


Figure 2.9 Percentage black ownership in consulting based on company type, 2004

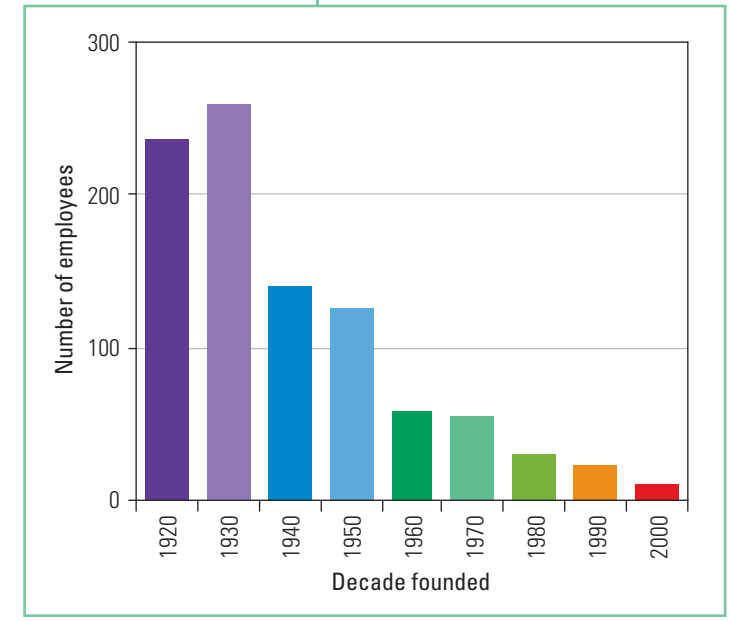
Figure 2.10 Average size of consulting practices formed per decade and still operating in 2004

larger companies offer specialist skills to the industry. They would have difficulty in transferring any ownership.

Many are sole traders who would not have shares to sell. Many operate from their homes and selling a portion of ownership would mean selling a part of their family assets!

It has been suggested that non-engineering owners or investors should be considered to accelerate the transfer of ownership in all companies. But this could have a negative effect on businesses in the following ways:

- ***Staff retention:*** Retention of technical staff would become a problem, since junior staff aspire to becoming registered and, one day, partners or shareholders. If a large portion of the business is sold, there will be fewer opportunities for the existing civil engineering employees to aspire to, and this would reduce the appeal of serving the company for a long term.
- ***Staff supervision and training:*** As the number of technical staff is reduced, so too the company's ability to recruit, supervise and train young technical staff will diminish. This problem has been experienced in the public sector.
- ***Knowledge of the industry:*** The unique characteristics of the industry, particularly its boom and bust nature, can best be understood by those familiar with it. All too often, new owners and shareholders who do not understand the business have made inappropriate decisions on the deployment of capital, technology and skills required to perpetuate its sustainability.



(e) Company age, size and success

Large companies may be able to advance the transformation process by introducing black professionals from other disciplines, such as social and environment consultants, project and construction managers and financial and HR professionals.

This is not feasible for small companies where most or all staff are involved in production, and extra tiers of management would not add value. Introducing specialists would be a luxury, since smaller companies appoint external expertise for specific projects only when required.

The SAACE CEI Report 2004 stated that smaller firms appear to experience tougher working conditions than larger firms, indicating that growing larger firms or setting up mergers would yield more efficient structures.

The procurement criteria defined to encourage

black economic empowerment have resulted in the establishment of a plethora of small companies, many with inadequately qualified and experienced staff, as well as insufficient numbers of staff.

With more companies pursuing business opportunities than in the past, fees have been driven down, threatening company survival. The associated loss of people from the industry can ill be afforded.

But 21 consulting firms (in relation to size and age (Figure 2.10)) offer clues as to how emerging companies could be successful and grow their businesses.

These 21 consulting firms employ 100 or more staff. Sixteen were established before and up to 1965, two in the seventies, and one in the eighties. The average size of companies therefore appears to be proportional to the age of the business. Many established companies have achieved their size through mergers over the years, and their company names bear testimony to many respected professionals having formed partnerships to grow their businesses.

Two large companies emerged recently that started their impressive growth only in the last ten years. Each is black owned, and was started by highly qualified and experienced engineers who had significant management and business training and experience. They achieved their growth by recognising that they need expertise in their chosen fields of operation. They employed senior professionals, regardless of race or gender, to offer input and assistance in all facets of consulting, including marketing and business development; general and financial management; supervising of projects; and training of young staff.

This formula should be more widely adopted. Experience and knowledge in the industry should be harnessed to grow capacity as a matter of urgency. Management and business training and experience must be incorporated in the grooming process.

(f) Employment equity

There has been a steady increase in PDIs moving into junior management. As the PDIs who are now entering the industry mature, one can expect middle and senior management to become more representative.

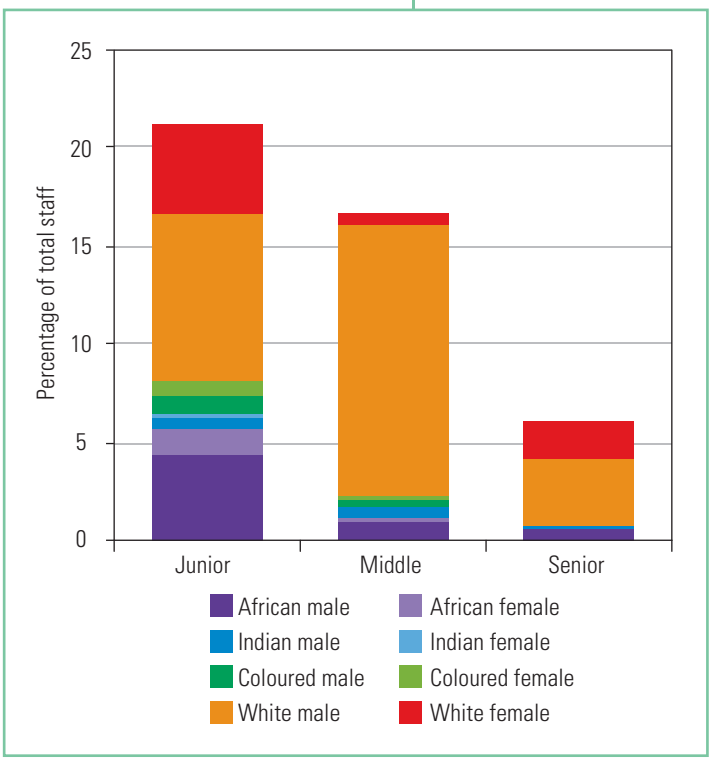
With the implementation of the Construction Charter, the need for career-path development and succession planning has never been so critical. Companies need to recognise talented people within their ranks, in order to train and groom them for more senior roles.

The value of experienced engineers and professionals as senior managers has already been outlined. They must be utilised and skills transferred through coaching.

The employment equity profiles for large, medium and small established consulting practices are similar (Figure 2.11).

However, the same profile is not applicable to the several hundred, long established micro companies that consist almost entirely of white men.

Figure 2.11 Employment equity profile in consulting for established small, medium and large practices, 2004.



CTCG transformation survey

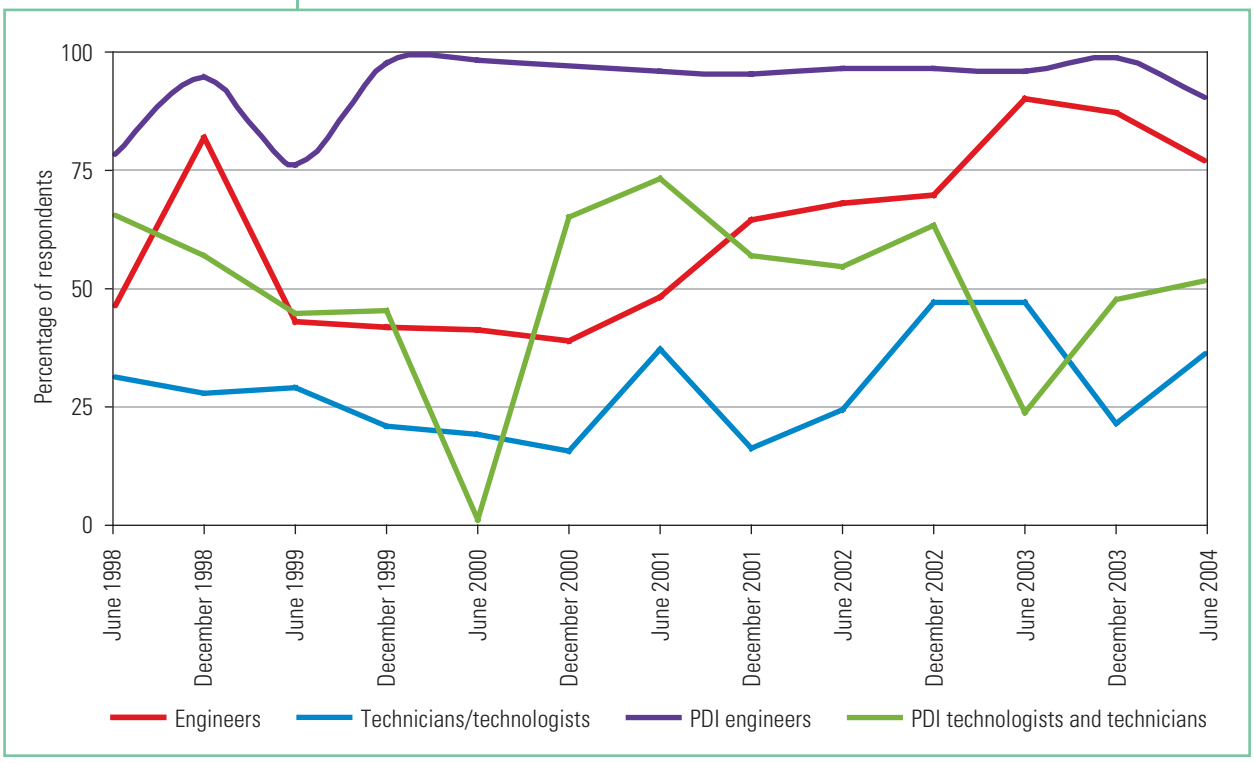
The emerging sector reflects a different profile, with significantly higher numbers of black professionals at all levels of management. Although there are exceptions, many civil staff are relatively inexperienced and the typical company profile is the antithesis of that of the large, established and successful consulting companies (see section 2.1.2) where the management are usually experienced, if not long serving, engineers. In order to ensure that staff are not catapulted to senior positions without appropriate experience, it is going to be necessary to define years of experience in relation to junior, middle and senior management definitions in the charter.

(g) Corporate social investment

Recognising the need to transform, the large consulting practices now spend some 1% of turnover on corporate social investment. Activities in the responses included:

- Basic literacy
- Bursaries
- Career guidance
- Cerebral palsy
- Community upliftment
- Contractor training in contract administration and tender procedures
- Donation of computers
- Engineering and agricultural resource management
- Environmental and community awareness for school children
- HIV/Aids programmes
- Investigation and rectification of lack of water supply in destitute communities
- Community projects

Figure 2.12 Percentage of consulting firms requiring additional staff



SAACE CEI report 2004

- Mud Hut School upliftment programme – Eastern Cape
- Schooling assistance
- Skills building of new professional candidates
- Sports developments / sports clubs
- READ Educational Trust for primary schoolchildren
- Talks to tertiary institutions
- Teaching at technikons and universities and other educational institutions
- Lecturing at technical conferences
- Water services

2.1.10 Future demand

Most respondents indicated a need for more staff in the next two and five years. All need more PDI engineers and technologists, and more technicians as a whole. The recent SAACE CEIR reflected a similar requirement (see Figure 2.12).

Consultants also indicated a need for 10% more draughting staff in the next two years and 25% within the next five years. The number of experienced structural steel and RC detailers has declined to such an extent that consultants indicated that they would need 40% more detailers in the next two years and 80% in the next five years to cope with the large projects that are anticipated in the near future.

2.2 Contracting

South Africa's construction industry is a national asset that contributes 2%–3% of GDP and is essential for growth in GDP, employment and poverty alleviation. Contracting companies are the largest employers in the industry and are therefore expected to lead job creation.

Contracting is made up of three sectors, civil engineering contractors, residential contractors and non-residential contractors. The area of operation and activities per sector will be described in detail under each section below. Their relative sizes are given in Table 2.2.

The staffing profile here is significantly different from that of consulting. Contractors rely on large pools of unskilled and semi-skilled labour as well as artisans and many other built environment professionals.

A number of organisations represent contractor interests. The main bodies are:

- ABA – African Builders Association, which represents black building contractors and plays a skills development and support role
- MBSA – Master Builders South Africa, which represents mainly established residential and non-residential contractors and to a lesser extent emerging and smaller companies

Table 2.2 Civil, non-residential and residential contracting in South Africa[4]

Type of contracting	Total number of employees	Approx. number of companies	Average company size
Civil engineering	90 000	260	346
Non-residential	142 000	3 500	41
Residential	190 000	18 000	11
Total	**422 000**	**21 760**	**19**

Figure 2.13 Staff distribution in contracting by company size, 2004

- NABCAT – National Association of Black Contractors and Allied Trades, which represents black contractors in all three sectors
- NAFBI – National Federation for the Building Industry, which represents larger black building contractors
- SAFCEC – South African Federation of Civil Engineering Contractors, which represents large established civil engineering contractors and to a lesser extent emerging and smaller companies
- SAWiC – South African Women in Construction, which offers support for women-owned construction companies
- WFH – Women for Housing, which also supports the growth of women entrepreneurs in the construction industry

There are thousands of small black contractors with very different profiles from the large established members of SAFCEC and MBSA. These developing businesses need operational and financial support in order to grow (Staff utilisation in the industry as a whole is shown in Figure 2.13).

Less than 6% of the civil engineering professional team are women. Large numbers of technicians are employed (See Figure 2.14).

2.3 The Construction Industry Development Board (CIDB)

Before we look at each of the contracting groups, the Construction Industry Development Board (CIDB) must be mentioned. Construction is the fourth largest employer. Contracting companies range from large long-established listed companies to recently formed micro organisations, all vying for work in the three sectors outlined above.

The CIDB was formed to ensure that the public sector gets the best from the contractors it employs, and contributes to their growth and wellbeing. The CIDB Act 38 of 2000 calls for:

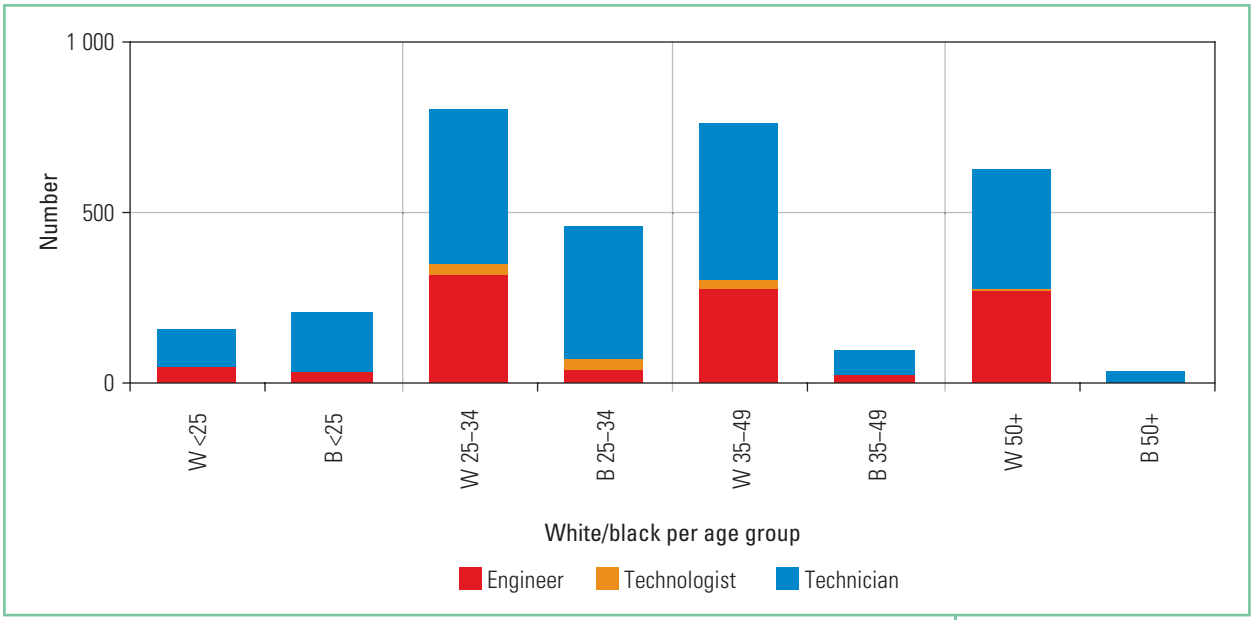


Figure 2.14 Number of civil professionals by demographic group, age and qualification in contracting, 2004

'a national Register of Contractors … which provides for categories of contractors in a manner which facilitates public sector procurement …'

'a best practice contractor recognition scheme … which promotes contractor development and monitors contractor performance …'

The categories define turnover brackets and the range of skills required for each level. In order to grow, small companies must be able to employ skilled staff such as artisans, and beyond a certain level they require registered built environment professionals on their staff. The CIDB register and support system encourages not only enterprise development, but also an increase in professional skills.

At provincial workshops with industry to discuss the Construction Charter, emerging contractors expressed their unhappiness at the criteria imposed by the CIDB. They felt that the CIDB should be assisting them with finance, making tenders freely available, and opening doors for them, even in the neighbouring SADC countries. They also called for mentoring.

Established business, however, complained that the barriers to entry into the sector were low, leading to huge problems in tendering and reverse fronting. They welcomed the CIDB criteria.

2.4 Civil engineering contracting

Civil engineering contractors generally belong to the South African Federation of Civil Engineering Contractors (SAFCEC). They are responsible for the development of roads, earthworks, harbours, and potable water, sewerage and stormwater networks. Some civil engineering contractors are also involved in non-residential developments.

Contractors employ a large number of unskilled labourers, trade workers and professional staff such as civil engineers, project and construction managers and quantity surveyors. SAFCEC boasts some 260 member companies, who collectively employ about 90 000.

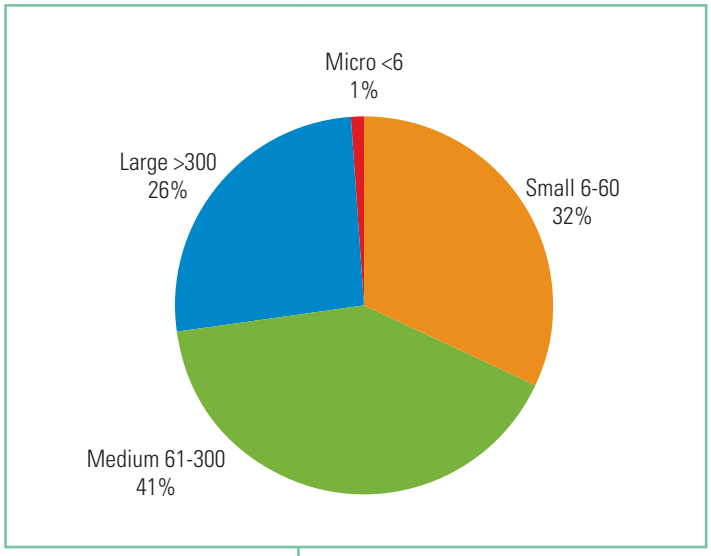


Figure 2.15 SAFCEC members by company size, 2004

Companies range in size from a few micro organisations to large companies employing thousands of staff (Figure 2.15).

2.4.1 A decline

There has been a gradual decline in the number of employees in contracting since the seventies and eighties.

2.4.2 The professional profile

The larger contracting firms have significantly fewer engineers than the consulting sector. In these companies major projects require experienced construction and project managers. In the past these were civil engineers, as this was considered part of the civil engineer's role. Construction management graduates now also assume these roles.

A large number of technicians are used on site as supervisors and site agents. In the past artisans worked their way up the ladder and became foremen and supervisors. The dramatic reduction in the number of artisans entering the field over the past 10 to 15 years has meant that contractors now use technicians as foremen during their experiential training and groom them to become supervisors. The problem with this approach is twofold:

- **Lack of experience:** Young technicians do not have the wealth of practical experience of their predecessors and require significant workplace training to become competent
- **Not assertive:** Seventy to eighty per cent of all technicians entering the experiential phase are African, and their culture has not prepared them for giving instructions to those who are their elders. Considerable coaching is required to overcome this problem, before the contractor can confidently leave a team of staff under the supervision of a young African technician.

The ratio of engineer to technologist to technician in the larger companies is 1:0,1:2. This means a 1:2,1 ratio of university to technikon graduates. In smaller companies the proportion of technikon graduates is higher.

Established companies, from the largest down to those employing as few as 60 staff, have at least one professional engineer on the staff; and as the size of the company increases, so too does the number of engineers. The ratio of engineers to total staff ranges from 1:70 to 1:100, depending on the type of organisation and size of projects being handled.

The government has long since recognised the construction industry as a key player in job creation. However, this role can be achieved only as long as there are sufficient professionals to support the industry. For each civil engineer who leaves the industry, 70 to 100 jobs will be lost, as companies will not have the capacity to manage the additional staff and therefore maintain the level of work. Every engineer lost reduces the capacity to create the infrastructure required to alleviate poverty – the poverty trap of insufficient capacity is a real possibility!

2.4.3 Artisans

Artisans in the built environment include bricklayers, carpenters, joiners, painters, plasterers, plumbers, roofers, shopfitters and tilers.

Although the scope of this project was to examine the profile of civil engineering professionals and advise on their education and training needs, a great deal of information was gathered regarding the declining pool of fully qualified artisans.

Urgent attention needs to be paid to training artisans before there are no experienced staff to offer this training. (The age profile is shown in Figure 2.16.[5])

A separate SAICE report covers the reasons for the decline and the detailed interventions that are required in this area. Suffice it to say, industry does not have time or contracts long enough to carry out comprehensive artisan training from scratch on site, but teaches labourers the particular skill required for the current job.

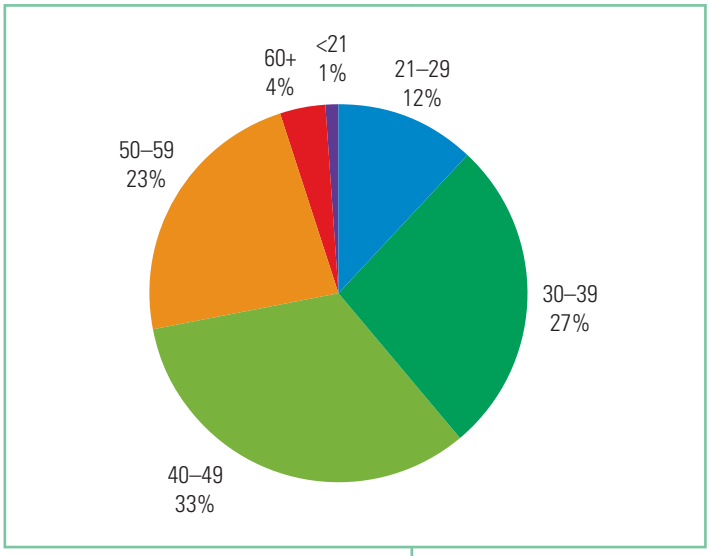


Figure 2.16 Age profile of artisans in the building industry

This is possible because there is still a pool of experienced staff to teach and supervise. When this ageing group are no longer available, there will be no capacity to train on site.

To reverse the trend (Figure 2.17) dedicated training centres, sensitive to the needs of industry, must be re-established, and trainees must be given practical training at these centres before going to site.

This was also the conclusion of the National Advisory Council for Innovation (NACI) survey[6] carried out in 2003, which said:

> *'… courses are not aligned with industry needs ... graduates have theoretical training but very little practical experience ...'*

At the provincial hearings of the Construction Charter there were many calls for the previous training centres to be revitalised.

Essentially, the current learnership model makes all practical training the responsibility of the employer. With limited duration contracts (LDC) in place, training does not take place.

Furthermore, the learnership model offering various exit levels has its pros and cons. Although achieving a portion of the outcomes allows fast tracking to employment opportunities, interim qualifications are misleading. For instance, a certificate in bricklaying does not mean that the learner has been taught anything about laying face bricks, or constructing an arch.

Industry expressed the need for a national test, similar to the trade testing to be introduced at the end of the learnership, so that fully trained and competent artisans can be differentiated from those who have only a part qualification. This approach was also considered necessary as the continuous assessment method was proving a problem in terms of the quality of training offered.

The worth of artisans was noted by the Minister of Labour in his speech at the opening of the 2003 National Skills Development Conference when he said:

> *'… no one need be concerned that apprenticeships will suddenly cease to exist … I do not want to fully merge apprenticeships and learnerships until*

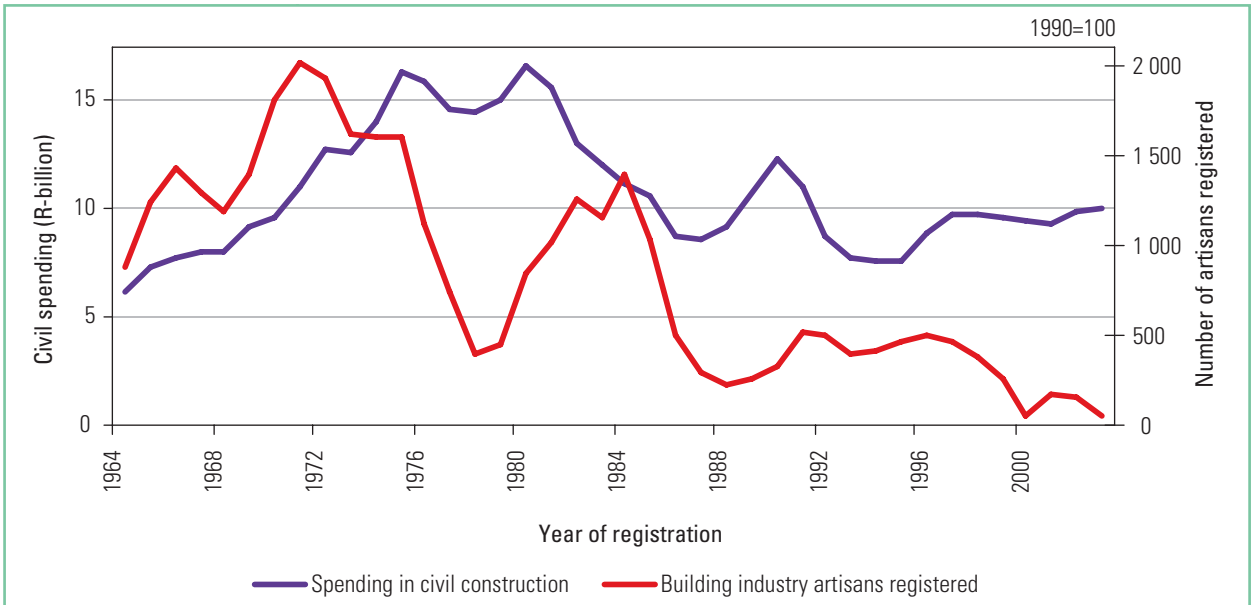


Figure 2.17 Building industry artisans registered, compared with civil spending, 1964–2002

'... Colleges must realise that employers will continue to train their own artisans unless they can rely on the quality and responsiveness of the colleges ...'

– Naledi Pandor

we can be sure that the graduates from the learnership system command a similar level of recognition from the labour market as artisans do …'

Artisans are a dying breed, a problem that is echoed worldwide, and urgent attention needs to be given to training before it is too late. This has been recognised by the International Labour Office (ILO), which stated:

'… trades are dying as skilled artisans retire and new entrants are not trained in these skills …'[7]

Similar problems were found in Ghana. See opposite!

Just as the large consulting firms are the training ground for young civil professionals, large contractors should recognise that they have a role to play in developing the artisans of tomorrow. Without renewed training efforts, there will not be resources to develop and sustain the many small contractors that service the millions of homes in South Africa for their electrical, plumbing, carpentry and other needs.

2.4.4 ECSA recognition

Seventy two per cent of the contractors that responded to this question indicated that they offered training for young graduates to gain experience and exposure to various facets of the industry, in order to become professionally registered with ECSA. Few responses from those who did not provide training said why they were unable to support young graduates.

Again there was a disparity between supporting the notion of workplace training and carrying out the activities!

Although 72% said their companies provided workplace training,

- only 20% regularly supervised the graduate's work
- only 24% regularly checked the graduate's work before it was issued
- only 44% regularly provided a more senior staff member to assist the young graduate at site meetings

When one of the parts of the ageing machinery in the Volta Dam, Hydro Electric Plant in Ghana broke, it could not immediately be replaced, resulting in a major power crisis because:

- The machinery was obsolete and parts could not be purchased
- The old fitter and turner who had always made spare parts had retired and no one else had been trained

A major search was mounted to locate him. Here he is, back on the job, having been retained to avert the crisis and train the next generation.

- only 20% provided a mentor
- only 24% moved graduates from one department to another to gain all-round experience.

Graduates who work for contractors are better off than other groups in terms of recognition of registration, because 55% of the contractors either promoted staff or gave increases on registration. However, the lack of checking is again cause for concern.

2.4.5 Contract employees

As a result of the boom and bust nature of the industry, the total staff make-up of most of the large contracting firms includes some 52% contract employees, termed 'limited duration contract employees' (LDC employees). Structuring staff in this way allows companies to reduce staff without major Labour Law implications when projects come to an end and no further work is available for the 'excess' staff.

Generally contract staff are more likely to be labourers, trade-workers (artisans), draughting staff and detailers than technologists and engineers. This practice contributes to the lack of artisan training, because artisan training and equivalent learnerships take longer than the duration of most projects.

2.4.6 The export market

The construction industry has long been anticipating boom times in South Africa as a result of the government's development plans. However, the slow rate at which the projects have been initiated has forced contractors to pursue profitable cross-border opportunities to match their skills base. Many may not return unless positions, salaries, benefits and the situation in South Africa are more appealing than abroad.

The 'State of the Civil Industry'[8] 2nd Quarter 2005 report showed that just over 20% of the turnover for civil engineering contractors across the board was earned outside the country. The development of roads and bridges in the SADC region is the most significant type of export work being carried out. Major construction companies report[9] that up to 50%, and in some case more, of revenue is generated outside South Africa.

2.4.7 Transformation

(a) Staff composition

Since professional capacity is being considered, administration staff, labour and trade workers have been excluded in analysing staff composition. While the white male still dominates, his share has dropped to just over 70%. (See Figure 2.18.) Transformation by age and quali-

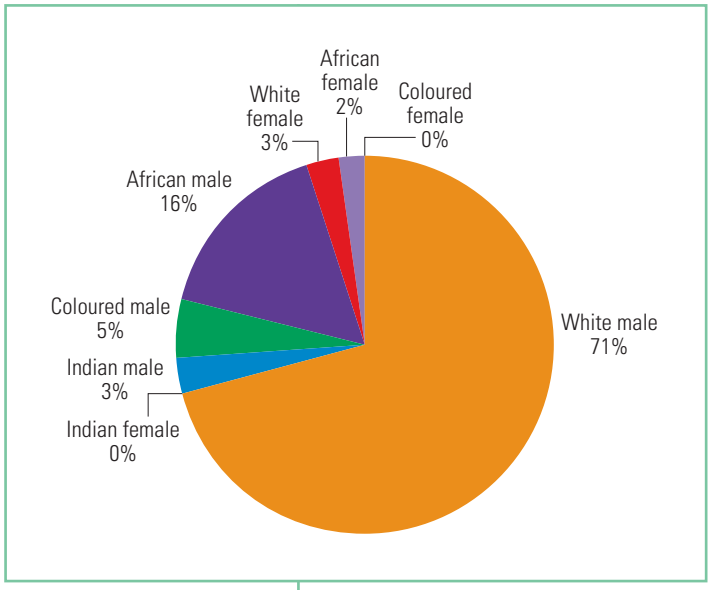


Figure 2.18 Transformation of civil professionals in contracting, 2004

fication is most marked at the technician level. The number of black engineers above 30 is limited, because few black learners were encouraged to enter tertiary education before the mid-nineties.

However, there are a number of recent recruits and Figure 2.14 indicates that there are many black graduates in training. The introduction of the national diploma civil engineering learnership has resulted in an acceleration of black technicians being appointed in the contracting sector.

(b) Types of company

Once again, in terms of company profiles there are three types of structure in the contracting field. These are medium and large, small established and emerging. The ownership and management structures are as follows:

(i) Medium and large companies

The largest organisations are public companies, listed on the Johannesburg Stock Exchange (JSE), which have significant assets and are multifaceted. They are involved not only in construction, but also in manufacturing and the supply of raw materials and equipment.

They employ professional managers for all major business functions such as HR, accounting and finance. Civil engineering professionals are employed in the top management roles, and run the technical functions.

(ii) Small established companies

These are long-established organisations owned by one or two white male professional engineers who have years of experience, and are usually now in their fifties. These owners were employed in the contracting field for 10 or more years before starting their own businesses and thus had gained experience, and understood the technical and business aspects of contracting as well as the risks, rewards and capital requirements before starting on their own. They generally manage all aspects of the business themselves including HR and the finances, although they may employ a bookkeeper, wage clerk or junior HR person and a secretary to manage the day-to-day paper work.

(iii) Emerging companies

The emerging contractors are generally owned and managed by non-technical people or inexperienced young technicians and technologists. Their understanding of business and processes is limited and a significant number of liquidations are recorded annually. International figures on failures of start-up companies show that this is not unique to South Africa. Lessons from successful companies should be heeded by all who are starting their own businesses.

Those companies that are successful can generally attribute their success to their founders being civil professionals with experience in the sector before starting on their own.

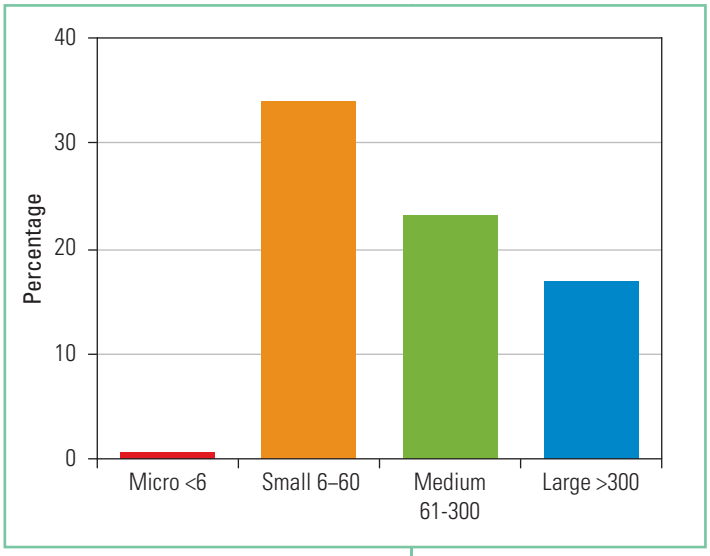
At the Construction Charter provincial hearings, young people complained that they were not being given enough support to start their own businesses. One young person asked:

'… how must students just qualified get the performance guarantees and working capital? …'

Going blindly into business with no technical or business experience is a recipe for disaster. Tertiary institutions need to instil into students the idea of gaining experience in all phases of the project cycle and the value of registering with ECSA.

Furthermore, they must be encouraged to remain in the industry for three to five years after registering with ECSA in order to have been exposed to all facets of the industry, rather than merely the basic technical and management criteria required for ECSA registration.

Emerging contractors are also established by other built environment professionals and experienced artisans. The latter have generally only held technical positions in the large companies in the past and, though technically very competent, need a great deal of business and financial support to succeed.



CTCG transformation survey

Figure 2.19 Percentage black ownership in civil engineering contracting by size, 2004

(c) Ownership

Until recently there has been little change in ownership in the established sector, with a few significant exceptions.

In terms of potential Construction Charter scorecards, the listed companies should consider their options in terms of selling shares to staff, or adjusting the share price and selling a significant portion to non-technical owners. There is a downside to this, as shares must be reserved for staff in order to be able to offer this incentive for staff retention.

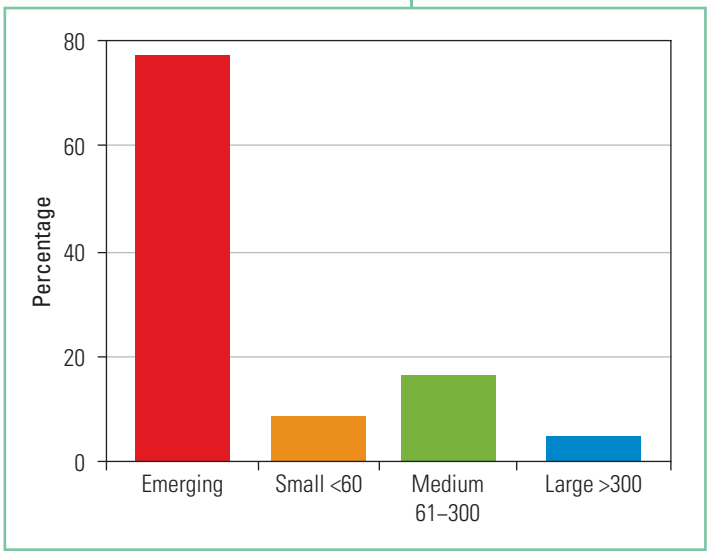
The transformation of ownership of public companies is therefore not a simple matter of selling shares to a selected group.

The ability to create additional shares and offer these to black staff gives considerable flexibility in transformation of public companies. The banking sector has led the way with many employee share-ownership plan (ESOPS) deals taking place in 2004. However, the longer-term impact on productivity and on staff retention of one group of employees receiving preferential treatment in terms of promotion and benefiting financially has still to be faced.

The companies that would be negatively affected are the established 50 to 500 staff organisations with only one or two professional owners. These smaller companies should be encouraged to impart their years of knowledge through enterprise development initiatives.

The promise of work has led to the establishment of thousands of emerging contractors, which gives rise to similar problems and concerns

Figure 2.20 Percentage black ownership in civil engineering contracting by company type, 2004



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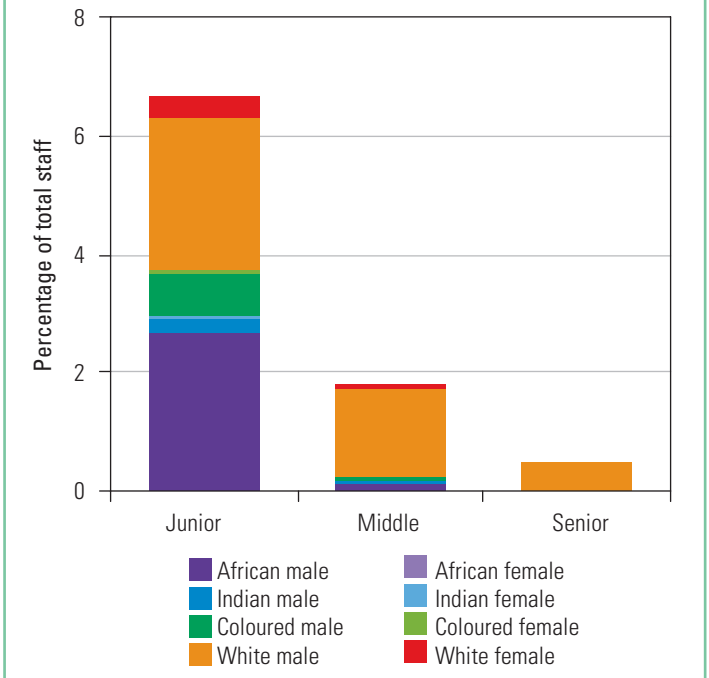


Figure 2.21 Employment equity profile in SAFCEC member companies, 2004

to those expressed under the consulting sector. This phenomenon is unsustainable. The SAFCEC study of emerging contractors from 1995 to 2002 showed that 40% fail within the first six months of start up, and less than 30% of those remaining are still active three years after start up.

The CIDB classification has been developed to address this problem. The challenge is now to link small emerging companies with registered professionals to assist with the growth of the small companies, and allow established companies to transform.

(d) Employment equity

There has been a steady increase in PDIs moving into junior management. The percentage of black junior management is very high, as it includes supervisors who are either young technicians or older black artisans who have risen in the ranks. (See Figure 2.21.)

One can therefore expect middle and senior management to become more representative. With the implementation of the Construction Charter, the need for career path development and succession planning has never been more critical. Companies need to recognise talented people within their ranks, in order to train, groom and retain them for more senior roles.

(e) Corporate social investment

Contractors are also committed to corporate social investment and list typical activities to which they contribute as follows:

- Armsorg Funds (Municipality Springbok)
- Career guidance
- Support for science centres
- Support of the SAICE Bridge Building Competition
- Child welfare
- Support for early childhood development
- Community upliftment
- Building classrooms and schools
- Donation of computers to schools
- Providing water to communities near contract sites
- HIV/Aids programmes
- HIV/Aids care centres
- Kinderhuise
- Training young candidate engineers and technicians
- Sponsorship of provincial hockey team
- Sports development / sports clubs
- Support for READ Educational Trust in primary schools
- Sponsoring chairs at tertiary institutions
- Teaching at technikons and universities and other educational institutions

2.4.8 Future demand

The shift from formal to informal and/or contract employment in the construction sector means that contracting companies rely largely on a core of highly skilled staff to supervise a largely semi-skilled and unskilled workforce.

Most respondents indicated the need for more civil engineering professionals for this purpose over the next two to five years. The number of technologists in contracting is low. Since it is becoming increasingly difficult to attract engineers into contracting, there is a pressing need for more technologists. Respondents indicated that they needed to more than double the number of technologists on their staff over the next five years.

Contracting is the ideal sector for technicians to gain experiential training, and the take up of these students is quite high. As such, additional future demand for technicians is below 5%.

2.5 Residential contracting

Residential contractors tend to be small companies, employing few civil professionals. Instead they employ more artisans (many not formally trained) and labour. The NHBRC (National Home Builders Registration Council) lists some 19 000 companies that have registered to build homes since its inception. The total employment in this sector is about 190 000.

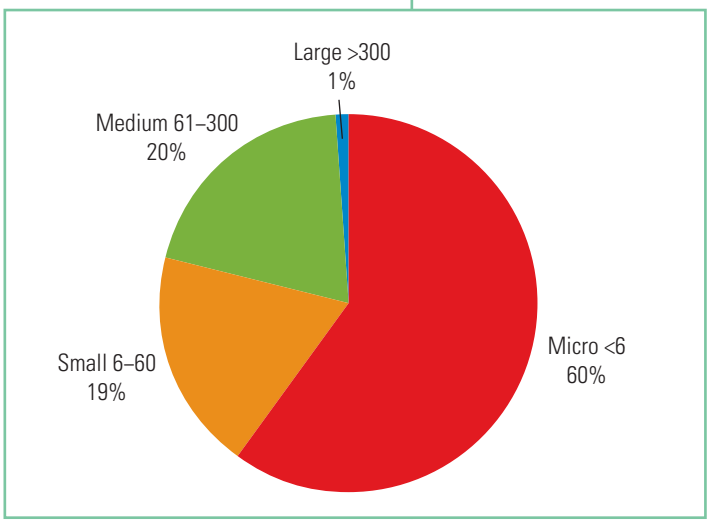
The sizes of companies range widely from one- or two-man labour-only home builders to larger companies involved in building luxury homes. (See Figure 2.22.)

The NHBRC has a mandate through the Housing Consumers Protection Measures Act (Act 95 of 1998) to provide warranty protection against major structural defects in new homes. In terms of section 10(1) of the Act, any person in the business of home building must register with the council. Evaluation of registration is based on the technical and construction capabilities and financial and credit worthiness of the applicant.

To qualify for a bond, home owners are obliged to use contractors registered with the NHBRC. To register, the person responsible for technical aspects of the business, who must be an employee, must submit a CV, outlining his or her highest qualifications, write a technical report, and attend a professional interview.

The NHBRC has a wealth of knowledge of the technical capacity in registered companies. Some 335 engineers, 384 technicians and 57 technologists operate in this sector.

Figure 2.22 NHBRC member companies by size, 2004



2.5.1 Transformation

Until April 2002 only companies that were involved in building properties in the bondable market were required to register with the NHBRC. The original companies were largely white owned. When registration was linked to all funding, including the government subsidy market, transformation began. Now one third of registered companies are black owned and black males dominate the staff composition in this sector.

As with all other sectors, building contractors complain of not being able to employ enough experienced professionals and artisans.

A total of 19 000 companies also present a problem in terms of competition and sustainability

– so much so that about 7 000 of these companies are no longer active, with only 12 000 companies having registered in 2004.

The NHBRC is embarking on a major business training programme for their member companies to ensure that they survive beyond the first 18 months.

2.6 Non-residential contracting

The non-residential sector addresses the construction of major private sector structures such as office blocks, industrial structures, shopping malls, leisure developments (including hotels, casinos and time-share resorts) and government projects (including national, provincial and municipal buildings, schools, hospitals, police stations, prisons, military bases and recreation centres).

Many of the major civil engineering contractors are involved in both civil and non-residential development, hence their profiles and demands were covered in section 2.4. Those companies that develop only major structures and not civil engineering projects tend to employ few civil engineering professionals, and utilise building science, construction management and quantity surveying graduates.

The established companies in this sector are represented by the MBSA, which boasts some 2 500 member companies, from the large office block developers down to the small artisan-owned companies. Emerging black contractors generally belong to ABA, NABCAT, NAFBI, SAWiC and WFH.

Industrial structures, being largely steelwork, fall under manufacturing (discussed later). In terms of staff shortages and transformation, these companies are experiencing similar challenges to those of the civil engineering contractors and residential contractors.

2.6.1 Transformation

Transformation issues are similar to those of the civil engineering contractors, with the large companies and established small companies still being predominantly white owned, apart from a few exceptions, mostly in the Western Cape. A plethora of small black-owned companies have sprung up to service smaller-scale needs of the public sector.

2.7 Specialist and sub-contractors

Figures from the Department of Trade and Industry (DTI) indicate that about 110 000 companies are registered in the construction industry. Because many shell and joint venture (JV) companies are created for specific tasks, it is estimated that only half to two thirds are active. In addition, many small companies are not registered for PAYE or VAT. These would add to the DTI estimate of companies in the sector. Sub-contractors and specialist contractors make up a large portion of these companies.

In 1997 the Department of Public Works (DPW) estimated that sub-contractors accounted for 65% to 95% of the labour employed on site in general contracting; 40% to 85% in home building; and 10% in civil engineering. There are two types of 'sub-contractors': those with limited skills, who are usually labour-only sub-contractors; and those who offer specialist skills, and are known as specialist contractors.

2.7.1 Sub-contractors

Over the past decade the industry has restructured in a way that has resulted in an upsurge in the number and range of informal work arrangements. This has happened largely through the system of labour-only sub-contractors (LOSC). LOSC perform narrowly defined tasks,

often not highly skilled, relating only to basic crafts, with materials and equipment being supplied by the main contractor. Civil professionals are generally not found in this group.

Sadly industry acknowledges that having taken this route to reduce their labour risks has resulted in:

> *'… a decline of productivity and quality of work ...'* as *' ... labour-only subcontractors do not have time, skill or facilities to train their workers ...'*[10]

At construction charter provincial hearings small contractors complained that employers use labour off the streets without complying with minimum law requirements. The CIDB register appears to limit small contractors to opportunities as sub-contractors and they are not able to grow and handle their own projects. A great deal of effort is needed to grow the skills in this sector.

2.7.2 Specialist contractors

Generally specialist contractors have their own tools and supply their own material.[11] Specific tasks in major contracts are outsourced to these companies, or they may handle stand-alone specialist contracts.

The list of activities in which these companies specialise is endless, including aluminium fittings, brick laying, carpentry, carpeting, ceilings, cleaning, concrete units, fencing, finance, flooring, glazing, guttering, investment, marble and granite, mirrors, painting, partitions, paving, piling, plant hire, plumbing, pools, reinforced earth, roofing, shop fitting, surveying, thatching, tiling, wall coatings, wallpaper, waterproofing and welding.

A limited number of civil professionals are employed in these companies, mostly in the more high tech fields such as precast concrete units, piling, pool construction, quarrying associated with supplying marble or granite, and reinforced earth.

2.8 Industrial engineering

For some years the specialist nature of industrial civil engineering has been recognised in the construction industry. Industrial civil engineering covers the civil engineering needs of industry. The term 'industry' refers here to organisations that produce large quantities of quality material goods and services.

An industrial development may include production and non-production buildings; raw material, intermediate and final product storage and handling facilities; equipment, services and utilities; and infrastructure. Most activities take place in heavy industrial developments, although light industries require specific assistance. Among the industries requiring industrial civil engineering input are metallurgical, mining, power generation, cement and building materials, petrochemical, paper and wood, food and beverages and heavy machinery manufacturing.

The interests of industrial engineers are served by the Southern African Institute for Industrial Engineering (SAIIE), while corporate interests are served by the Industrial Development Engineering Association (IDEA).

Industrial projects are handled by multidisciplinary design consultants and multidisciplinary contractors (many of them major international players) who undertake major capital projects in mining, mineral beneficiation, petrochemical and many other industrial sectors. They assume the engineering-procurement-construction management role (EPCM) or engineering-procurement-construction (EPC) role.

2.8.1 EPCM and EPC contracting

EPCM contractors act as the agent for the owner of the project, carrying out procurement 'for and on behalf' of the owner, and managing vendors and the construction activities of several contractors. The EPCM contractor's responsibilities usually run through to 'cold' commissioning only and hand-over of the facility, to be 'hot' commissioned by the owner's team.

EPC contractors undertake to deliver the entire project. This includes providing plant, performance guarantees, procuring all equipment and materials, and carrying out all construction in their own right. When the EPC contract is drafted around the delivery of a completed facility that meets certain performance requirements of the owner for a fixed price, the term 'lump sum turnkey' (or LSTK) is used to denote this arrangement.

Both EPCM and EPC contractors typically provide engineering and design across the full range of disciplines from front-end and detailed process (or chemical) engineering.

In addition to engineering, the EPCM or EPC contractor is required to provide project- and construction management; project controls (planning, cost engineering and estimating); procurement (including contracts administration, logistics and expediting); information management and document control; quality assurance and control; health, safety and environmental; and pre-commissioning services. Civil engineering professionals perform many of these activities.

2.8.2 The professional profile

Owing to the multidisciplinary nature of these organisations and the need to understand all facets of the projects, the number of engineers is more than double the number of technicians and technologists, although this sector uses only 1% of all civil professionals in South Africa.

2.8.3 Demand

Owing to the complexity of industrial projects, highly experienced staff are required. This sector complains of shortages and has supplemented its capacity by using state-of-the-art technology that allows designers and detailers to carry out much of the work elsewhere in the world. Many offices operate 24/7. They tap into capacity in Australia and Southeast Asia and the Americas.

It may be necessary for consulting practices to adopt a similar approach if South Africa is unable to build sufficient capacity locally to address their needs.

2.9 Mining houses

Historically, mining houses had large design offices that were involved in designing not only the mining process, but also a large portion of the civil and structural works for the mine itself, and the mine properties and services for the communities employed on the mines.

In the nineties the need to downsize and concentrate on core business saw most mining houses close their non-core divisions, and appoint industrial companies or EPCM or EPC contractors (discussed above) to carry out their civil and structural design work. Few civil professionals are found in any of the mining houses, with one or two exceptions. As a result, this sector has a negligible effect on the numbers of civil professionals who must be trained.

Interestingly, electrical and mechanical engineers deployed in the mines receive comprehensive training in concrete technology, since large volumes of concrete are poured underground during the development of the stopes.

2.10 Manufacturing and supply

Assessing the number of civil engineering professionals employed in the supply chain is extremely difficult as most suppliers are not limited to supplying to the construction industry. Timber for instance may be used as a structural element, or it may be used in other fields such as furniture, mine props, pulp and paper.

Few civil professionals are to be found in the residential supply chain, which covers bricks, fittings and finishes. In the non-residential and construction supply chains, civil professionals are employed in companies supplying products relating to the major structural components and civil engineering services. Products relating to non-residential fittings and finishes are the domain of other professionals.

The major civil engineering suppliers are the suppliers of steel, cement, pipes, and road and rail materials and these were canvassed. Most technical staff were involved in research and development (R&D);[12] production and quality control. Contrary to the belief that R&D is not happening in the construction sector, research at UCT indicated that R&D was taking place in construction materials and component manufacturing. Companies cited their reasons for investing in R&D as:

- competitive advantage
- product differentiation
- prestige/excellence
- awards/rewards

However, sales staff in these organisations are artisans and not civil engineering professionals.

This finding should also arouse concern, since the training of artisans has largely been dismantled over the last 10 to 15 years. This means that artisans with the technical knowledge to support the industry on matters relating to usage and specifications will not be available, and in time the quality of support from suppliers will decrease, perhaps even impacting on safety.

Each of these sectors is now examined in more detail:

2.10.1 Raw materials

Large volumes of raw materials such as sand, stone, and cement play a major role not only in the development of concrete components and structures, but as foundation material for roads, rail and pipe bedding. The demand for these raw materials has been on the increase (see Figure 2.23).

These industries employ mostly unskilled labour and a few technical staff who are involved mainly in R&D to ensure improved production and extraction of material and use of the products, and improved product performance. Many of the major suppliers are listed companies that have already made progress in terms of BEE.

2.10.2 Manufactured goods

Suppliers of pipes, valves, pumps, processed materials such as steel and bitumen are increasingly restructuring into separate manufacturing and supply units.

R&D and manufacturing remain in high tech companies, employing significant numbers of engineers, technologist and technicians to carry out R&D, quality control and production management. The supply chain is transforming into many independent SMMEs or franchises, which are largely black empowered or black-owned companies.

The ratio of senior technical staff to the total employed in the sector is about 1:80. The senior technical staff consist largely of ageing white males with vast experience who are still

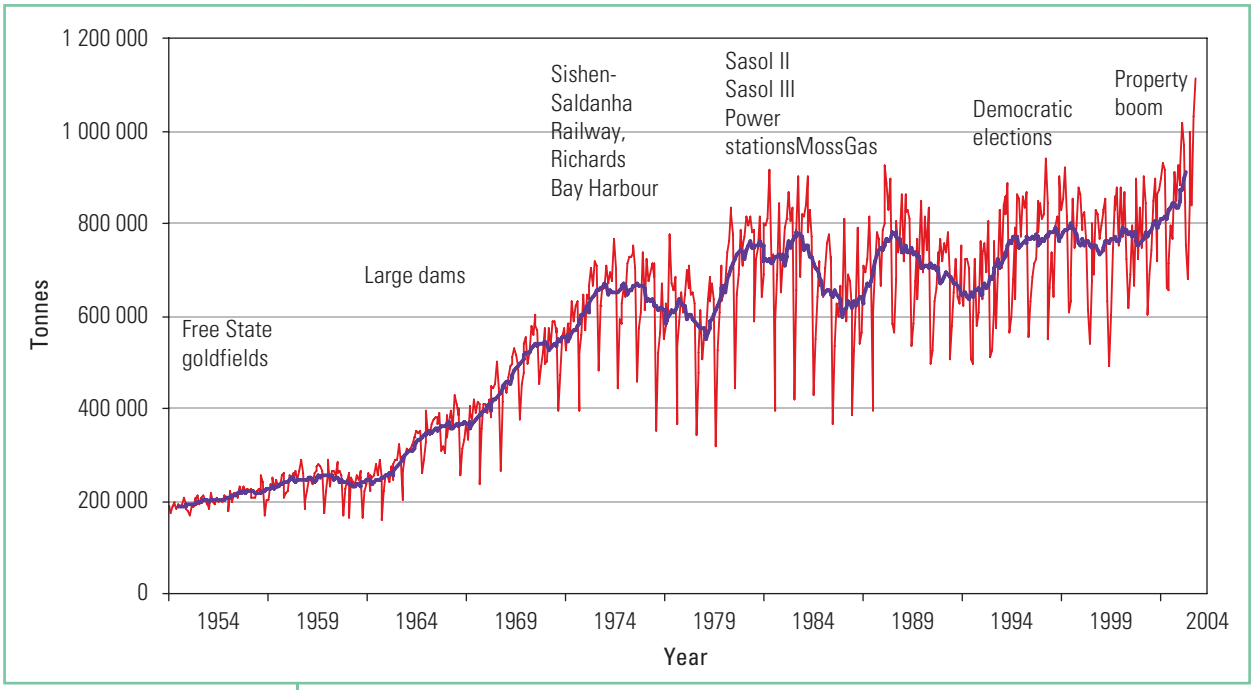


Figure 2.23 Cement sales (metric tonnes) 1952–2004

applying their knowledge to keep companies ahead of the competition, and ensure continuously improving efficiencies. There is a need for younger and mid-career staff.

The Steel and Engineering Industries Federation of South Africa (SEIFSA) represents the majority of employers in steel manufacturing and engineering and recently published the FRIDGE[13] (Fund for Research into Industrial Development Growth and Equity) Report on retention and job creation. They comment that:

> *'… the sections in which the majority of surveyed respondents experience the availability of skills as a restraint are also those that are more "design-intensive" …'*

(a) Steel – structural steel

The manufacturing category includes the many steelwork fabricators who manufacture and erect steel structures from industrial and farm sheds to frameworks for multi-storey buildings. Trade workers tend to dominate the staff in these organisations, although designers and detailers are required. Here the ratio of civil/structural engineering personnel to total staff is about 1:90. The profile of the technical staff is ageing white male, and alarm bells are ringing as the ratio continues to increase.

The lack of artisans and structural detailers is causing the greatest concern. Many of the retiring detailers were trained artisans such as boilermakers who had worked their way up into the drawing office. They had exceptional understanding of the detailing and fabricating processes. Comprehensive training needs to be initiated very urgently before the ageing group are no longer available to train replacements.

(b) Steel – formwork

The formwork industry also falls into this category. Here the ratio of technical personnel to total staff is roughly 1:40. The profile is also one of ageing white males whose numbers

are dwindling fast. The work is highly specialised and the industry has failed to attract young entrants. As a result, international companies are now making their debut, as their resources are such that South African clients are experiencing better response times from the international teams than the depleted local teams.

Companies that belong to the South African Institute of Steel Construction (SAISC) employ 55 000 staff. In a recent survey SAISC found that although there is physical capacity to support increased production, there is little capacity in terms of skills. It is critical, as in consulting and contracting, that this sector should score highly in terms of training and knowledge transfer in the Construction Charter.

2.10.3 Equipment

Civil engineering is known for its construction equipment, fondly termed 'yellow machines'. Suppliers of yellow machines reported significant increases in sales in 2004, particularly in low-end equipment, which was largely purchased by SMMEs for labour-based projects.

Many innovative 'low-end' pieces of equipment have been developed to allow small contractors to perform at a higher level where more sophisticated activities were previously carried out by larger contractors.

This sector uses a limited number of civil engineering professionals, as the components are largely mechanical and are developed and supported by the mechanical and electrical professionals.

CONCLUSIONS

To match the demand, significant numbers of civil engineering professionals must be educated and trained. Staff who left the industry should be enticed to return and retention mechanisms must be put in place to ensure that losses from the industry are kept to a minimum.

Building blocks

Before considering how to address these shortages, the supply-side and associated constraints will be discussed in Chapters 4 to 7. An adequate supply of well-trained professionals is very important to the industry. To develop a stable pool of professionals the following are required:

To address the core government goals of poverty alleviation and development through employment creation and skills development, the 'Chippie' was born to revolutionise traditional road surfacing methods.

This hand-operated chip spreader, developed by Deon Pagel of Tarfix, has raised labour-intensive methods above demeaning back-breaking procedures. Using the chip spreader, labour-based methods allow quality results equivalent to those of machine-based methods, with no cost premium.

While the Chippie is at the entry level of the 'yellow machine' market, it is contributing to increased equipment sales.

- High-calibre matriculants
- Quality graduates from tertiary education
- Entrants into the profession
- Employment and training opportunities
- Sufficient numbers of projects to sustain employment of the human capital so developed

RECOMMENDATIONS

Reconstruction required

The interventions that are required to ensure that the building blocks are in place will be discussed under each of the supply chapters. However, changes in approach are important from a corporate point of view.

- **ECSA registration:** There a lack of recognition of the value of ECSA registration. Hence graduates are given insufficient support to develop the required competence. It is necessary to:
  - Develop learnerships to cover workplace training in order to register with ECSA
  - Create awareness in the entire sector of the importance of ECSA registration and the associated training
  - Create awareness among students and recently graduated population must be aware of the ECSA criteria and ensure that they are offered adequate training by their employers
  - Create awareness among employers of the value of ECSA registration and encourage them to provide suitable training

The training of draughting staff and artisans is outside the scope of this project. However, it is essential that:

- **Draughting:** The requirements for a draughting qualification appropriate to civil engineering should be researched and implemented as soon as possible
- **Artisans:** A new approach to artisan training should be implemented as soon as possible.
  - Training colleges with appropriate equipment should be established where potential artisans can not only learn the theory, but also do their practical training before going to site
  - A national test, equivalent to trade testing, needs to be promoted once again, to differentiate those who are partially trained from those who are fully trained and competent

Suggested Construction Charter activities

Transformation and sharing of knowledge and experience are key to growing the industry and the economy. There are many emerging contractors whose principals have technical skills at artisan level, but who require business support and a professional on the staff to climb the CIDB ladder. On the other hand, many small professional firms are trying to find suitable black partners.

Structured networking needs to be set up to introduce emerging and established professionals in order to:

- Create potential alliances for mergers
- Enable emerging companies to meet professionals who can help with their company growth
- Enable established companies to identify companies in which they can offer supervision, training, mentorship or enterprise development

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12 Adrian Lawless, Innovation and the use of R&D by construction materials and component manufacturers in South Africa, BSc (Hons) research report, University of Cape Town, 2004.

13 FRIDGE (Fund for Research into Industrial Development Growth and Equity), Study to Facilitate the Formulation of an Integrated Strategy for the Retention and Creation of Employment in the South African Metals and Engineering Sector, FRIDGE, 2003, p 5.

CHAPTER 3

The public sector

INTRODUCTION

In the past most departments responsible for infrastructure in the public sector had large technical departments, yellow machines and site teams who carried out all maintenance and construction of most small projects and many larger projects.

This model has now changed. Technical departments have become strategic, and only initiate projects that are designed and constructed by the private sector. This is particularly true of national government and increasingly so in local government. The Departments of Transport in the provinces and Spoornet/Protekon still tend to carry out a significant portion of their own design and construction work.

As a result of this shift, work from the public sector accounts for more than 70% of the work carried out by civil engineering contractors in South Africa. Furthermore, many residential and non-residential contractors are involved in government housing projects and the development or refurbishing of hospitals, schools, prisons, recreation facilities, etc.

In order to conceive, adjudicate and manage projects, as well as continue with maintenance and react timeously to service emergencies, all technical departments still require civil engineering staff. Unfortunately the number of staff has drastically reduced.

Since the business of most organisations covered in this sector is based on the delivery, operation and maintenance of civil engineering infrastructure, reduced capacity means that departments are unable to spend their budgets and service delivery is being hampered.

Over 300 000 people are employed in local government, the water sector, the parastatals, provincial and government departments providing civil engineering infrastructure. It is therefore imperative in terms not only of the delivery of infrastructure, but in supporting such a large sector that efforts should be put in place to address the demand for more technical staff.

'… Clearly this situation has to change in favour of the skills profile … geared towards meeting the development needs of our people …'

– Thabo Mbeki, 2000

THE STATUS QUO

3.1 Local government

Traditionally local government has been a major employer of civil engineering professionals. Engineers occupied the key roles of city or town engineer and senior engineers/designers, while civil technicians generally managed maintenance and operations.

3.1.1 A decline

The demand for civil professionals in the public sector should have increased and not decreased, as most councils are now responsible for at least twice the area and population than before the new demarcations of 2 000. Some have expanded by up to ten times the area and have seven times the population to service. Further, the Millennium Development Goals (MDG) require an acceleration of infrastructure delivery.

As a result of the restructuring in local government and the appointment of an additional, non-technical senior level of management, an understanding of the importance of professionals has been lost. Significant numbers of professional staff have been offered

Shortage of engineers in state departments


Engineers, Mbeki wants you!

By Ryan Nash
Engineering News Staff Writer

President Thabo Mbeki is on the prowl for engineers to join the public service as part of his vision for reskilling government.

Engineering News, March 2000

Table 3.1 Percentage vacancies in local government reported from WSP submissions

Occupation	Skills shortage	Employment Equity requirement	Other, including budget constraints	Total
Leadership & governance	0,00	0,00	0,13	**0,13**
Senior officials and managers	1,01	0,09	2,37	**3,57**
Professionals	3,99	0,13	1,67	**5,79**
Technicians/associated professionals	12,76	0,22	1,27	**14,25**
Skilled agriculture & fishery workers	0,00	0,00	0,00	**0,00**
Clerks	11,79	1,05	6,62	**19,46**
Service workers	8,11	0,26	4,25	**12,62**
Craft & related workers	1,67	0,04	1,27	**2,98**
Plant, machine operators	5,61	0,26	5,09	**10,96**
Elementary occupations	21,96	0,18	8,20	**30,34**
Total	**66,90**	**2,24**	**30,86**	**100,00**

LGWSETA

early retirement, or have been replaced by non-technical decision makers and have left the sector because of extreme frustration. Recent research has reflected extensive vacancies and associated problems.

Table 3.1 was prepared by Local Government Water Sector Education and Training Authority (LGWSETA) from the workplace skills plans (WSPs) that were submitted. It is believed that this information grossly underreports the professional and technical vacancies, since only those councils with adequate capacity have been able to fill in and submit their WSPs!

Visits to two councils per province, one large and one small, yielded individual vacancy statistics which are much higher than those reflected above.

Further, the research included a complete census of all civil professionals in the 284 local and district municipalities and metros. The civil engineering professional statistics are as follows:

- **No civil professionals**
  - Of the 231 local municipalities 79 have no civil engineers, technologists or technicians
  - Of the 47 district municipalities 4 have no civil engineers, technologists or technicians
- **Only one civil technician**
  - Of the 231 local municipalities 42 have only one civil technician
  - Of the 47 district municipalities 4 have only one civil technician
- **Only young staff**
  - Of the 231 local municipalities 38 employ only technologists and technicians under the age of 35
  - Of the 47 district municipalities 6 employ only technologists and technicians under the age of 35
- **Only 70 with civil engineers**
  - Only 45 of the 231 local municipalities have any civil engineers
  - Only 25 of the 47 district municipalities have any civil engineers

Local and district municipalities who did have civil staff reported that on average 35% of the existing posts were vacant. Others reported that where there had been budgetary constraints, vacant posts were removed from the organogram to balance the books. Still

others advised that over and above the vacancies in existing posts, newly created posts could not be filled. Alarmingly organograms in some municipalities made no provision for technical staff at all. This seems to indicate that vacancies would be in excess of 40%. Metro vacancies ranged from 30 to 50%. The average is also taken as 40%.

In a paper entitled 'The forgotten municipalities'[1] delivered at the IMESA (Institution of Municipal Engineering of South Africa) conference in 2004, it was suggested that many councils were not able to deliver services because many new structures were still being established. While this is definitely true of district municipalities, most local municipalities were constituted by combining several smaller structures into a larger unit, on the premise that they could make better use of resources if consolidated into larger structures. It is particularly disturbing that larger councils that previously employed ten and more technicians, technologists and engineers, now have only one or two, and in some instances no civil professionals on their staff.

The severe shortage of civil professionals in local authorities was noted for the first time in the SAACE CEI Report[2] of September 2004. It was reported that in the first half of 2004 local government replaced the private sector as the single most important client for both small and large firms, although the larger firms were more reliant on government work.

While the increased workload may in part be attributed to government's policy to make greater use of the private sector, the author believes that it is largely due to ever-reducing capacity at all levels of government.

3.1.2 The professional profile

In the past municipalities that were Grade 9 and above required a registered Pr Eng with a minimum of 10 years' experience to fill senior posts such as director of technical services, town engineer and deputy/assistant town engineer. The sound infrastructure in these established cities bears testimony to the understanding and experience of these professional leaders.

These stringent criteria have been relaxed and in many instances have been done away with altogether. The author glimpsed an employment policy document that stated 'do not be too rigid on qualifications or experience'. Now inexperienced young technicians, graduates in other built environment or engineering professions, and even non-technical staff are employed in senior positions.

As a result, decisions are often delayed, or are taken without understanding the upstream or downstream effect of new developments, impacting on the ability to service and maintain the extended areas. The problems relating to the restructuring of local government are covered in Chapter 9, 'Drivers and inhibitors – the public sector'.

There are now only 381 engineers in municipalities nationwide (240 of whom are employed in the metros), 369 technologists and 784 technicians. The composition of civil engineering staff in metro, local and district municipalities is shown in Table 3.2.

University training of civil engineers covers one year of basic scientific study, followed by

Table 3.2 Civil professionals employed in all levels of local government

	Municipalities	Engineers	Technologists	Technicians	Total
District municipalities	47	43	43	154	**240**
Local municipalities	231	98	100	377	**575**
Metros	6	240	226	253	**719**
Total	**284**	**381**	**369**	**784**	**1 534**

three years of intensive study in all technical fields, including structures, water, sanitation, roads, geotechnical and an introduction to environmental engineering and project management. To register as a professional engineer, the graduate must work for a minimum of three years to gain sufficient experience in all facets of the project cycle. After registration the engineer should have all-round knowledge of his or her chosen field.

In contrast, the technician receives one year of basic scientific training followed by a year in the workplace and returns for one year to study basic structures, water, sanitation, roads, etc. This means that technicians generally perform well on a practical level, but lack the broad perspective of planning and strategy that the engineer develops.

The introduction of the BTech degree has enabled technicians to choose subjects in which they wish to specialise. They return to universities of technology (formerly technikons) for a further 18 to 24 months, mostly part time, to specialise.

BTech graduates are highly sought after because they have specialist knowledge in a particular field and become specialist designers or leaders in these fields. A BTech qualification in water and sanitation or in roads is therefore ideal for staff working in specific departments of local government. Registered technologists are able to perform well in specialised fields and are considered as technically competent as engineers in that field.

A problem arises at the more senior levels when a technologist becomes a technical director or similar, and must take responsibility for all aspects of municipal engineering, covering many facets for which he or she has inadequate training.

The previous appointment criteria for the various levels in technical departments called for specific qualifications, registration and a minimum number of years of experience. In pursuing equity targets, the age profile and hence level of experience have dropped significantly in the past few years.

Figure 3.1 The civil engineering profile by age, race and qualification in district municipalities

(a) Capacity in district municipalities

The age reduction phenomenon is particularly acute in district municipalities (see Figure 3.1). This lack of experience and expertise is not only problematic for a municipality in

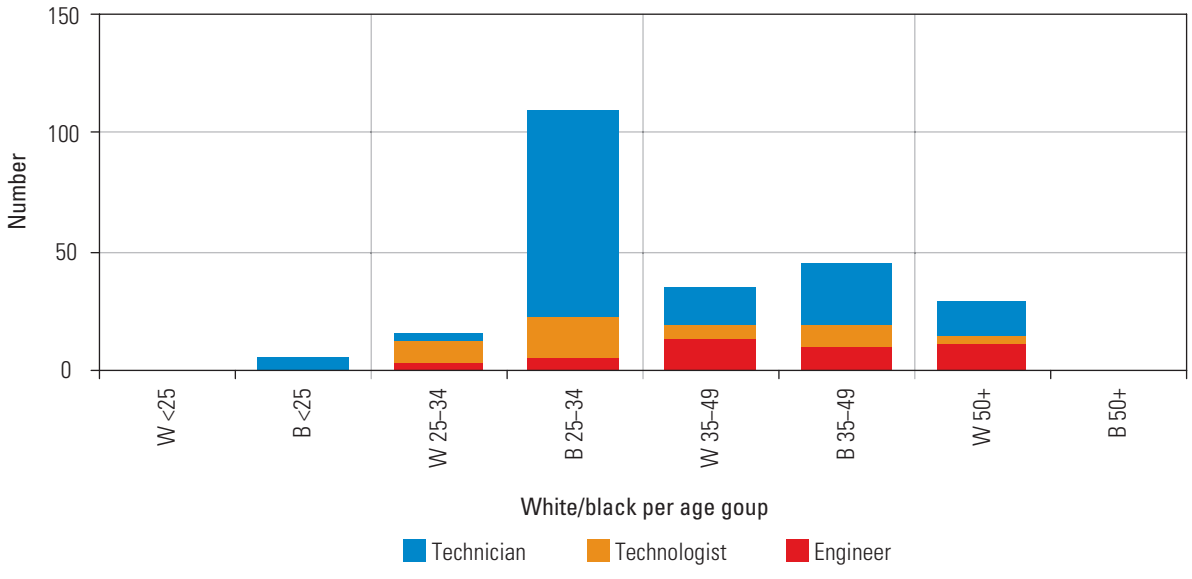


Table 3.3 Additional staff required to roll out MIG in some district municipalities

District municipality							
Number of people required	For budgets within the following ranges						Total
	Up to R20 million		R20 to R50 million		R50+ million		
	Internal	External	Internal	External	Internal	External	
Engineers	1	6	2	1	4	2	**16**
Technologist	-	1	-	-	6	-	**7**
Technician	1	10	2	2	13	3	**31**
Project managers	5	-	-	-	11	8	**24**
Others	1	2	2	-	10	3	**18**
Total	**8**	**19**	**6**	**3**	**44**	**16**	**96**

terms of delivery, but is tough on the incumbents on whom unrealistic demands are made, considering their level of experience.

In terms of project management units (PMUs) tasked to deliver basic services, there is an acute shortage of capacity (see Table 3.3). These figures were reported by 11 units, suggesting that even more staff will be required for the remainder of the units.

(b) Capacity in local municipalities

The profile in local authorities is somewhat different. The smaller local authorities have no civil staff, while the established councils still employ staff from the previous structures who did not wish to move to other jobs or other centres. But most of the senior staff will be retiring in the next five to seven years and there is an urgent need to employ and train more young people.

The majority of young people in Figure 3.2 are employed in the smaller municipalities where there are no senior staff to train them.

Figure 3.2 The civil engineering profile by age, race and qualification in local municipalities

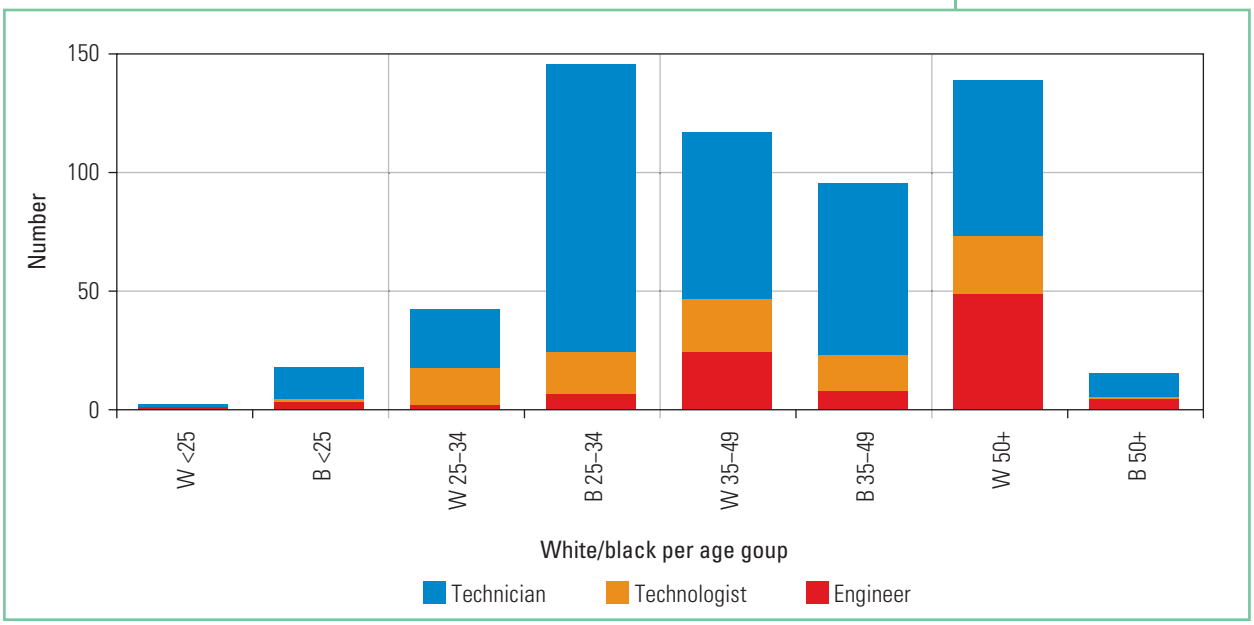


Table 3.4 Additional staff required to roll out MIG in some local municipalities

Local municipality							
Number of people required	For budgets within the following ranges						Total
	Up to R20 million		R20 to R50 million		R50+ million		
	Internal	External	Internal	External	Internal	External	
Engineers	8	16	1	2	5	14	**46**
Technologist	11	1	1	-	10	17	**40**
Technician	17	-	6	-	22	32	**77**
Project managers	3	11	5	3	11	7	**40**
Others	-	7	-	-	7	4	**18**
Total	**39**	**35**	**13**	**5**	**55**	**74**	**221**

In terms of PMUs tasked to deliver basic services, there is an acute shortage of capacity (see Table 3.4). These figures were received from 23 units, suggesting that even more staff will be required for the remainder of the units. A total of 100 additional internal technical-staff was required and support from additional 103 external technical staff, sourced from consultants, was needed.

(c) Capacity in metros

The metros have a better mix of experienced staff, with many in mid career, working their way up to senior positions. (See Figure 3.3.) Furthermore, there are proportionally more engineers and technologists in the metros than in local or district municipalities. There is, however, a need to employ and comprehensively train additional young people, particularly engineers.

3.1.3 ECSA recognition

It is clear from the responses that there is a general lack of knowledge in local authorities of ECSA's requirements for professional registration and the benefits. There also appear to be a lack of motivation and resources to provide the appropriate workplace training and range of experience required for registration.

ECSA, SAICE, IMESA and other role players must increase their efforts to inform, assist and convince government departments and municipalities to provide appropriate support to enable graduates to achieve professional registration within a reasonable time.

Most senior civil engineering respondents agreed that professional registration was important and that registration should be recognised and rewarded by means of a salary increase or promotion. The opposite view is held among senior non-technical management, councillors, politicians and human resource departments.

This presents a serious challenge to all parties involved to change this perception. This attitude affects technical staff negatively in many ways. For instance, remuneration tends to be well below that of other professionals in local authorities who have equivalent or less education and training

Only 40% of the local municipalities, 45% of the district municipalities and 55% of the metros indicated that they offered training for young graduates to become professionally registered with ECSA.

Although nearly 50% said they provided workplace training, only 15 to 30% supervised or

checked the graduate's work and provided a mentor, while only 16% in local and district municipalities moved graduates from one department to another to gain all-round experience. The metros put much more effort into 'hand holding' and moving staff from division to division.

Built environment legislation will soon prescribe registration for engineering appointments. By the end of 2005, identification of work reserved for engineering professionals will create even greater challenges for local authorities to employ suitable staff to comply with the law.

3.1.4 Transformation

(a) Staff composition

Transformation is most evident in remote areas. Many of the young technicians who were interviewed were passionate about making a difference to the communities from which they came. This trend has been observed in other developing countries. Management is generally in the 35 to 41 age bracket in these areas.

There is still a preponderance of white males in the main centres and the metros. Management are generally in their late forties or fifty plus in these councils. There are few black professionals over the age of 41 and relatively fewer white professionals below 41 (see Figure 3.4).

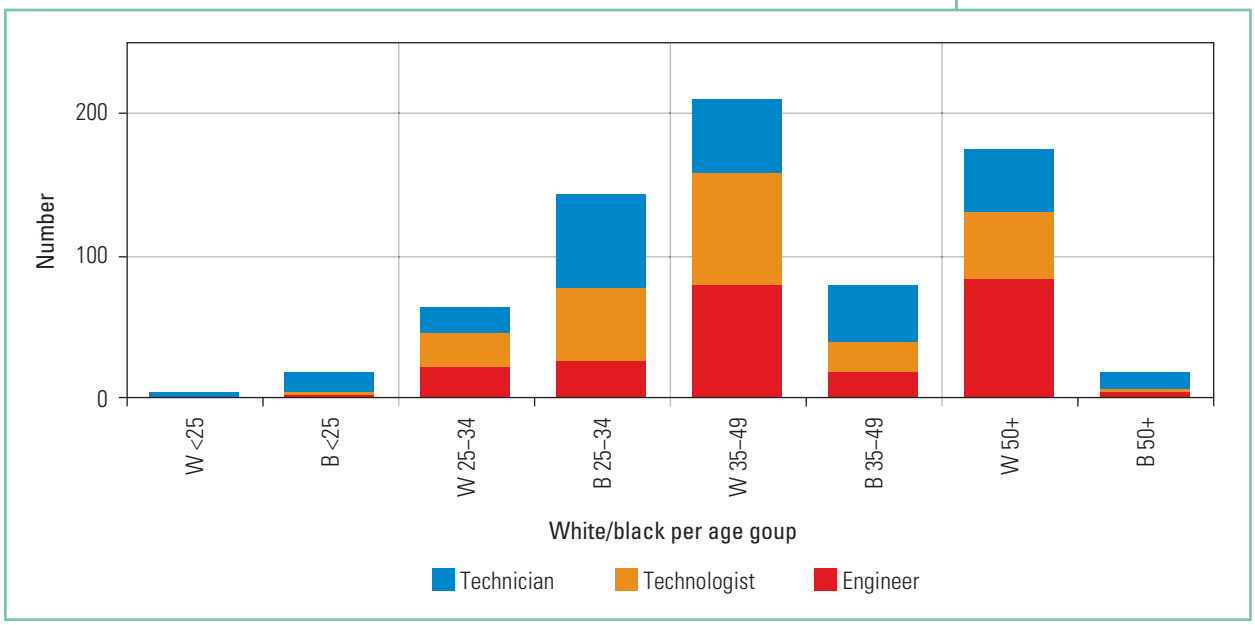
(b) Corporate social investment

Recognising the need to transform, councils have started to invest in secondary education, bursaries, training and development of PDIs, and their families. Most effort is expended by the metros. Local government and district municipalities have little capacity to deal with their own development, let alone attend to CSI matters.

3.1.5 Future demand

The current composition of staff needs to be understood and the decline must be reversed, if sensible decisions are to be made in terms of appropriate and sustainable new developments, maintenance and operations.

Figure 3.3 The civil engineering profile by age, race and qualification in metros



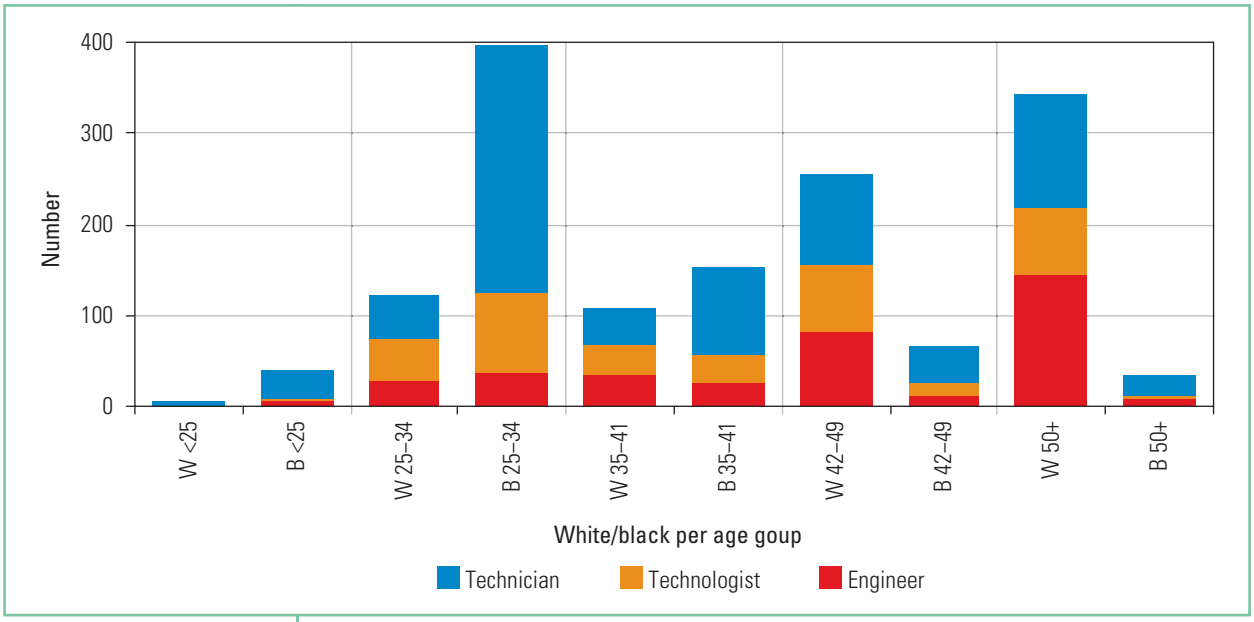


Figure 3.4 The overall civil engineering profile by age, race and qualification in local government

Over one quarter of those interviewed reported a shortage of good, experienced technical staff as a stumbling block. Almost as many stated that employment equity (EE) was a problem when recruiting experienced technical staff.

The following would therefore be minimum estimated shortages (see Table 3.2):

(a) Local and district municipalities

Where there are no civil professionals, it is assumed that at an average of two per municipality will be required, that is, a total of 156.

In those municipalities that do have staff, at least 543 professionals will be required to fill the 40% vacancies.

(b) Metros

The metros currently employ 719 civil engineering professionals, with an average vacancy figure of 40%. This will require an additional 480 professionals.

Almost 1 200 civil engineering professionals will therefore be required to fill vacant posts in local authorities alone. The demands from other tiers of government are no less severe (as will be seen later in the chapter).

While it is understood that the design and construction of new projects may be handled by the private sector, it is critical that technical staff, who understand the social versus economic infrastructure needs of the council and the impact of development on all communities, must conceive projects, negotiate with communities and politicians, and define and manage the development of solutions that are affordable, appropriate and sustainable.

Richard Kruger,[3] director, Infrastructure Implementation at the Department of Local Government (DPLG) commented,

> *'... the municipal engineer is the key to drafting the capital budget and the operation and maintenance budget. If there is no proper plan to address the infrastructure programme over the short to medium term, it could lead to the total collapse of services …'*

The 'stricken municipality' phenomenon has already been experienced and has been widely reported recently.[4]

The Millennium Development Goals (MDG) pose even greater challenges. Barry Jackson, policy analyst at the Development Bank of Southern Africa (DBSA), stated:

'… the Municipal Engineer is the only one who can deliver on the Millennium Goals …'

'… the Municipal Engineer is the only one who can deliver on the Millennium Goals …'

3.2 Provincial government

3.2.1 A decline

The number of professionals employed in the provinces has dropped steadily over the past 10 to 15 years. Many provinces reported unfilled key posts that had been vacant for up to seven years. Some provinces are considering recruiting Cuban engineers to fill vacant posts.

While the supply of basic services and, to a lesser extent, housing has been decentralised to local government, the same cannot be said of provincial roads, which are still the responsibility of the Department of Transport in each province. However, in these departments civil staff have continued to drop.

Expenditure on equipment and maintenance has been vastly reduced, so the number of staff has been reduced and the departments feel that they are now unable to offer the service required in terms of development and maintenance.

Two anecdotes highlight the result:

(a) Repairs after the 2000 floods

After the 2000 floods, six months elapsed before major repairs took place on affected provincial roads. Frustrated staff said that previously the senior engineers would simply have ordered the maintenance crews to re-prioritise and relocate to the problem areas immediately after the rain had stopped, and roads would have been repaired within weeks if not days. The inability to take prompt decisions in this case caused enormous hardship and additional damage.

(b) Deteriorating infrastructure

Lesotho engineers, who have travelled to Bloemfontein for many years to attend meetings and to do their shopping, complain of the deteriorating condition of the Lesotho to Bloemfontein road.

3.2.2 The professional profile

The ratios are as follows:

(a) Transport (and public works in some provinces)

- Engineer to technologist 1:0,2
- Engineer to technician 1:1,7

(b) Other provincial departments (housing, public works and local government)

Several other provincial departments such as housing, public works and local government employ civil professionals. The aggregate ratios across these departments are as follows:

- Engineer to technologist 1:0,25
- Engineer to technician 1:1,6 (old engineers, young technicians)

3.2.3 ECSA recognition

There was great support for the ECSA registration process, with 85% saying they provide training towards it.

However, when each activity was analysed, the involvement was as follows:

- 48% said graduates were trained by senior engineers
- 48% checked the graduate's work
- 33% assisted graduates at site meetings
- 29% provided mentors
- 33% moved graduates from one department to another to gain all-round experience

In terms of promotion after registration, the results were as follows:

- 27% promoted graduates on attaining a Pr Eng
- 17% promoted graduates on attaining a Pr Tech Eng
- 8% promoted graduates on attaining a Pr Techni

An encouraging 85% said that graduates should be promoted on registration because:

- registration improves competence
- a registered person is more responsible and can work independently
- registration should be considered a milestone in career development

3.2.4 Discipline distribution

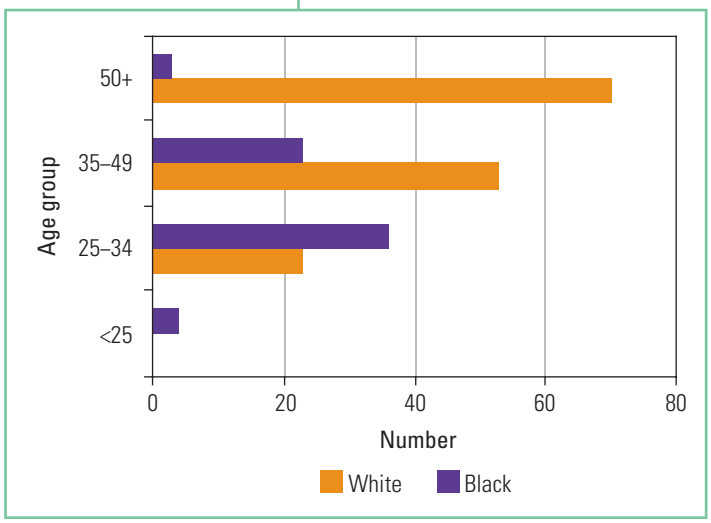
The largest group of engineers in provincial infrastructure units are involved in the development and maintenance of the road network, although the numbers have dropped significantly since the eighties. Technicians in local government and housing make up the balance.

3.2.5 Transformation

(a) Staff composition

As can be seen in Figures 3.5 and 3.6, there are two distinct profiles in provincial government.

Figure 3.5 Civil professionals in provincial departments of transport by age and race, 2004



(i) Departments of Transport

The Departments of Transport need to employ a significant number of engineers. As a result there is not as much transformation in these departments, because few black engineers graduated before 2000. The strategic specialist nature of work in provincial transport departments requires the appointment of experienced engineers.

(ii) Departments of Local Government and Housing

The Departments of Local Government and Housing employ more technicians and in many provinces artisans who have worked their way up through the ranks as supervisors. The profile shows significant transformation.

The numbers of professionals in all departments are extremely low, however, and this is cause for great concern.

(b) Corporate social investment

Faced with huge shortages in professional staff, provincial departments contribute towards bursaries. But interviews showed that only some provinces were successful, and others that have not had experience in this field are not handling the process adequately and are thus experiencing very poor results. Several provinces expend huge effort on developing students and young graduates.

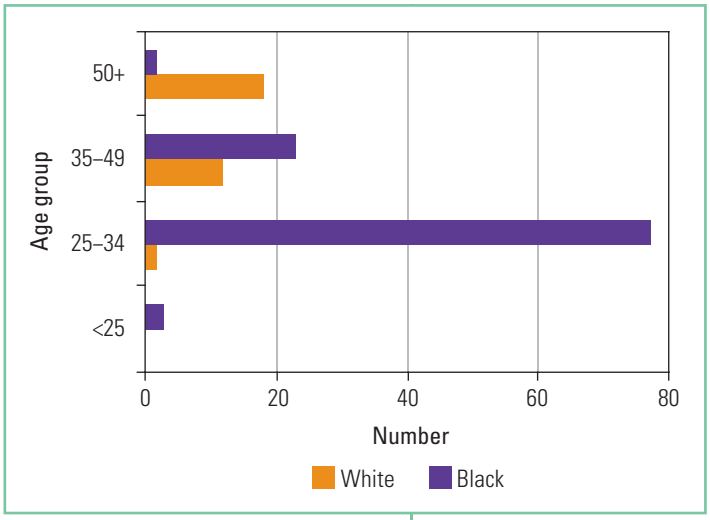


Figure 3.6 Civil professionals in provincial housing, public works and local government by age and race, 2004

3.3 Government infrastructure departments and agriculture

3.3.1 A decline

The decision to decentralise has had the biggest impact on national departments. There are few civil engineering professionals in the Departments of Local Government, Housing, Public Works and Transport. The latter is supported at least in part by SANRAL. The Department of Water Affairs is the only department that employs professionals in significant numbers to deal with national infrastructure. Here too the numbers have dropped significantly over the past 15 years.

Although not recognised as a traditional employer of civil staff, the Department of Agriculture employs many technicians as a result of the demise of the National Diploma in Agriculture at many institutions. The main activities here are the design of irrigation schemes, dams and farm structures as well as environmental issues relating to water sources, erosion, etc, all of which can be handled by civil professionals with appropriate training. The numbers employed in this sector have dropped significantly, which is also disquieting.

3.3.2 The professional profile

The ratios are as follows:

(a) Infrastructure departments

- Engineer to technologist 1:0,17
- Engineer to technician 1:0,93

(b) Department of Agriculture

This department employs many civil technicians. The ratios are:

- Engineer to technologist 1:0,35
- Engineer to technician 1:4,8

3.3.3 ECSA recognition

There was support for the ECSA registration process, with 60% providing training towards ECSA registration. It was disappointing that few responded to the activities offered in support of registration. In terms of promotion on registration, the results were as follows:

- 50% promote graduates on attaining a Pr Eng
- 40% promote graduates on attaining a Pr Tech Eng
- 40% promote graduates on attaining a Pr Techni

Table 3.5 Number of employees in state-owned enterprises

Organisation	No of employees
ACSA	1 710
DBSA	425
Denel	9 000
Eskom	35 707
IDC	391
NECSA	1 600
RandWater	3 235
SABC	3 140
SANRAL	120
Telkom	43 758
Transnet	90 514
Water boards	3 513

Forty per cent said that graduates should be promoted on registration because a registered person is more responsible and can work independently.

3.3.4 Transformation

(a) Staff composition

While there is transformation in the younger age group, insufficient numbers are coming in to replace the experienced ageing group.

(b) Corporate social investment

No CSI expenditure was reported in the returns, but this does not mean that it does not happen, simply that the forms did not get to the right desks for the information to be supplied, which points to another capacity problem.

3.4 Parastatals

The parastatals that were considered are shown in Table 3.4.

3.4.1 A decline

In the past, these organisations had well-structured engineering departments responsible for all development, including civil and structural work. Now, apart from a handful of civil professionals at Eskom and DBSA, and with the exception of Transnet and Randwater, all have completely outsourced construction of their civil works.

The responsibility for design, construction, maintenance and operations of the rail network has remained largely within the Transnet group, with little work having been outsourced. The ageing group of professionals now employed in the rail sector are cause for great concern, as there is little knowledge outside Transnet to be able to take over this responsibility, should succession planning not be implemented immediately.

3.4.2 The professional profile

It is necessary to look at the units of Transnet separately from the other organisations.

(a) Transnet

Transnet is unique in that it employs many technologists. Many were artisans who came up through the ranks from the workshops, continued to study, and they are a unique breed with detailed practical experience supported by the latest theory. There are 96 civil engineers, 63 civil technologists and 183 civil technicians in Metrorail, Propnet, NPA, Protekon and Spoornet. That is,

- Engineer to technologist 1:0,65
- Engineer to technician 1:1,91

(b) Other entities such as water boards, ACSA and SANRAL

The ratios are similar to the rest of the profession.

- Engineer to technologist 1:0.27
- Engineer to technician 1:2.2

3.4.3 ECSA recognition

There was support for the ECSA registration process, with 58% providing training towards it. It was disappointing that few responded to the activities offered in support of registration. In terms of promotion on registration, only 25% promoted staff on attaining a Pr Eng, Pr Tech Eng or Pr Techni.

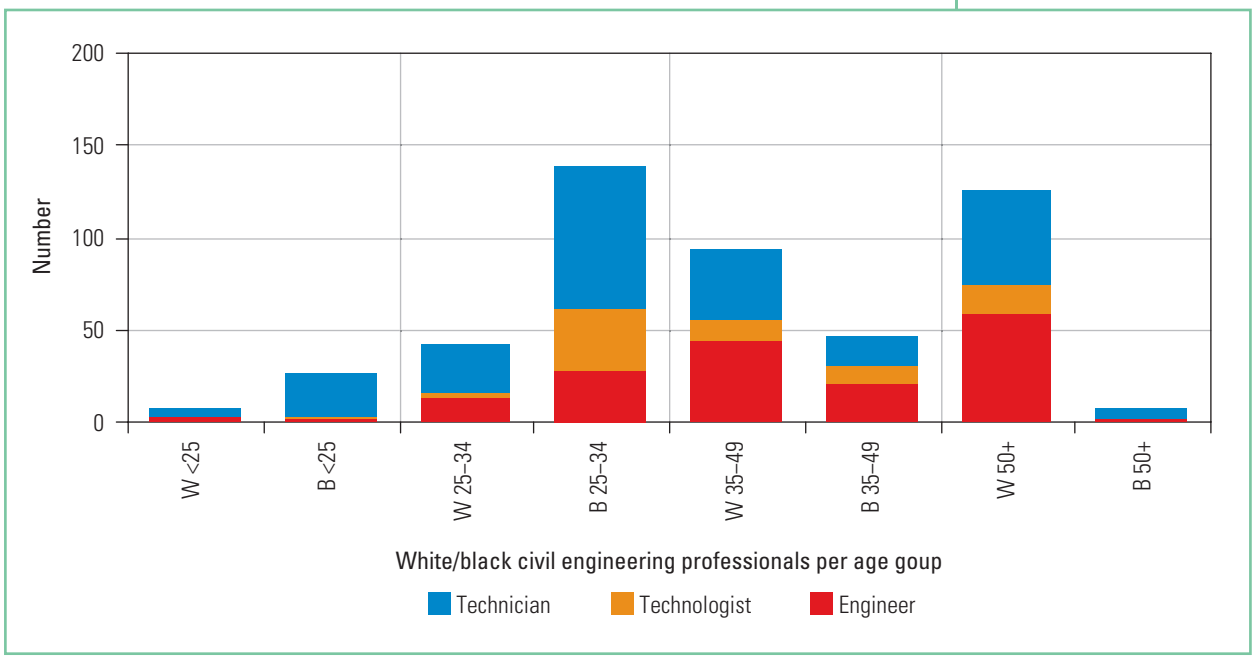
A surprising 66% said that graduates should be promoted on registration because registration improves competence.

3.4.4 Transformation

(a) Staff composition

The profile is similar to most of the other profiles studied so far (see Figure 3.7), with a large number of young black professionals having entered over the past 10 to 15 years. The only structure that has not transformed to this extent is the National Roads Agency which, like

Figure 3.7 The civil engineering profile by age, race and qualification in parastatals.



the Provincial Departments of Transport, requires experienced engineers, many of whom are white males over the age of 40.

(b) Corporate social investment

The parastatals listed activities as follows:

- Bursaries
- TRAC
- READ Education Trust
- Water services

3.4.5 Future demand

A unique breed of civil professional is to be found in Transnet – the 'railway engineer'. The number of professionals with skills in rail alignment, rail-wheel interaction, drainage and maintenance has reduced dramatically. Further, heavy haul lines servicing mining exports require specific expertise. To build new lines and upgrade many of the existing services, the numbers need to be increased.

The other parastatals employing civil engineering professionals also indicated shortages and need for more qualified staff. Eskom for instance has started redeploying those involved in power stations in the seventies to train young graduates to fill the gaps.

CONCLUSIONS

To match the projected, greatly increased workflow from government, the number of professionals needs to be dramatically increased. Organograms should be revisited to ensure that capacity is planned for, and succession planning is implemented. Retention issues such as salaries, authority and supporting capacity in departments should be examined and addressed. A number of these aspects will be covered under the 'Supply' and 'Drivers and Inhibitors' chapters.

Building blocks

- Develop a sound pool of professionals, covering all ages, races, gender and fields of expertise.

RECOMMENDATIONS

Reconstruction required

The limited recognition given to ECSA registration and the associated training and support given to graduates is significant. It is necessary to:

- **Increase ECSA registrations**
  - Educate the student population on ECSA requirements and ensure that they are offered adequate training by their employers
  - Make management within the public sector aware of the value of the process leading up to ECSA registration and encourage them to invest in suitable training for their graduates to register
  - Encourage employers to pay ECSA fees
- **Develop standard organograms**

  To ensure that appropriate capacity is available, a set of standard organograms should be developed with appropriate levels of qualifications and experience, and should be implemented nationwide

NOTES

1 S Gibson, The forgotten municipalities, IMESA Conference, Mossel Bay, 2004.

2 South African Association of Civil Engineers (SAACE), State of the Consulting Engineering Industry Report, SAACE, Johannesburg, 2004, p 13.

3 E Shorten, The engineer in shining armour, *IMIESA,* 28(10), October 2003, p 8.

4 H Radebe, Help at hand for stricken municipalities, *Business Day*, I November 2002.

PART III
SUPPLY

Contents

CHAPTER 4

Secondary education

INTRODUCTION

The quality of education is key to developing a knowledge economy. A concerted effort needs to be invested in South African learners. To study civil engineering at university a higher grade mathematics symbol of A, B or C is required and for most universities of technology a minimum of a C symbol in standard grade maths is required. These criteria present a challenge.

In this chapter the bottlenecks in and proposed solutions to all aspects of secondary education and cultural diversity will be examined.

To ensure sufficient competent civil engineering professionals, an adequate supply of high-calibre entrants into the profession is essential. A number of factors affect this supply. They are:

- Funding
- Numbers qualifying for entry into tertiary institutions
- Awareness of the construction industry
- Competition from other professions

THE STATUS QUO

4.1 Numbers qualifying for university

University graduation figures for 2002 indicate that 37 000 students were awarded first-time qualifications.

4.1.1 Endorsement

Entry into university requires that matriculants receive an endorsement certificate.

Given that the drop-out rate at university is about 30%, this means that 54 000 students would have entered university at the outset, but the number gaining endorsement certificates at the time was 57 000. If one allows for those students with endorsement certificates who chose careers outside tertiary education, such as commercial pilots, this seems to indicate that the limited attainment of endorsemen t certificates restricts the number of students entering universities.

The number gaining endorsements has improved over the past few years, but not significantly (see Figure 4.1).

4.1.2 Mathematics

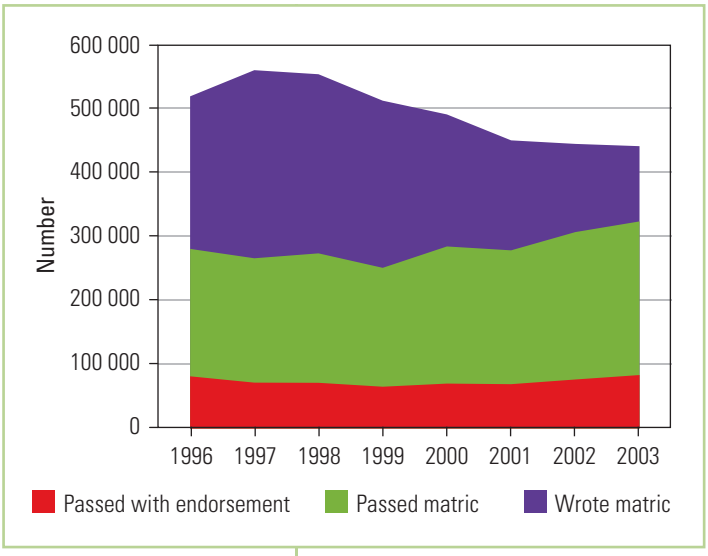
The number of passes in higher grade maths has seen little improvement over the years (see Figure 4.2). As the demand for professionals grows, particularly those from disadvantaged communities, this presents a problem.

The number of higher grade maths passes is not enough to satisfy the needs of science, engineering and technology (SET) and the financial professions. Few achieve higher grade A, B or C passes in maths, C being the minimum accepted by most universities. Government

'… Now is the time for concerted effort to improve the quality, participation and performance of South African learners in mathematics, science and technology education …'

– Mosibudi Mangena

Mosibudi Mangena
(Minister of Science and Technology)



Department of Education

Figure 4.1 Matric pass rates, 1996–2003

schools produced only 12 112 A, B and C maths passes in the higher grade in 2004 and the independent schools added a further 1 810.

In particular the number of black higher grade passes is severely hampering the transformation of these professions (see Figure 4.3). Further, simply passing higher grade maths does not necessarily mean that the student is adequately prepared for university studies.

With the proliferation of charters and black empowerment (BE) policies there is a desperate need for black engineers to enter the profession and rise in the civil engineering ranks. The bulk of today's civil engineering company owners and managers are university-graduated engineers.

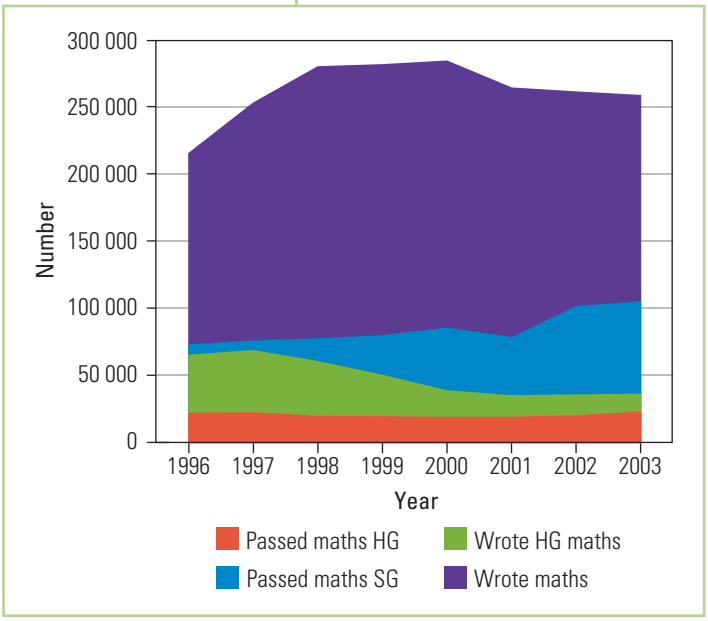
Fifty three per cent of the population live in rural areas, where education problems are the most acute. Ninety four per cent of this rural population are African, low numbers of whom are able to enter the professions at university level.

The situation may deteriorate when the new syllabus is introduced in 2006, because matric maths will become more complex than in the current higher grade curriculum.

4.2 Numbers qualify for Technikons

In 2002, 16 000 students graduated with first-time qualifications from South African technikons. Here the drop-out rate is considerably higher than at universities. There were 50 000 national diploma entrants in 2000. Since most programmes offered by technikons are technical in nature, 32 000 of these students required some form of mathematical ability for their chosen career. In many instances the minimum symbol acceptable was a standard grade C; again entry is largely governed by the standard grade mathematics pass rates in matric.

Figure 4.2 Matric maths pass rates, 1996–2003



Department of Education

The 2006 curriculum change is of major concern in terms of the pipeline for technikon studies because maths literacy will not be adequate for entering these courses. Tertiary institutions were concerned that engineering departments had not been consulted on the impact of the change on technical skills development.

4.3 Gender

In terms of achieving gender targets, there was little difference in higher grade results between male and female. Of those who passed in the higher grade, 62% were male and 59% female. The percentages achieving A, B, C and D were almost the same. An additional 3% of the males passed with an E symbol in the higher grade.

THE CHALLENGES – IMPROVING SECONDARY SCHOOL RESULTS

There are many problems that must be attended to, to improve secondary school results.

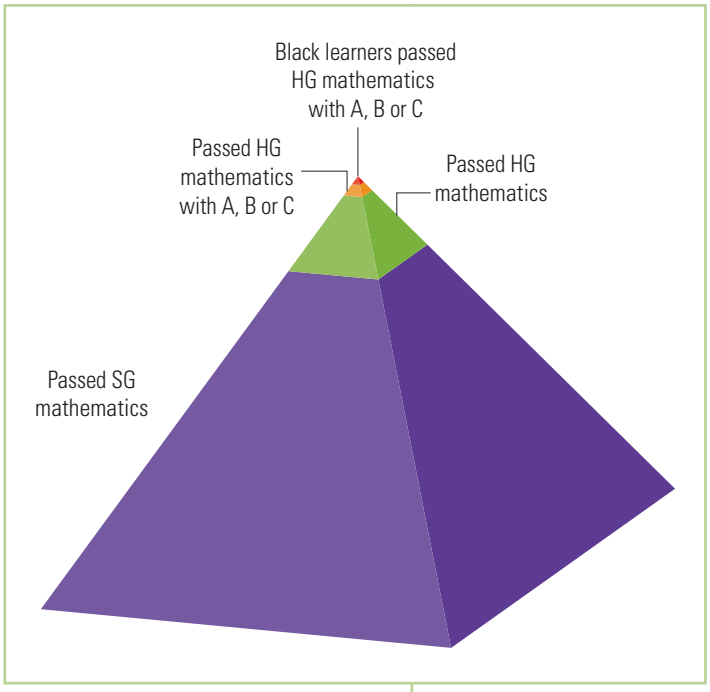
4.4 School mathematics

Maths is a major stumbling block for entry into civil engineering, and indeed any engineering programme. The detailed analysis of 2004 results (Figure 4.4) does not bode well for the professions in South Africa. Since there are over half a million matriculants annually, the number of students passing with higher grade maths is totally inadequate.

When John Perlman interviewed a number of education authorities on SAFM towards the end of 2004, they cited the reasons for poor mathematics performance in South African schools as follows:

- Mental arithmetic exercises have been dropped from the syllabus
- Outcomes-based education (OBE) does not develop competence
- Mathematics is not perceived as a learning subject
- The obsession of schools with achieving a 100% matric pass rate means that students are encouraged to take standard grade mathematics

Gone are the days when the 'times tables' were printed on the back of every exercise book and numbers were drilled until they became second nature. This gives rise to the following two problems.



Department of Education

Figure 4.3 Percentage of matriculants passing maths in 2003

4.4.1 Magnitude

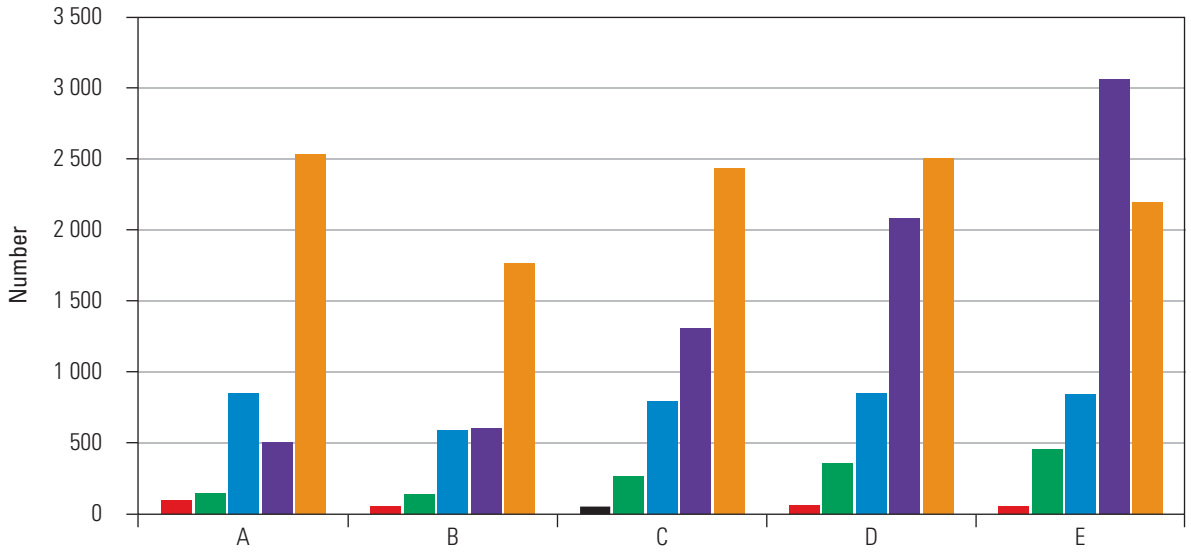
Numbers are not internalised, so orders of magnitude are meaningless. To many students the difference between 100 and 1 000 is simply a zero and not an order of magnitude. This is a major problem in terms of engineering judgement – engineers must be capable of deciding whether loads, deflections, pressures, flows and prices are reasonable or unrealistically large or small.

4.4.2 Memory training

Memory training is greatly reduced; as a result, not only are numbers not remembered, but learners have reduced ability to remember everything else as well! Further, fewer neural pathways are developed in the brain – the connections that contribute to intelligence.

As far back as 1997 Professor Les Clarke,[1] professor of civil engineering at Birmingham University, made the following observations in his inaugural speech as president of the London-based Institution of Structural Engineers:

> *'… secondary education is very different from the traditional education which many of us would have experienced. There is far less teaching of facts and techniques, and the associated hard work of practising techniques through completing numerous examples and learning facts by rote has decreased enormously …'*



	A	B	C	D	E
Asians	92	52	46	59	52
Coloureds	147	140	261	353	455
Indians	848	586	790	846	844
Africans	501	605	1 310	2 080	3 059
Whites	2 533	1 765	2 436	2 507	2 194

Department of Education

Figure 4.4 Matric higher grade maths symbols, 2004

He argued that scholars have not grasped the basic principles and as a result at university level:

'… basic mathematics and physical concepts have to be taught …'

The London Mathematical Society,[2] in its document 'Tackling the mathematics problem', stated that:

'... recent changes in school mathematics … have greatly disadvantaged those who need to continue their mathematical training beyond school level ...'

and that there was:

'… a marked decline in analytical powers when faced with simple problems requiring more than one step …'

They attributed this to the current school system approach where learners are led through set questions step by step, rather than being taught the principles.

Research by the Centre for Development and Enterprise (CDE)[3] indicated that regardless of the locality and wealth of a school, strict discipline and drilling in basic numeracy produced good matric results.

Table 4.1 Analysis of scores by former racially based departments, 2004

	Maths score	Science score
Former African schools	227	200
Former white schools	456	468
National average	**264**	**244**

TIMSS

It would seem that the South African curriculum was modified in the process of addressing the inequalities of the past, although up to 1994 the previously advantaged schools had produced excellent matriculants. This is a great shame. Had traditional teaching methods been retained and extended to all schools, the magnitude of the current maths and science challenge would have been reduced.

The recent Trends in International Mathematics and Science Study[4] indicated that, of 50 countries, South Africa achieved the worst average maths and science scores. The average total mark was 264, (see Table 4.1) compared with the international average of 467 for maths, and a total of 244 were achieved for science, compared with the international average of 474. However, on analysis, learners in African schools had the lowest scores and learners in the former white schools had the highest scores. The latter were only slightly below the international mean.

The challenge therefore is to re-instate the tried and tested techniques that contributed to better results in the white schools and extend them to all schools.

4.5 Language proficiency

Competence in the language of instruction is a major stumbling block to grasping complex subjects such as mathematics and science. These were the findings of Sarah Howie, of the University of Pretoria, in her PhD thesis, 'English language proficiency and contextual factors influencing mathematics achievement of secondary school pupils in South Africa'.

To date, the national policy has been to teach learners in their mother tongue up to Grade 3. Thereafter all lessons are given in English.

4.5.1 Literacy

Today's school-going generation, whether from urban or rural societies, does not boast the literacy and writing skills of previous generations of tertiary entrants. This can be attributed to the following factors:

- The current trend is to move away from rote learning; hence competence in spelling is not fully developed
- Computers are used for projects from an early age, hence the reliance on the system to manage grammatical checks and corrections
- Learners do not read but watch TV or play computer games for entertainment
- Modern information and communication technology (ICT) has replaced letter writing with cryptic SMS or e-mail messages
- Learners no longer keep detailed diaries
- Religious education dictated learning verses by heart, resulting in structure and advanced vocabulary being internalised
- Today's learners are termed the 'latchkey kids' who have been left at home while their baby boomer parents work long hours and have little time to communicate with their children – in contrast with previous generations who enjoyed mother's full-time attention and a great deal of socialising within the community

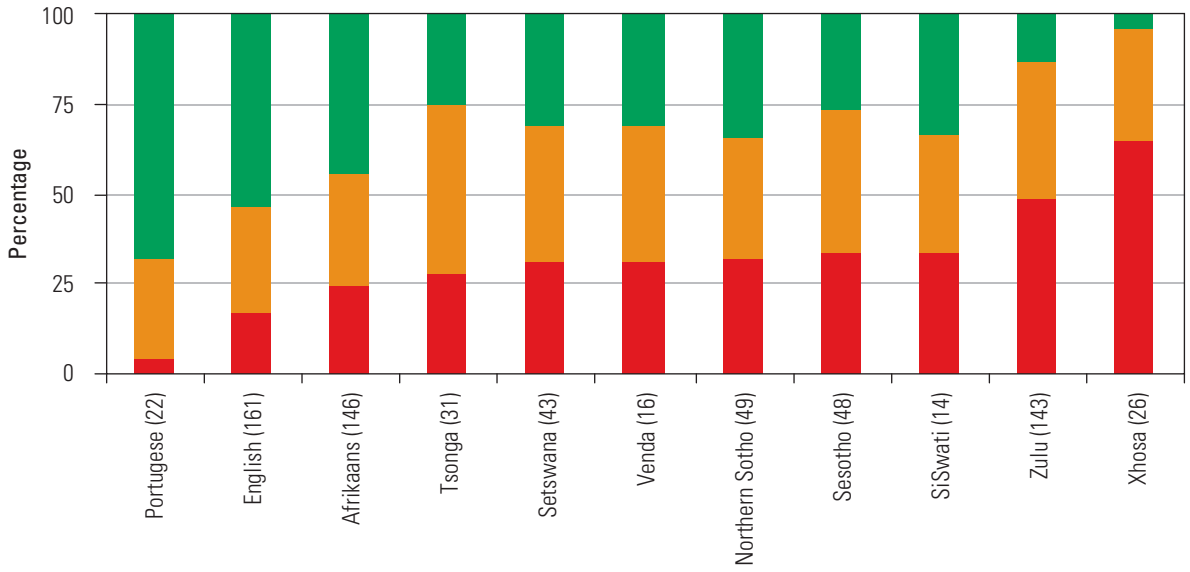
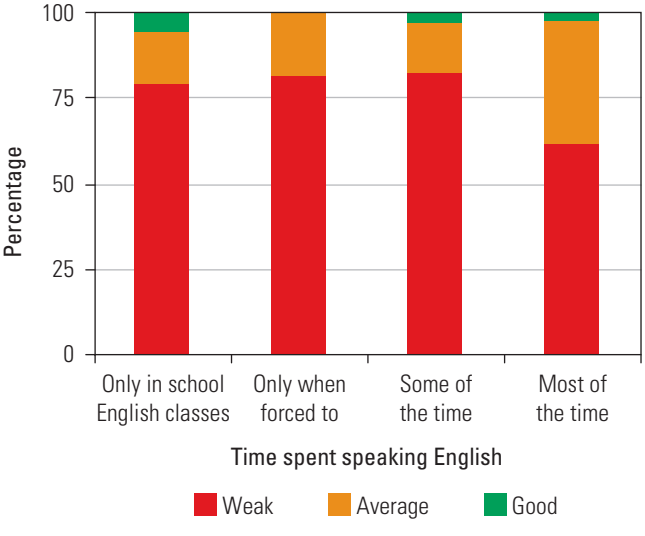


Figure 4.5 Maths success as a function of mother tongue – first year (figures in brackets = sample size)

- Rural learners rarely hear English spoken, while urban learners have developed their own cryptic 'teen speak' dialects

From an analysis of civil engineering student results it can be seen that the mother tongue has some influence on maths proficiency, as has the time spent in speaking the language of instruction, which in most cases is English (see Figures 4.5 and 4.6).

Figure 4.6 Maths success in relation to time spent speaking English



4.5.2 The language of instruction

The correlation of maths success with language points to particular weakness in students whose mother tongue is Xhosa, followed by those whose mother tongue is Zulu. (See Figure 4.5.) A similar trend was seen in the final-year sample.

The figures reflect on the quality of the education in rural areas and the observation that the tertiary institutions to which they have access accept entrants with lower grades than other institutions.

Apart from those learners whose mother tongue was English or Afrikaans, less than 8% of South African learners received maths lessons in their mother tongue. The remainder were taught in English.

In the total sample of first-year and final-year students, 25% had good maths results, 32% were average and 43% were weak. However, looking at the 8% who were taught in their mother tongue, only 13% of those achieved good results, 35% were average and the remaining 51% were weak.

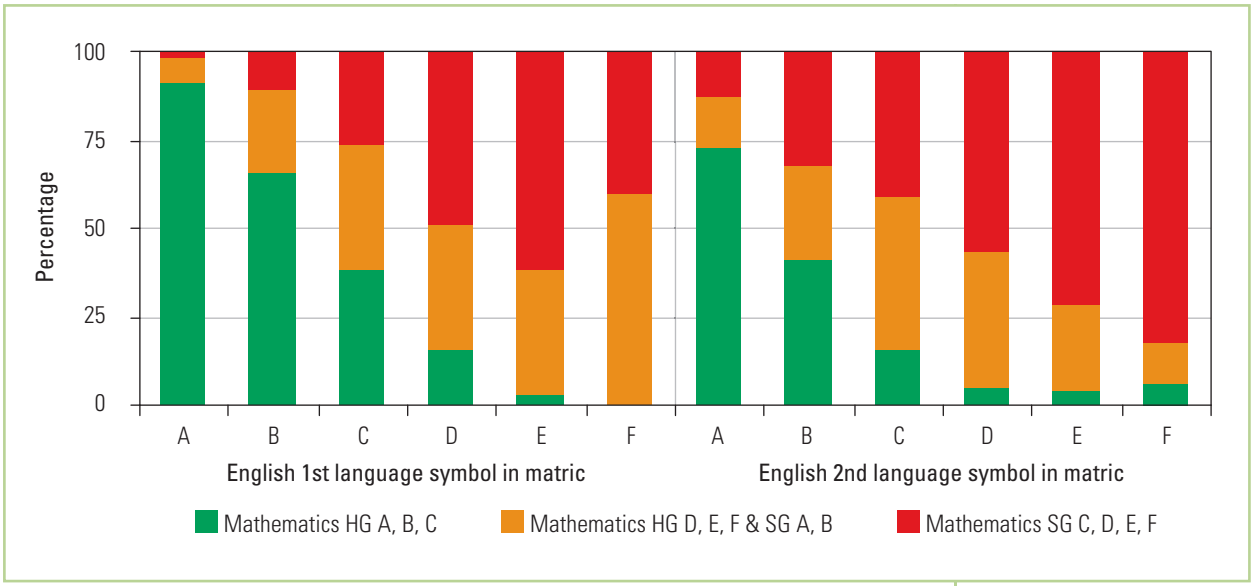


Figure 4.7 Maths results versus English results

Thus being taught in the mother tongue is only one of the many factors required for success. Improved teaching, the environment and other factors outlined in this chapter all need to be attended to.

Although they represent a relatively small sample, 67% of those students from other countries who were taught in Chinese, French, Portuguese and other languages had good results, 11% were average and only 22% were weak. This again shows the weakness of the teaching and maths performance in South African schools.

Learners whose mother tongue was not English showed maths improvement in relation to the amount of English they spoke outside the classroom (see Figure 4.6).

Speaking the language of instruction is important, as is the level of competence. Research undertaken by the Centre for Development and Enterprise (CDE) resulted in a number of indicators being developed. It was found that in order to pass higher grade maths, the learner needed to gain a minimum of 54% for English First Language (that is, a D symbol or better), or 71% for English Second Language (a B symbol or better).

Further, to pass standard grade maths the learner needed to gain a minimum of 45% for English First Language (a mid-E symbol or more) or 60% for English Second Language (a C symbol or more).

Because proficiency in the language of instruction is so important, improving English results is no less important than addressing weaknesses in maths and science. Figure 4.7 shows that the parameters developed by the CDE apply to the whole profile of first-year and final-year civil engineering students. Only a handful achieved higher grade maths A, B and C and obtained poor results in English.

A change in language policy is to be implemented in 2006 that will allow learners to study in their mother tongue. This should go some way towards addressing these problems, provided that teachers are competent and appropriate learning materials are available. However, when considering science, engineering and technology (SET) careers, it would be impractical to expect tertiary institutions to offer courses in 11 languages, which means that students will face enormous challenges when introduced to complex subjects at tertiary level in a language in which they are not proficient.

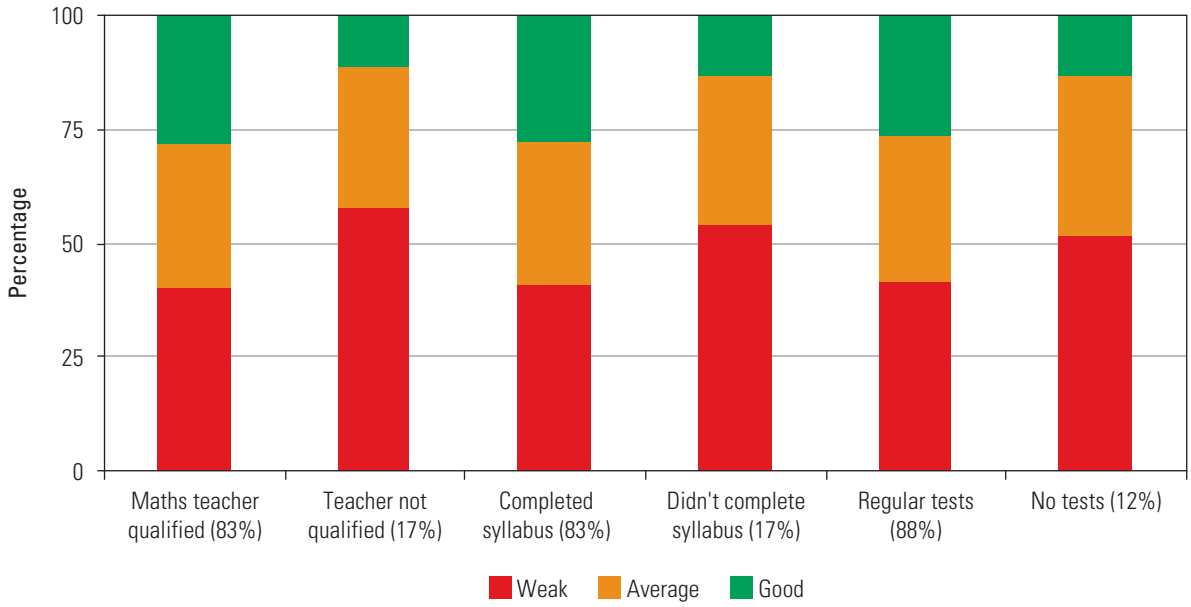


Figure 4.8 Maths success in relation to teacher competence

4.6 Teacher competence

The teachers' strike of 2004 highlighted the plight of teachers.

Owing to declining employment conditions and benefits, the pool of excellent, dedicated professional teachers is limited and the recruitment of bright young minds into teaching has been reduced to a trickle. Teachers have had many major changes in policy and practices thrust upon them in recent years and the demands and pressures are overwhelming.

Many teachers have qualifications below the level at which they are being asked to teach. This is partly because too few teachers are being trained. The ravages of the Aids epidemic are exacerbating the problem. In many instances, learners report being taught by

- Underqualified teachers
- Teachers who do not complete the syllabus
- Teachers who cannot give adequate explanations
- Teachers who do not mark or check their work

(See Figure 4.8.)

One of the best-known rankings for international competitiveness is produced by the Institute for Management Development International (IMD). The 2001 publication[5] makes the following link between human resource development (HRD) and competitiveness:

> *'… In a modern economy, nations do not rely only on products, and services, they also compete with brains. The ability of a nation to develop an excellent education system and to improve knowledge in the labour force through training is vital to competitiveness …'*

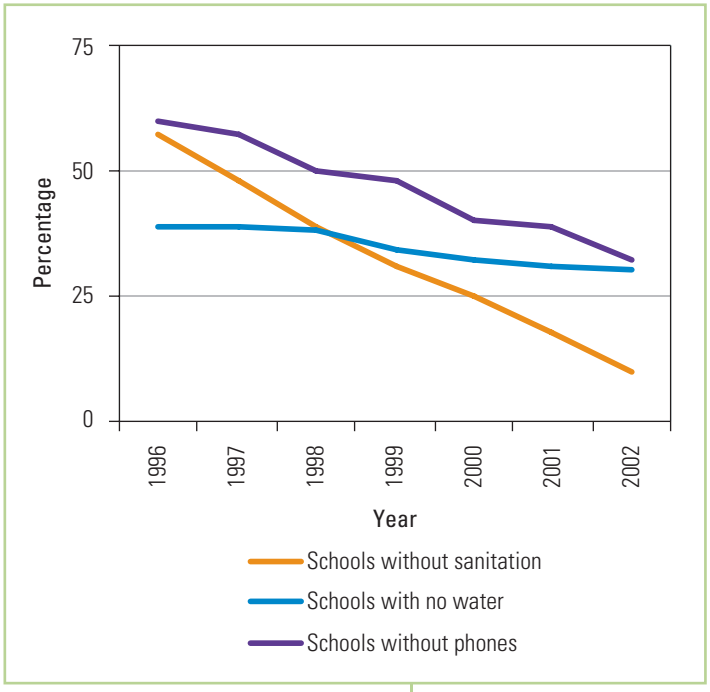
If, as a country, South Africa is not able to make teaching a 'profession of choice', the situation in the classrooms will become unbearable and the haemorrhaging from the profession will intensify. It is not an overstatement that learners are currently deemed fortunate if they have quality teachers in their classrooms – something that should be the right of every learner. This issue needs to be addressed urgently.

4.7 The standard grade versus higher grade problem

All too often when visiting schools to carry out career guidance, one discovers learners who cannot be considered for university degrees because they are enrolled for standard grade maths. Where qualified teachers are in short supply, particularly in the rural environments, this is understandable to some extent, but some of these schools produce excellent higher grade learners.

Of much greater concern is the habit of ex-Model C and independent schools to stream some learners into standard grade to ensure a 100% pass rate in the higher grade. The country desperately requires more entrants into scientific and engineering degree courses, but efforts to grow capacity are apparently being undermined by the schools that wish to reflect excellent pass rates.

The government should consider a bonus scheme for schools that increase the ratio of higher grade to standard grade passes. However, criteria should be set to ensure that they do not simply poach good performers and teachers from other schools.



South Africa – The Good News

Figure 4.9 Facilities at schools nationwide

Alternatively, designated schools, particularly well-resourced schools, could offer only the higher grade stream. With the teaching capacity that is available in many of these schools, there should be no reason that classes could not be structured to ensure that all learners achieve higher grade passes.

4.8 Quality of school facilities

From a big city vantage point, it is difficult to imagine schools with the limited facilities outlined in Figure 4.9. In addition, by the end of 2003, 48% of schools still did not have electricity. Even more alarmingly, many classes were still given under trees! Several thousand new schools are required.

Unfortunately standard school designs have not been updated for many years and expertise in appropriate twenty-first-century school layouts and facilities is in short supply.

The civil engineering industry should be called upon to develop more appropriate designs and enhance the facilities at schools as part of their corporate social investment (CSI). Learners can hardly be expected to achieve under the conditions shown in Figure 4.9.

4.9 Support from home

Support from home contributes significantly to the success of the school learner. In the past few years various aspects have been widely researched and documented as follows:

4.9.1 Premature group-based care

Studies by Oxford University's Families, Children and Childcare Project[6] and other international research have shown that group-based care such as day care and nursery schooling can cause long-term damage to children younger than two years. These children were found

Support from home contributes significantly to the success of the school learner

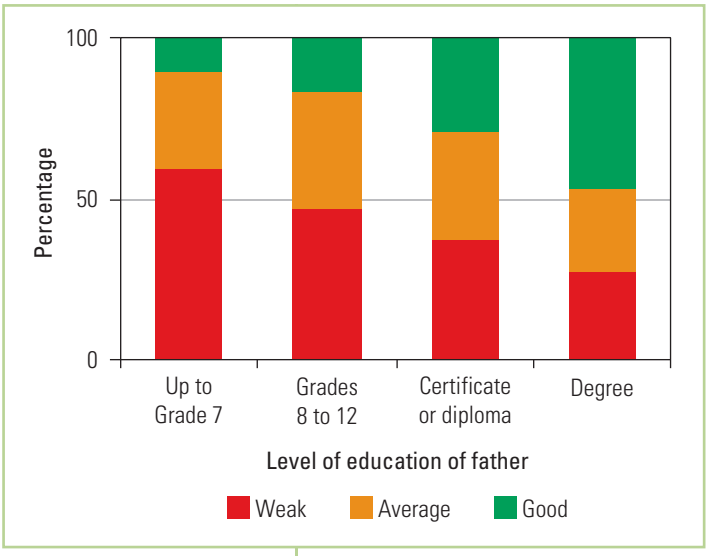


Figure 4.10 Success in matric maths in relation to level of education of father

to exhibit problematic emotional and anti-social behaviour, including disobedience and aggression – which would later impact on their ability to listen and learn in the schooling situation.

4.9.2 Later group-based care

The same research, which was aimed at discovering the influences of different types of child-care on child development, has shown that group-based care above the age of three has beneficial effects in terms of developing interpersonal skills and coping with the challenges of later formal education.

4.9.3 Parents and the home environment

Parental involvement has considerable impact on academic achievement.

(a) Education level of parents

There is a correlation between the education level of the parents and the success of the child (see Figure 4.10). However, degreed parents generally send their children to schools that are successful; so this graph also represents success in relation to financial wellbeing. The success of learners whose parents have not been educated beyond high school points to other factors.

Figure 4.11 Success in matric maths in relation to mother's occupation

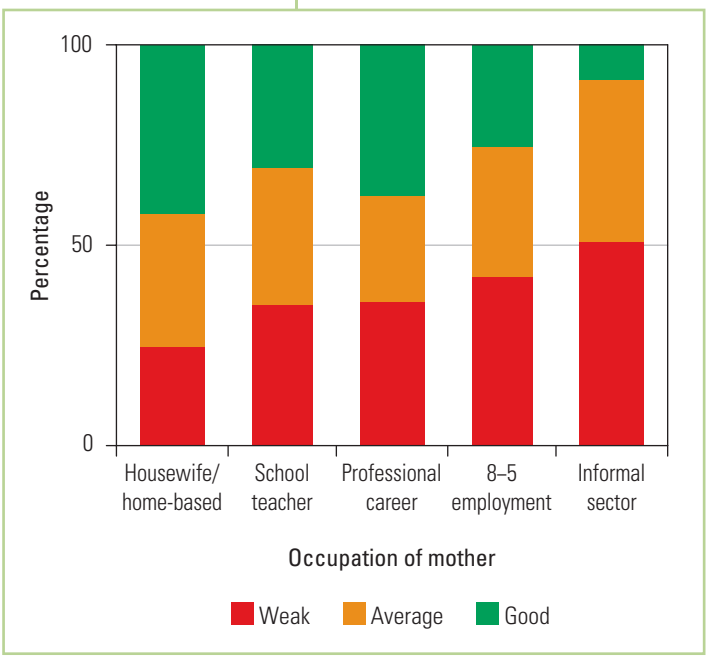
(b) Parental involvement

Success because of parental involvement transcends differences in socio-economic status, and may be regarded as an important component in raising the educational outcomes of struggling learners. Parents are encouraged to read with their children, check or become involved with their homework, and attend school functions and extra-mural activities.

South African households, regardless of socio-economic status, do not appear to be ideal for the development of successful learners.

Few mothers stay at home with their children until age two or more since most high-earning families achieving their status because both parents are involved in high-profile, time-consuming careers. Figure 4.11 illustrates the value of the mother's presence in the learner's development, with the best maths results being achieved by those whose mothers are home-based.

In the low-income group, mothers are forced to work to make ends meet. In rural areas they often leave their children with limited supervision and little input to assist with child development (see Figure 4.12).



(c) The caregiver(s)

As divorce rates soar and fewer mothers marry, many children will live in single-parent homes, in which the parent is preoccupied with economic survival and family duties. As a result, involvement with the child is reduced, which has a detrimental effect on studies (see Figure 4.13).

This experience is not unique to South Africa. Anne Atkins,[7] in her book on child rearing, quotes many research projects worldwide:

> *'… children whose parents are separated, divorced or single are disadvantaged in almost every way. They perform less well academically, leave school younger, get fewer educational qualifications and end up with poorer jobs …'*

Graeme Codrington, a widely acclaimed generation expert, expresses the problem poignantly in his master's dissertation:[8]

> *'… if today's young people are "lost" it may not be entirely because they have wandered off … it may be because they were "abandoned" as babies …'*

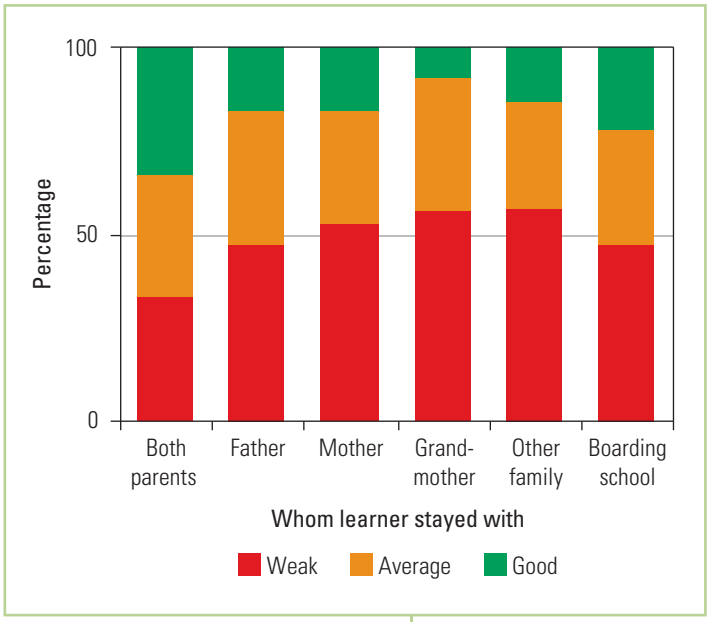


Figure 4.12 Success in matric maths in relation to the person the learner stayed with during high school

The deteriorating results problem is not limited to South Africa but has become a worldwide phenomenon. Over the past 30 years more and more women have joined the workplace, with gender mainstreaming being 'the flavour of the day'.

While this apparently makes economic sense, the lack of parental input appears to have a detrimental effect on the development of the next generation.

Gredler,[9] in discussing how children develop a culture of learning, states:

> *'… without social interaction with more knowledgeable people it is impossible to … learn … young children develop their thinking abilities by interacting with adults …'*

The Indian literacy programme

There are 130 million illiterate females in India. At the current rate it will take some 20 years before the whole population will be literate. Said one delighted woman who had attended literacy classes ...

'… I did not know how to help my children in their studies ... I had to seek help in getting directions to get about ... Now I check their reports and refuse to sign them if they are not doing well ...'

She is delighted at the improvement that she has seen in her children's schoolwork.

Dr Mashelkar, CSIR, India

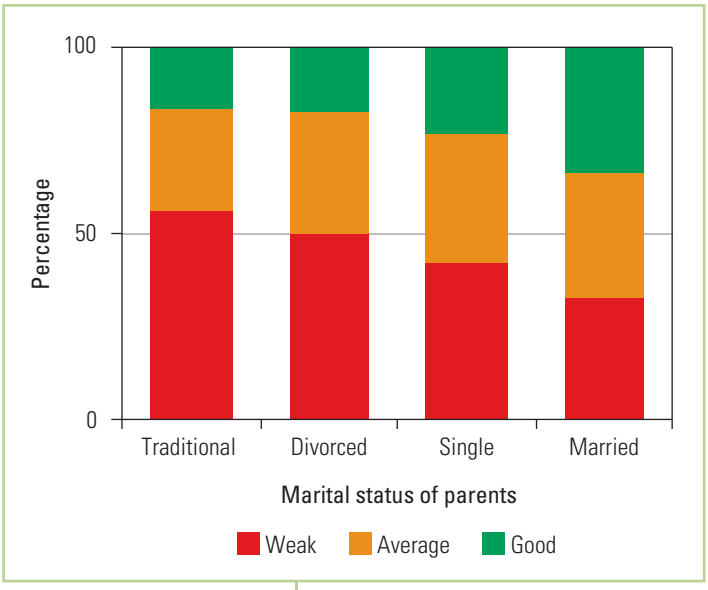


Figure 4.13 Success in matric maths in relation to marital status of parents

Parents should be encouraged to spend more time with their children and industry should be more supportive of mothers who wish to balance home and business life. Today's technology makes it possible for staff to carry out a considerable portion of their responsibilities from a home office.

Adult basic education and training (ABET) courses should be considered for grandparents who look after their grandchildren in the rural areas, so that they can play a more meaningful role in assisting their school-going charges. As the HIV/Aids pandemic results in child-headed homes, support with homework from communities also needs to be encouraged.

4.10 Recommendations

In order to increase the number of professionals, a major effort is required to augment dramatically the number of adequate matric results. Interventions are required at three levels, namely long term, medium term and short term.

4.10.1 Long term

- Reform curricula for maths teaching at primary level to develop competence in dealing with numbers.
- Improve competence in English. (The alternative of teaching subjects in the mother tongue dictates that tertiary institutions should offer their courses in all official languages, which would not be practical for engineering studies either in terms of economy or capacity.)
- Encourage more input and support from parents and child minders.

4.10.2 Medium term

- Increase the number of teachers who are qualified to teach higher grade maths and English. This requires three actions:
  - Re-employ older, quality teachers to fill the gaps until many more younger teachers are well trained
  - Train more teachers
  - Pay a premium for well-qualified 'scarce skills' teachers

Success story: SAICA and the Thuthukha project

In the Eastern Cape, Limpopo and North West Province, the South African Institute of Chartered Accountants (SAICA) busses several thousands of Grade 11 and 12 learners and their teachers to weekly lessons in literacy, mathematics, accounting and life skills in order to increase the pool from which they can identify suitable candidates for their profession.

As a result of improved selection and interventions at tertiary level, students at Fort Hare now outperform their University of Johannesburg (formerly RAU) counterparts in many BCom exams set by the University of Johannesburg Economics Department.

Success story: Civil engineering initiative in the Free State

For the past ten years 20 learners per grade from Grade 8 to 12 have been bussed weekly to Vista University for teaching by professional teachers. Learners are taught literacy, maths, science, biology and computer skills.

Industry in the area has educated and subsequently appointed solid professionals who have completed their undergraduate studies and are now working in their offices during the candidate/registration phase of their professional training.

- Educate Grade 9 learners and parents to appreciate the importance of taking higher grade maths
- Encourage schools to promote higher grade maths

4.10.3 Short term

- Nurture learners currently in the system. Interventions are required from Grade 10, as learners failing their first Grade 11 higher grade tests are dropped to standard grade to ensure that they pass at the end of Grade 12
- Transfer learners with maths and science potential to schools that are adequately resourced

A number of successful nurturing projects have been identified, two of which are detailed below:

THE CHALLENGES – AWARENESS, SELECTION, FUNDING AND ORIENTATION

4.11 Awareness – career guidance

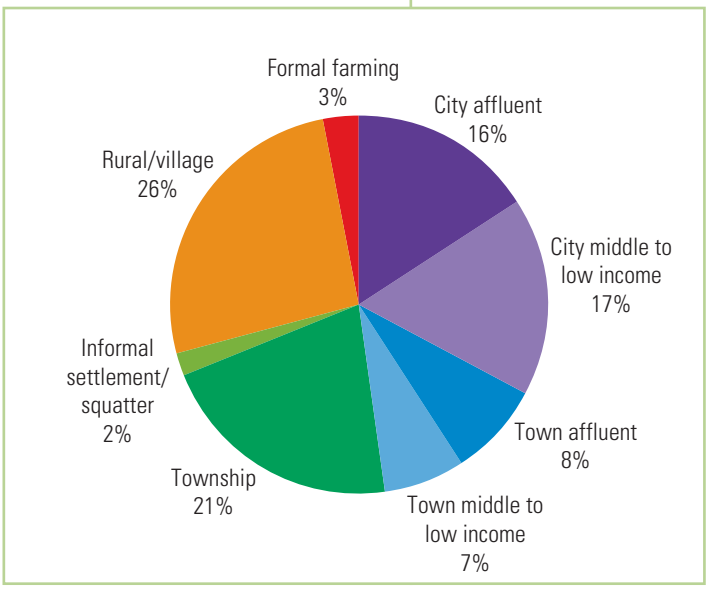
In the past career guidance was carried out through reading, counselling and family influence. Today the young generation are influenced by images and lifestyle portrayed on the television. The legal and medical professions are glamorised, but little is seen or heard of the engineering profession.

Numbers entering engineering degrees have dropped throughout the Western world as a result of many other careers being popularised and school maths standards declining. In South Africa the problem has been exacerbated by many other factors.

Until 1994 a system of psychometric testing and career guidance was in place. Since the method of testing was considered Eurocentric, it was discontinued. Without an instrument to test and evaluate learners, guidance became difficult; hence career guidance programmes at schools declined.

As there was less and less call on industry for guidance material, professional bodies and employers who had previously marketed heavily at schools reduced their efforts and the entire guidance process was drastically reduced. The declining industry also found companies battling to survive, with little capacity or funds to devote to career guidance activities.

Figure 4.14 Distribution of home environment of student sample



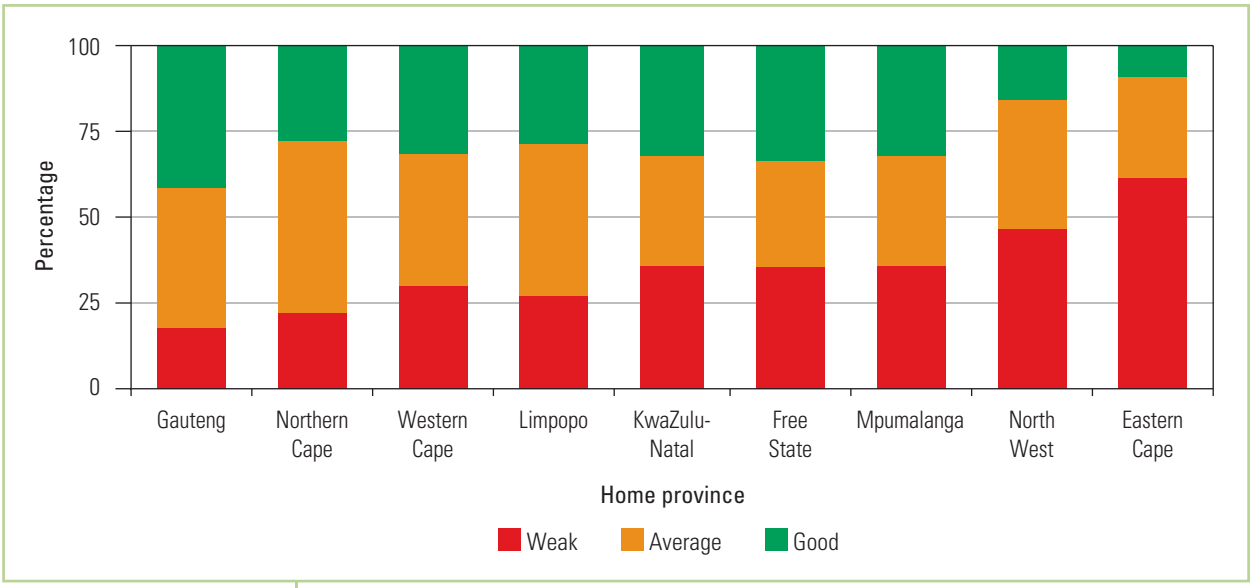


Figure 4.15 Maths success in relation to home province

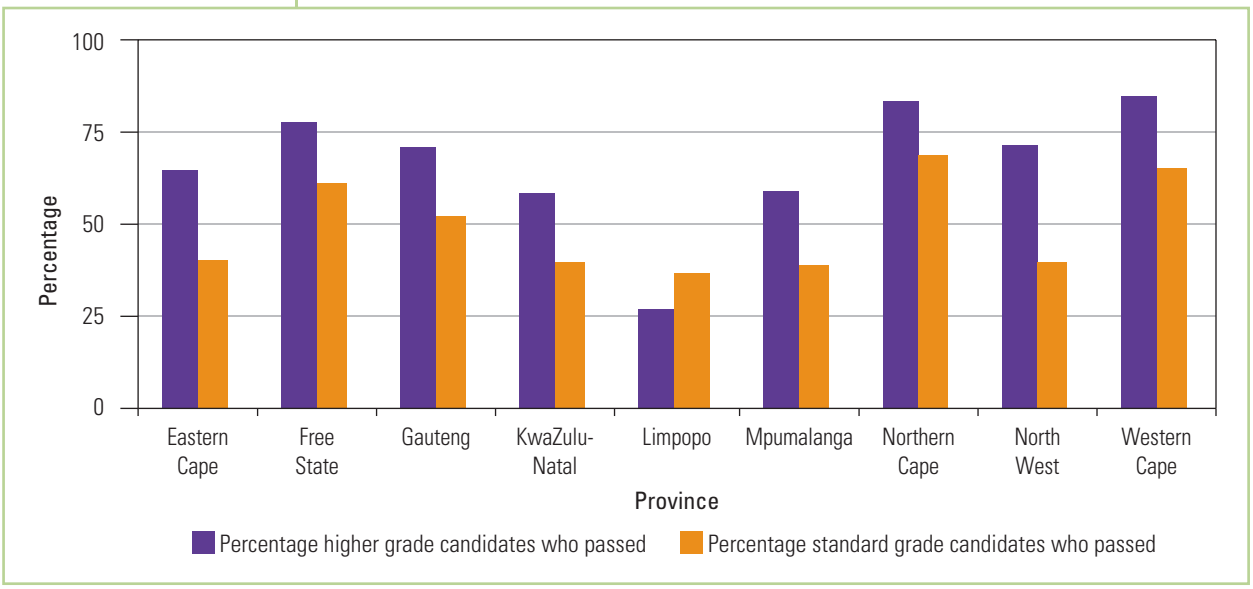
Career guidance in secondary schools is now limited. The problem is particularly acute in rural areas. But there are many examples of good old-fashioned schools in these areas that are disciplined, drill learners well and achieve good results. Without career guidance and technology to access websites, these capable learners are not aware of the opportunities in civil engineering, or the ways in which to access funds to enter tertiary education.

Although 53% of the South African population reside in rural areas,[10] less than 30% of the tertiary student population come from rural areas (see Figure 4.14).

Given that only a small percentage of any population are of exceptional calibre, high-calibre entrants should be identified by targeting the top learners in all areas.

Nationwide marketing campaigns are needed to identify all top learners and not just those in areas adjacent to the major centres.

Figure 4.16 Percentage matric maths passes per province, 2004



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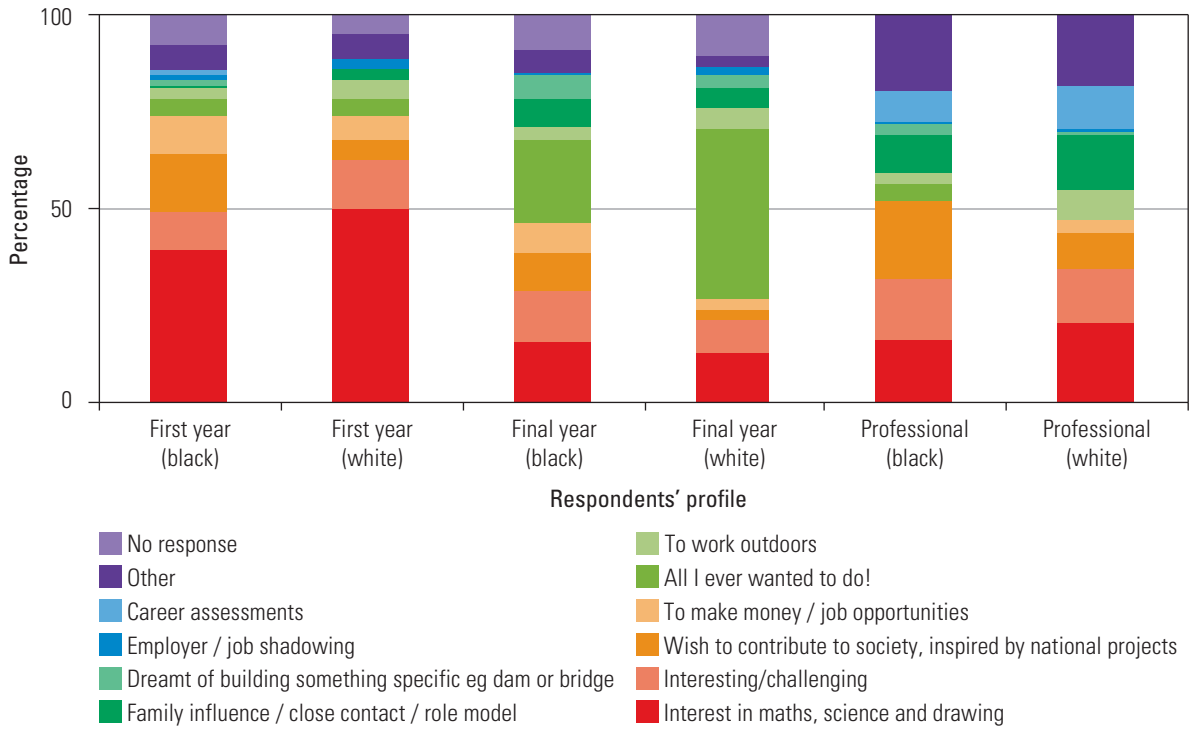


Figure 4.17 Reason for wishing to study civil engineering

4.11.1 The current civil engineering student profile

There are about 6 000 high schools in South Africa. However, the students who were registered in first-year and final-year civil engineering came from just over 500 schools nationwide. Of these 6 000, some 3 000 offer higher grade maths. Of these only 1 500 schools have 10% or more learners passing higher grade maths. There is therefore scope for identifying high-calibre learners from a broader base than at present.

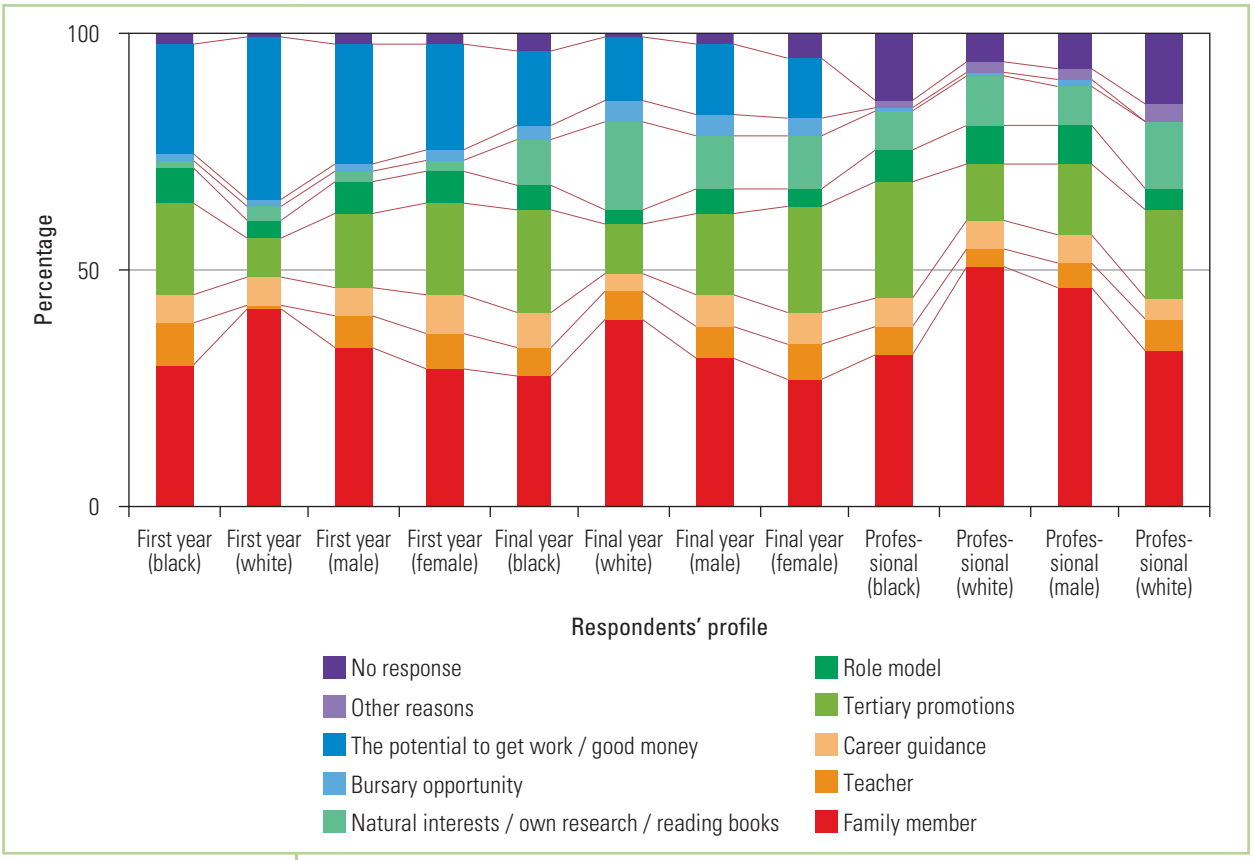
It seems that a great deal of effort has been expended in contacting schools in the Eastern Cape, as the percentage of students studying civil engineering from this province is significantly higher than in any other.

The skewed distribution in the Eastern Cape may be attributed to the many career awareness campaigns aimed at rural schools in the province by other professions such as chartered accountants and actuaries.

Gauteng is under-represented (10% of students come from this province, which has 19% of South Africa's population). This imbalance must be addressed, as 80% of the learners schooled in Gauteng achieved high-end standard grade or higher grade matric maths passes (see Figure 4.15).

Under-representation also applies in Limpopo (7% of students from 12% of the population), Mpumalanga (4% from 7%) and North West (4% from 8%). The latter three provinces do not have civil engineering faculties, nor are there any nearby, which seems to indicate that nowadays a lot of canvassing is done by tertiary institutions.

When one considers the national pass rates, and the under-represented provinces, North West appears to perform better than many and should be targeted for career guidance (see Figure 4.16).



Department of Education

Figure 4.18 Person that most influenced the decision to study civil engineering

All these parameters need to be carefully considered before a major national career guidance drive is embarked upon.

4.11.2 Reasons for studying civil engineering

Three classic responses for choosing civil engineering were given by students:

- I want to build roads like in the Carling Black Label advert.
- I want to build Tower Bridge in South Africa.
- I want to work on site because I do not like to wear a collar and tie.

(The overall view is given in Figure 4.17.)

When we consider the group that are currently practising, 15% chose civil engineering as a result of career assessments. (Career guidance played an important role in many schools prior to 1994.)

Since an aptitude for maths is one of the main reasons for selecting civil engineering as a career choice today (unlike thirty years ago, see Figure 4.17), a great deal of career guidance could be done by including science, engineering and technology (SET) career guidance material in maths and science textbooks.

4.11.3 The person who had the most influence on the learner's career choice

The person who had the most influence on the learner has changed over time and varies with race and gender (see Figure 4.18).

Today's older white males were largely influenced by their fathers and role models, while

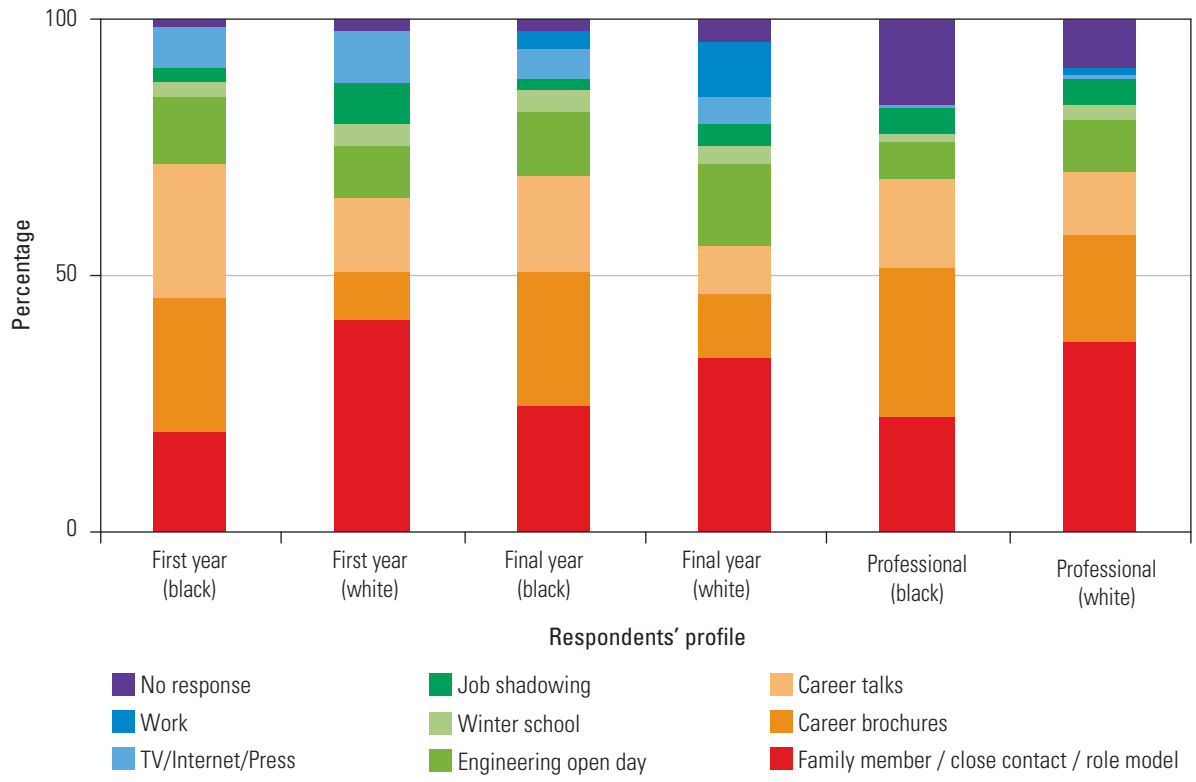


Figure 4.19 Source of career guidance information

a significant portion of the student group based their choice on employment potential and the opportunity to earn.

Interestingly, the students who cited money and work potential as their reasons were not so successful as those who were motivated to study civil engineering for philanthropic reasons, intellectual stimulation and self-fulfilment.

4.11.4 Sources of career guidance information

Few current students found out about careers in civil engineering from their own detailed research – they generally picked up data at career shows, or civil professionals had encouraged or inspired them to enter the industry (Figure 4.19).

Many students who are now completing their first year expressed disappointment with the field they had chosen, stating that they had not known enough about the scope of civil engineering when they set out. An urgent review of career guidance material is required.

More detail is essential to enable students to make informed decisions. Entrance interviews at tertiary institutions to ensure that students understand their future should also be considered.

4.12 Competition from other professions

Research by the Human Sciences Research Council (HSRC) has shown that students who successfully complete technical or financial studies and achieve professional registration have strong numeracy and literacy skills when they enter tertiary educational institutions.

Civil engineering qualifications at most South African universities require at least a C

in higher grade maths, and technikons require a minimum of a C in standard grade. Many other professions and careers have similar requirements, including accountancy and commerce, business science, medicine, science, statistics, and other industrial disciplines. The 14 000 university graduates in these fields in 2002 would have had to have higher grade mathematics to enter university. Given that there is a one third attrition rate through universities, 20 000 students with higher grade matric mathematics would have entered first year. This seems to indicate that the higher grade mathematics pass figures of approximately 19 300 in 1999/2000 limited the number of students entering universities for professions that required proficiency in numeracy in those years.

4.13 Selection

To select the most suitable students for civil engineering without arousing excessive expectations, selection tests should be developed to allow learners to be tested and ad-

Success story: The SAICE 100 x 100 recruitment campaign

The SAICE 100 x 100 initiative of 2003, to recruit 100 rural students into civil engineering as part of the SAICE centenary celebrations, has resulted in some interesting findings.

Funded by RAU, SAICE, SAISC, Stewart Scott and Goba, a highly qualified mathematician and maths teacher, Dudu Mkhize, was appointed to identify suitable students to enter civil engineering studies.

Mrs Mkhize identified schools in deep rural areas and visited schools in Limpopo, North West and the Midlands of KwaZulu-Natal, as well as townships in Gauteng. Armed with career guidance material, a maths competency test which she devised and questionnaires, Mrs Mkhize introduced learners to opportunities in civil engineering and invited those interested to complete her test and questionnaire.

Those who scored poorly were advised that they should not be considering civil engineering as a profession. The questionnaires were used as a filter to select appropriate students.

Most students came from very disadvantaged backgrounds, with parents either unemployed, or earning part time or unskilled wages of below R2 000 per month. These students would therefore all qualify for NSFAS loans if they were unable to secure bursaries.

The matric results yielded 32 excellent candidates, several with straight As. Many would not have considered civil engineering or even the possibility of tertiary education had Mrs Mkhize not visited the schools and identified such potential.

Merit bursaries were secured for several, industry bursaries for others and NSFAS funding for the rest. Industry was impressed with the calibre of student offered to them, stating that the quality was better than had been made available to them in the past through other sources. The tertiary institutions have also been happy with this group of students.

However, the project has not been without its challenges. From such disadvantaged backgrounds, the families could not cope with the additional financial demands made on them by way of registration as well as academic, boarding and bookshop deposits. The various bursaries and loans covered these expenses, but funds become available only in May and June while the payment of the above is required in January and February.

If industry is to transform, problems such as these must be addressed to make it possible for disadvantaged students to successfully enter tertiary education. Without the contact these students had with both Mrs Mkhize and the civil network, they would not have had the finances to get through the first six weeks!

Assessment of results, awarding of bursaries and paying of the funds must be resolved by the end of January. It is therefore necessary that industry extend Mrs Mkhize's tests and other selection mechanisms in order to have prepared short lists in the previous year, to speed up the process once matric results are published.

The 2004 results confirmed that this approach was worth pursuing. Five students at RAU earned a total of thirteen distinctions between them and only two failed more than two subjects. Many of the students at Wits performed exceptionally well.

The experience gained during the first year of the project showed that students are not confident enough to ask for help when in difficulty. In 2005 students have been paired with young professionals who acted as role models, mentors and where necessary, as coaches.

SAICE Bridge Building Competition

As part of career guidance and creating awareness of civil engineering, SAICE organises an annual bridge building competition.

Over 500 schools nationwide, including many rural and disadvantaged schools, are hosted by SAICE's 17 branches and compete for their place in the finals. Entrants from neighbouring states also participate in the finals.

The events give learners the opportunity to experiment with structures and gain an understanding of civil engineering.

vised whether they have the aptitude for engineering and specifically civil engineering. By developing well-designed tests, students who are not suitable would not be exposed to the traumas of failure and study debts.

The interests and lifestyle influences of 400 practising civil engineering professionals and all first-year and final-year civil engineering students were studied and yielded interesting results.

4.13.1 All students

Students were asked about their extramural activities, leadership achievements and involvement in community and religious activities (see the student questionnaires in the separate methodology report, which is available on request from the author). There was a strong link between involvement in extramural activities, leadership and community activities and achieving excellent results. Most students who reached their final year were active leaders.

4.13.2 First-year students

The first-year group is larger than later years and many drop out for the following reasons:

- Not coping with the work
- Choosing the wrong career
- Insufficient funds and results not good enough to obtain bursaries

Once again, those who were doing well and were happy with their career choice displayed active leadership characteristics.

Baroness Susan Greenfield, professor of pharmacology at Oxford, was asked to discuss the cerebral characteristics of structural engineers at the London Institution of Structural Engineers.[11] Her conclusion was that genetic influence is not so significant as the activities in which people are involved. The more a person experiences life, the more neural connections are made and the cleverer he or she becomes.

A cerebral study of London taxi drivers,[12] who are required to commit all the roads in London to memory, showed that the more they learned, the larger the hippocampus became. What people do physically changes their brains. The more the brain is used, the more capable it becomes.

4.13.3 Professionals

Civil engineering graduates were asked about voluntary work. Those who classified themselves as successful were generally active at school and involved in community development or church work. Those who rated themselves as struggling, mediocre, or unhappy in their careers were generally low or non-achievers at school.

What people do physically changes their brains. The more the brain is used, the more capable it becomes

Table 4.2 Staircase to success

Competencies for success

6 Success	Happiness Motivation Confidence Self-assessment ability Product creation Creative problem-solving
5 Learning	Analyse Evaluate Apply Understand Know
4 Thinking	Philosophy Statistical reasoning Systems thinking Research
3 Learning ability	Action learning Experiential learning Challenge cycle Understanding own style and type of intelligence Being taught
2 Skills	Lead Group functions Sell Present Speak Write Read Computers
1 Mindset	Passion for change Opportunity orientation Confidence Integrity Kindness and love Motivation Passion for learning

Spellbound

The interests and lifestyles of successful students and professionals can possibly be used to fine-tune selection criteria, in addition to numeracy testing and a review of academic records. Interestingly, those whose extramural activities were limited to sport did not achieve so well as those who were involved in cultural, intellectual and leadership activities.

4.14 Funding

Few students from disadvantaged backgrounds can afford tertiary education. Bursaries are essential. They should be available for students in all years of study and should cover all their needs so that they can concentrate on studying and not have to work for extra income, or study under adverse conditions.

Responses from first-year students included horror stories about their battle to survive.

Bursaries are awarded only after matric results have been published and institutions have made final placement offers. This means that students from disadvantaged backgrounds can only start after the academic year has commenced. Often funds are only paid over in March or April because of administrative bottlenecks and constraints imposed by financial year-ends. Before students can commence their studies they must pay tuition, accommodation, and bookshop deposits and purchase drawing equipment. This is often impossible, and many students return home within the first few weeks, devastated by such challenging conditions.

Selection criteria would make it possible for students to be selected for bursaries before matric results are published and make the necessary accommodation and travel arrangements before the beginning of the first term.

4.15 Orientation

Orientation before beginning tertiary studies has been shown to be a great advantage for all students. Developing a culture of learning and taking responsibility for their own future are difficult for young people.

In addition, those from disadvantaged backgrounds require orientation so that they can develop skills that they have not been exposed to, such as social awareness, computer literacy, driving a vehicle, report writing and public speaking.

In developing an orientation course to prepare young people for the world of work, Spellbound produced the 'Staircase to Success', (cited by Jean Cooper)[13] which outlines the competencies that must be in place for achievement in the workplace (see Table 4.2). Rural learners may have a passion for learning, but their total learning experience may have been limited to reading, writing and being taught.

Learners in former Model C and independent schools may not have a passion for learning, but may have been exposed to public speaking and the use of computers. To be successful in tertiary studies, most of the items from levels one to five must be in place. Later, for success in business, all aspects of level six must be mastered. Again orientation courses are very important.

In the USA a great deal of work has been done to address inadequacies in the education experience of African-American learners. Professor J W Carmichael[14] has been particularly successful, claiming that the students who progress through the SOAR (Stress on Analytical Reasoning) programme can out-perform any student in an Ivy League institution! Foundation courses cover not only the shortcomings in subjects such as maths and science but the many competencies required for success (outlined in Table 4.1).

CONCLUSIONS

If South Africa is to compete in the knowledge economy, a drastic overhaul of primary and secondary education is necessary. Curricula, teaching techniques, teacher qualifications, equipment and infrastructure require urgent attention, particularly with SET in mind.

The schooling system is deficient in capacity to identify and develop suitable candidates for engineering studies. This has become a worldwide problem but has been exacerbated locally by historical inadequacies, particularly in Bantu Education.

To develop a pool of professionals for the future, a great deal of effort is needed to create awareness, identify candidates with potential, nurture them through their high-school careers and ensure that they gain entry to tertiary education.

Building blocks

The building blocks for improving the quality and number of students entering civil engineering studies are:

- Appropriate content in maths, science, English and life skills tuition
- Quality teachers
- Career awareness and counselling
- Funding for tertiary education

RECOMMENDATIONS

Reconstruction required

Major interventions include:

- **Improve maths, science and English tuition**
  The Department of Education should:
  - Support teacher development
  - Provide incentives for schools to increase the ratio of higher grade to standard grade passes, rather than measure school success by the number of passes regardless of grade
  - Improve the numeracy and problem-solving components of the syllabus from Grade 1 and, if necessary, consider a return to some of the maths teaching techniques of the past
- **Supplementary maths, science and English tuition**
  SETAs need to:
  - Contribute towards projects that enhance tuition for the top performers in rural schools such as SAICA's Thuthukha project and the Free State's 'train an engineer' initiative
  - Encourage similar projects nationwide
  - Contribute towards teacher training in schools producing maths matriculants
- **Career guidance**
  A national campaign must be mounted to address all schools at which good maths passes are achieved. This can be achieved by:
  - Incorporating career guidance material in maths and science textbooks
  - Mobilising young role models in the industry to visit schools where there are learners with potential
  - Ensuring attendance at career shows

  Although career guidance teams could be volunteers from the industry, funding would be necessary for career guidance material, travel and coordinators who would select the schools, set up appointments, handle logistical arrangements, etc.

- **Career scouting**

  Counselling and testing of aspirant candidates is essential to ensure that students:
  - Make the correct decisions
  - Cope with their studies and chosen career

  The drop-out rate at technikons is extremely high (see Chapter 5) and this problem must be addressed. More top performers must be encouraged to follow the university route.
- **Funding**

  Without access to funding few PDIs are able to attend tertiary education instituions. Bursaries and assistance with accessing NSFAS funding is essential. However, students need to be assessed long before the end of matric so that they can be informed timeously of their selection and can attend orientation training before they start their studies.

  The CETA Rand for Rand scheme should be expanded so that students are linked to companies, role models and mentors from the outset.
- **Orientation**

  The change from school to tertiary education is dramatic, particularly for those from rural areas. Significant orientation is required. SETAs and other funders should consider adapting one of the successful orientation courses for all their bursary students.

Suggested Construction Charter activities

- **Upgrading of schools**

  Many schools do not have acceptable infrastructure. Contractors in particular could help to upgrade infrastructure in the area of an under-serviced school.

  Many new schools are required. The Minister wants basic, affordable, functional designs for future school developments so that the Department of Education (DOE) can maximise the use of its budget. Such a design project is a challenge for built environment consultants, and again the contracting community could invest in the construction.

  A task team needs to be set up to work with the DOE to develop solutions and document activities to which the private sector could contribute.
- **Career guidance**

  Young role models should visit over 1 000 schools nationwide. Companies could be called upon to donate time to perform this function.
- **Contributing towards sound maths, science and English interventions**

  A great deal of assistance is needed with maths, science and English tuition from Grades 10 to 12. There are several excellent interventions that would benefit from funding. A study to determine the most effective interventions should be commissioned and published for industry to invest in.

NOTES

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CHAPTER 5

Tertiary education

INTRODUCTION

A great deal was written in the press in late 2004 and early 2005 about capping the number of entrants and the funding formula at tertiary institutions. Blanket approaches to skills problems by adjusting policies will do little to increase the number of well-educated civil professionals. The problems facing each discipline should be considered individually and addressed accordingly.

Minister Pandor made a profound statement in November 2004 at the FET Curriculum Conference:

> *'… we need to focus on those skills that we need most – that is a limited number of fields in which there is large-scale demand …'*

This research indicates great demand for civil engineering professionals. As well as the bottlenecks identified in secondary education, industry input seems to indicate a mismatch between its needs and the supply from tertiary institutions.

To understand the supply, a comprehensive study of tertiary education has been carried out, including a look at enrolment and graduation figures from as far back as 1960, interviews with lecturers, and input from the majority of first- and final-year students through a series of questionnaires.

In addition, the management questionnaires returned by industry included four pages of their views on tertiary education.

The findings should form the basis for an ongoing relationship between industry, the DOE and tertiary institutions.

THE STATUS QUO

5.1 Qualifications

The full range of qualifications (past and present) is included in total graduation and enrolment figures, unless otherwise noted. They are as follows:

- **University** Bachelor's degree
  Postgraduate diploma/certificate
  Honours
  Master's
  Doctorate
- **Technikon** Technical certificate
  National diploma
  National higher diploma
  BTech
  M Dip Tech
  MTech
  DTech

'… we need to focus on those skills that we need most – that is a limited number of fields in which there is large-scale demand …'

– Naledi Pandor

Naledi Pandor
(Minister of Education)

Table 5.1 University datasets

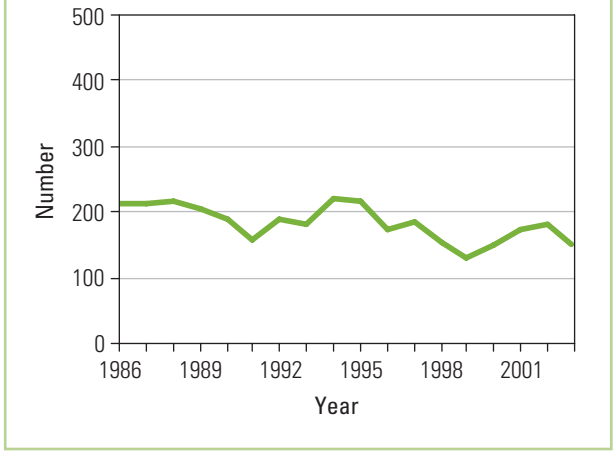
University names as reported on by DOE to 2002	Universities assessed by Industry	University registrations in 2004
Cape Town	Cape Town	Cape Town
Durban Westville	Durban Westville	-
Natal (Durban)	Natal (Durban)	University of KZN
Pretoria	Pretoria	Pretoria
Rand Afrikaans	Rand Afrikaans	Rand Afrikaans
Stellenbosch	Stellenbosch	Stellenbosch
Witwatersrand	Witwatersrand	Witwatersrand

5.2 Institutions offering civil engineering

Several institutions offer some or all of these qualifications. Data and comments on enrolments, graduations and the quality of graduates have been collected from a number of sources, including historical records from the DOE and the institutions themselves, telephonic surveys in 2003 and 2004 and workshops in 2004. However, mergers have been taking place over the last three years. (Tables 5.1 and 5.2 indicate the institutional structures that were in place when the data was collected and used.)

Table 5.2 Technikon and university of technology datasets

Technikon names as reported on by DOE to 2002	Technikons assessed by Industry	Technikon registrations in 2004
Border	Border	Border
Cape	Cape	Cape
	Durban Institute of Technology (DIT) (Natal & ML Sultan)	Durban Institute of Technology (DIT) (Natal & ML Sultan)
Eastern Cape	Eastern Cape	Eastern Cape
Free State	Free State	Central University of Technology
Mangosutho	Mangosutho	Mangosutho
ML Sultan	-	-
Natal	-	-
Northern Gauteng	Northern Gauteng	-
Peninsula	Peninsula	Peninsula
Port Elizabeth	Port Elizabeth	Port Elizabeth
Pretoria	Pretoria	Tshwane University of Technology (Pretoria and Northern Gauteng)
Technikon SA	Technikon SA	Technikon SA
Vaal	Vaal University of Technology	Vaal University of Technology
Witwatersrand	Witwatersrand	Witwatersrand



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5.3 Professional graduations

From 1986 to 2003 civil engineering first-degree graduations from universities declined while postgraduate research increased. (See Figures 5.1 and 5.2.)

Technikon graduations are very different and reflect a steady increase. (See Figure 5.2.) Technikon data over the period were difficult to collate, as qualifications were restructured at this time. The national diploma and higher national diploma of the past have been mapped as equivalent to S3 and S4. The BTech was introduced in 1994 (hence the different x-axis in Figure 5.4).

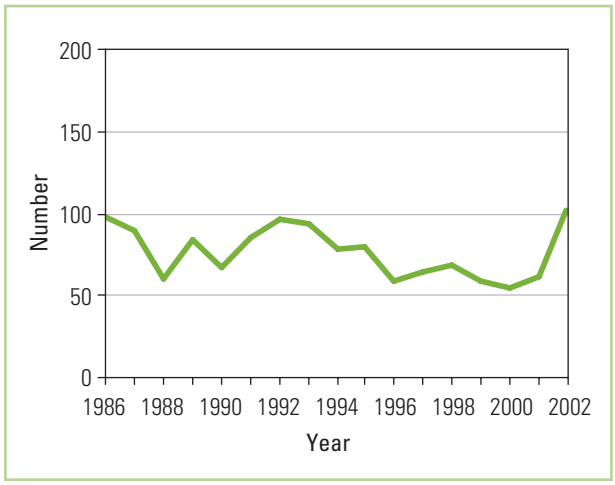
When the BTech was introduced, the profession mounted a major campaign to encourage their diplomates to return to technikons to enhance their qualifications. The peak between 1996 and 1998 reflects the initial flurry of activity as those in practice took the opportunity to improve their qualifications and hence their career paths.

5.4 Gender

Civil engineering is still male dominated, with meaningful change having taken place only recently in technikon enrolments and to a lesser extent in the numbers graduating from universities and technikons (see Figures 5.5 and 5.6).

Left *Figure 5.1 Number graduating with a BSc in civil engineering 1986–2003*
Above *Figure 5.2 Number graduating with a national diploma in civil engineering 1986–2003*

Left *Figure 5.3 Number graduating with university postgraduate qualifications, 1986–2002*
Below *Figure 5.4 Number graduating with a BTech, 1995–2003*



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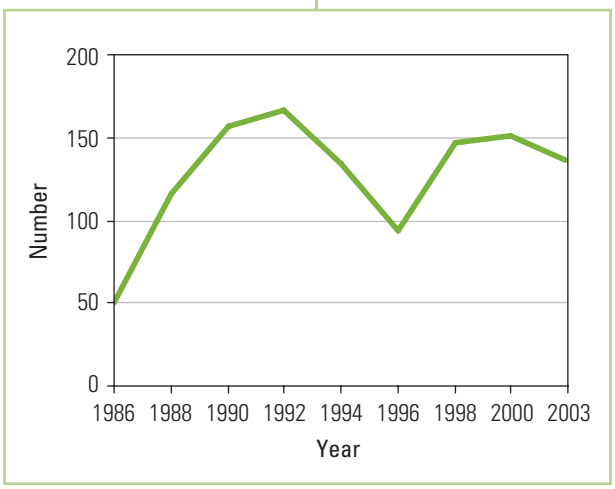

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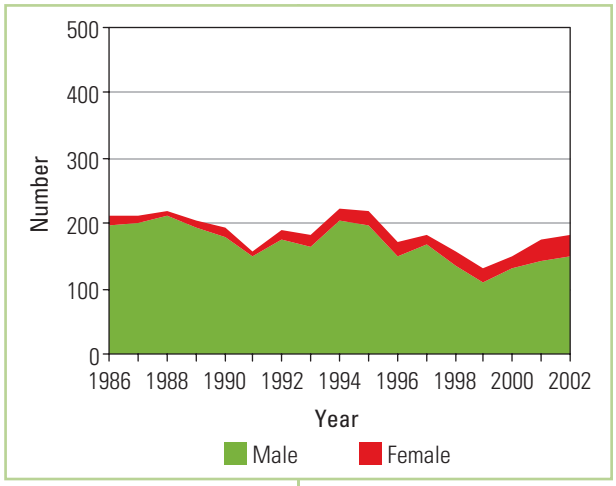

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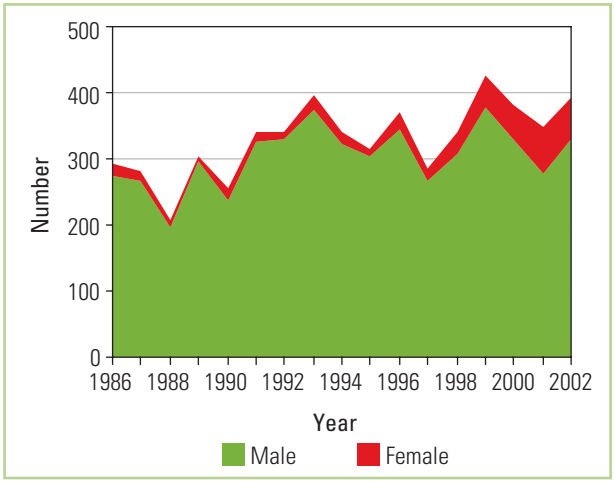

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Above *Figure 5.5 Civil engineering graduations from universities by gender, 1986–2002*

Right *Figure 5.6 Civil engineering graduations from technikons by gender, 1986–2002*

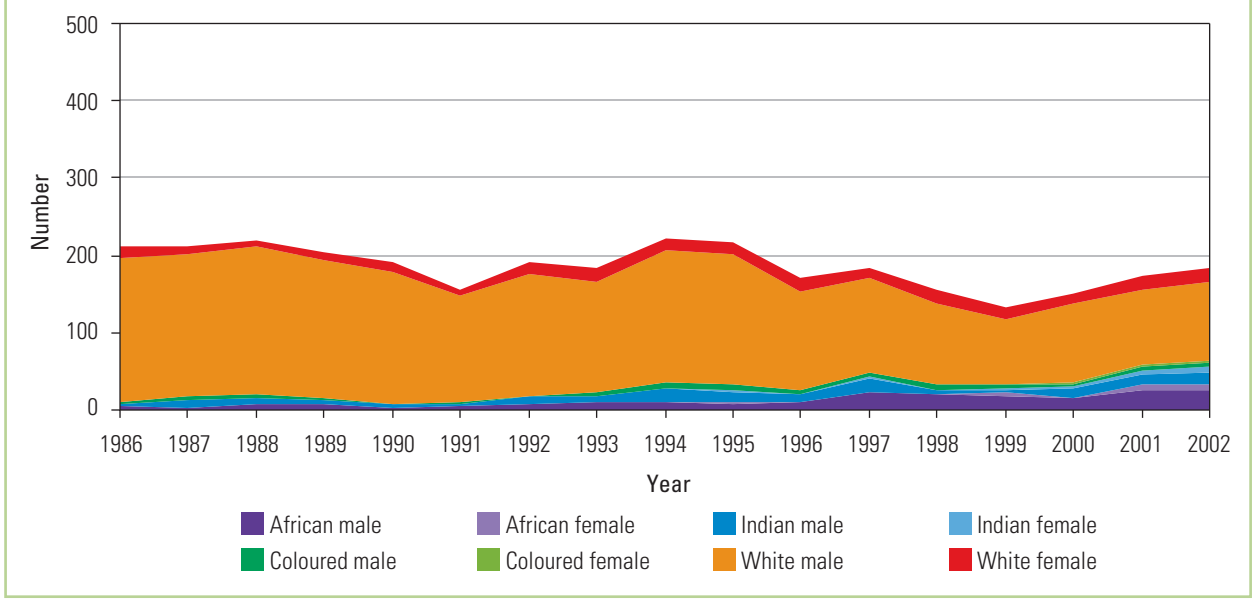
Given that engineering seeks to attract the upper echelon of school leavers, it is incongruous that half of those suitably qualified are not being attracted into the industry. Medicine, business, finance and law attract the vast majority of female high achievers.

5.5 Transformation

Until the mid-eighties it was difficult for Africans to gain admission to any university civil engineering class (see inset). However, SAICE and many institutions and corporations commenced career guidance for all schools, including rural and urban co-ed and girls' schools in the mid- to late-eighties. Slowly but surely, tertiary institutions have seen an increase in women and previously disadvantaged students.

Initially changes were insignificant. However, the release of Nelson Mandela and signs of the move to democracy paved the way for many more previously disadvantaged students to enter tertiary studies in the built environment. By 1998 graduations of previously

Figure 5.7 Civil graduations from universities by race and gender, 1986–2002



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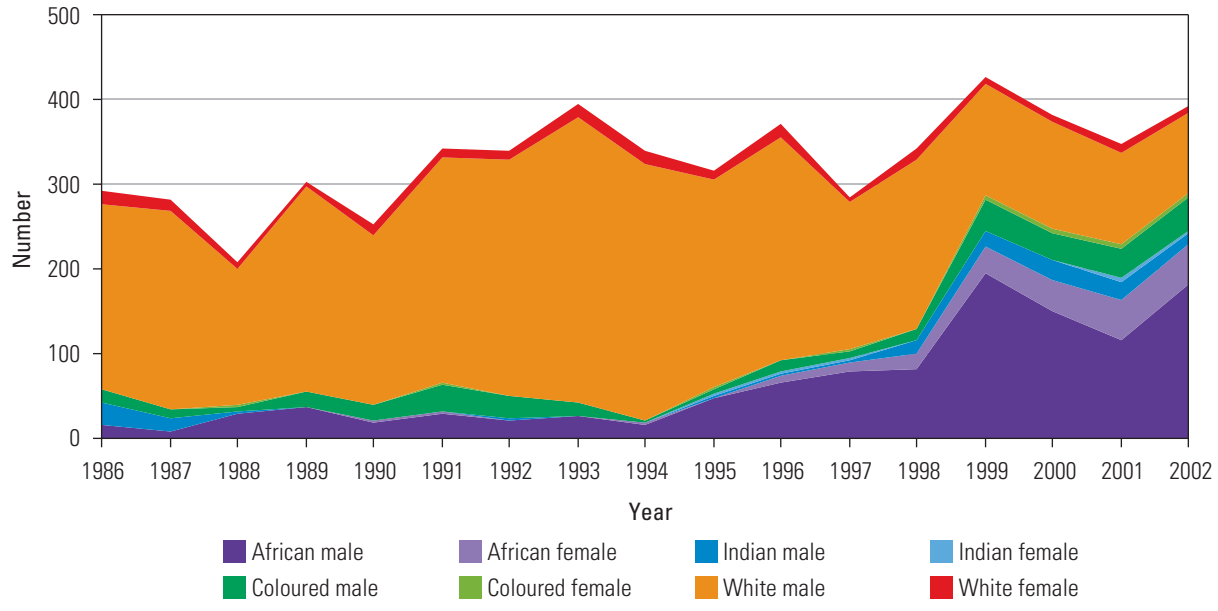

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Figure 5.8 Civil graduations from technikons by race and gender, 1986–2002

disadvantaged students at technikons exceeded those of the previously predominant white males.

5.5.1 Engineering graduations – universities

Graduations of all previously disadvantaged individuals (PDIs) have increased. However, while the number of white male graduates has decreased, 25% more white males than all PDIs still graduate. The second largest group of graduates are African males, but at the current rate of graduation there is little hope of transformation at management level in civil engineering organisations in the short to medium term. (See Figure 5.7.)

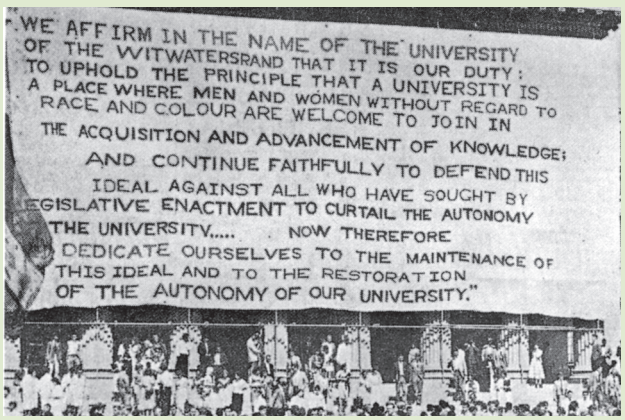
First-year registrations at universities in 2004 showed the same trend, with African males representing 24%. The total number of black students enrolled exceeded 50% for the first time, however.

In 1959 the government of the day put an end to academic freedom. Black students, the Government ordered, must be educated in separate universities, run by the Government. Only with ministerial permission could they get into white universities, a law which lasted until the middle 80s.

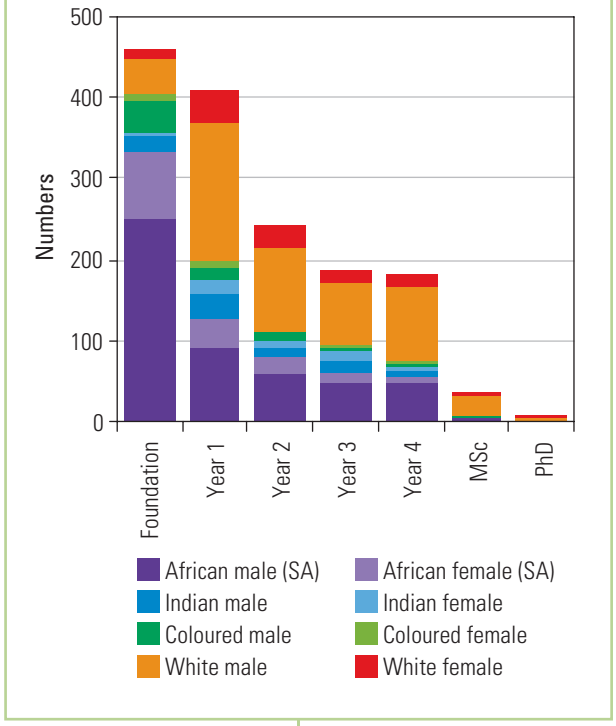
Only a few Africans now aged 45 to 65 ever managed to work through the bureaucracy to qualify as civil engineers in South Africa.

In 2004, 81% of technikon and 58% of all university civil engineering students enrolled were black.

Here Wits students stand in silence mourning the passing of academic freedom.



The Star, 16 April 1959



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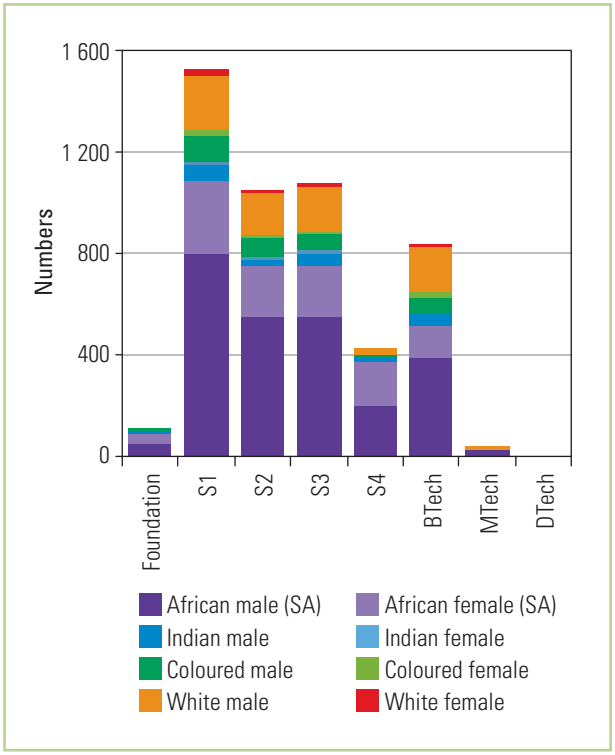

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Above *Figure 5.9 Civil engineering enrolments at universities, March 2004.*
Right *Figure 5.10 Civil engineering enrolments at technikons, March 2004*

These students still have to qualify, train, register and gain experience before they can take up in management positions, so there is a long way to go in terms of transformation at senior levels in this industry.

5.5.2 Engineering graduations – technikons

The picture is somewhat different at technikons, with the student population transforming dramatically. (See Figure 5.8.)

White males now represent less than 25% of technikon graduates. However, these numbers are not reflected in industry, and a great deal of work needs to be done to ensure that all graduates are employed.

5.6 Registrations 2004

To gain a perspective of the current student composition, a survey of the registrations at all universities and technikons in South Africa was carried out in early 2004, as DOE information is generally published almost two years after registration. (See Figures 5.9 and 5.10.)

The foundation figures at universities are not restricted to civil engineering, as many institutions have a general foundation programme for all engineering students. At technikons foundation years are not always limited to engineering, but can include the sciences. At others, S1 is simply spread over two semesters; hence the much higher numbers in S1.

Most institutions indicated that they had experienced dramatically increased registrations in 2004, particularly in civil engineering and architecture.

Institutions were asked to indicate non-South African students where possible. This information was not available from all institutions, but technikons that supplied such data

had at least 5% foreign students.

Foreign students in all tertiary institutions are contributing well over R1 billion to the national economy, according to the Council on Higher Education.[2] Fifty-eight per cent of foreign students were from Botswana, Lesotho and Namibia. A significant South African Development Community (SADC) contingent was also evident in civil engineering. (See Figure 5.11.)

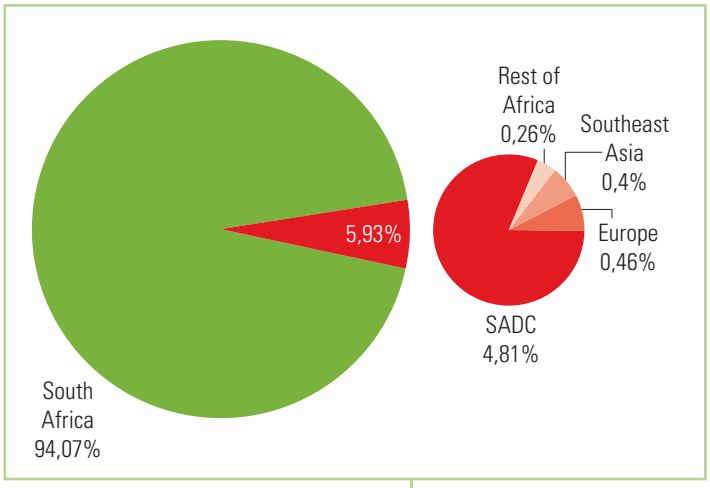


Figure 5.11 Distribution of nationalities studying civil engineering at tertiary institutions in 2004

THE CHALLENGES – THROUGHPUT AND RELEVANCE TO INDUSTRY

5.7 Graduation and enrolment – all engineering

Total engineering graduations in this context relate to BSc/BEng degrees in all engineering disciplines – including aeronautical, agricultural, chemical, civil, electrical, industrial, marine, mechanical, metallurgical, mining and nuclear. The trend that applies to all engineering is similar to the one that applies to civil engineering.

Enrolment is defined as all students enrolled at all levels.

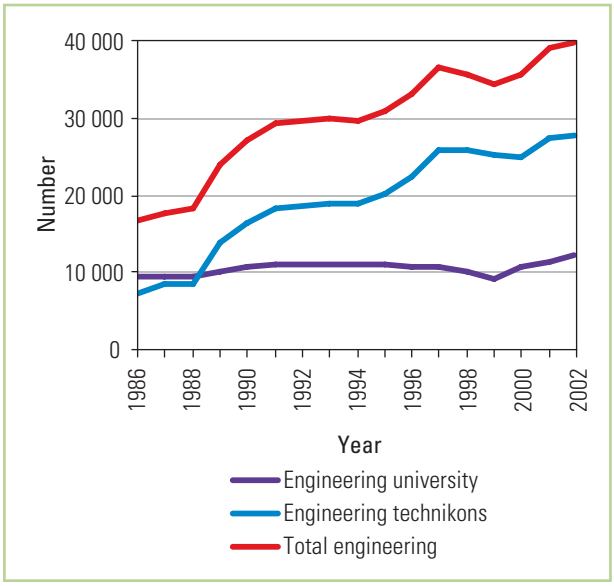
From statistics over the 16-year period it appears that in general enrolment is on the increase, while graduations decreased progressively in the latter part of the nineties, but are now starting to pick up slightly. (See Figures 5.12 and 5.13.)

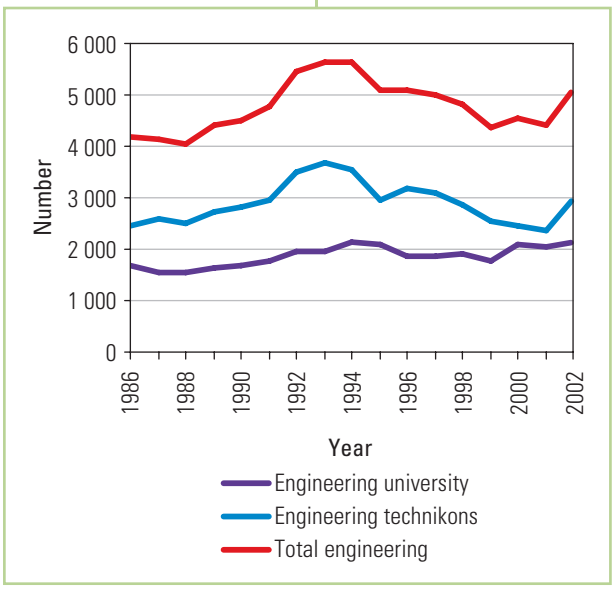
5.8 Graduation and enrolment trends – civil engineering only

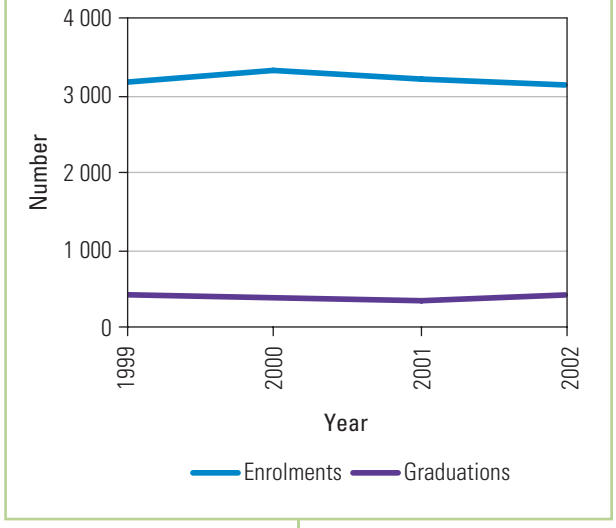
Since 1999 enrolment and graduation figures have been available for every discipline.

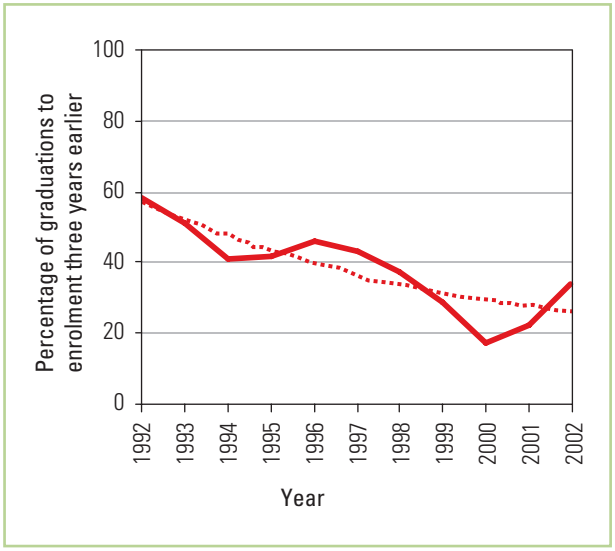
In the four-year period from 1999 to 2002, a slow-down in enrolments and slight improvement in graduation took place in civil engineering. This applied to universities and technikons (illustrated for technikons in Figure 5.14).

Left Figure 5.12 Engineering enrolments, 1986–2002
Below Figure 5.13 Engineering graduations, 1986–2002









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Above Figure 5.14 National diploma in civil engineering – number enrolled and graduating 1999–2002
Right Figure 5.15 Percentage graduations three years after enrolment for engineering national diploma

5.9 Reduced throughput

Throughput presents a serious problem (see Figure 5.15). Although Figure 5.15 relates to technikon throughput, the rest of this section applies to throughput problems at both technikons and universities. The method of comparing enrolments and graduations three or four years later to determine throughput is not totally correct as first-year enrolments will include those who are repeating, and final-year graduations will include those who are graduating after five or more years of study. Figures 5.15 to 5.17 are useful from a comparative point of view.

The drop is alarming. Comprehensive analysis has indicated many contributory factors:

- Major campaigns were mounted in the late eighties and early nineties to encourage previously disadvantaged learners to enter tertiary education, with few or no entrance criteria being applied or enforced
- Students who entered had poor grounding in maths and did not have a command of the language of instruction (See Chapter 4, 'Supply – secondary education'.)
- Institutions were not geared to offer supplementary courses to prepare these previously disadvantaged entrants to cope with tertiary education, so they did not pass
- Institutions needed to understand cultural diversity issues
- The huge increase in numbers meant in some instances that classes were too large to be taught effectively, or that additional staff were taken on with inadequate qualifications, because of budget constraints
- Few black students can afford tertiary education, unless they can secure loans or bursaries, and when they attempt to fund themselves, many problems arise
- The major drop-off is at technikons where it is necessary to do workplace training before qualifying, and sufficient opportunities are not available

Many interventions are clearly necessary to allow these young people to develop to their full potential! (These and other constraints will be covered in more detail below.)

5.9.1 Entrance criteria

Analysis of the throughput rates and selection criteria for each of the institutions in South Africa show significant disparities. Pretoria Technikon (now Tshwane University of

Technology (TUT)) and Stellenbosch University each achieved the highest throughput measured in this way. These institutions apply the most stringent entrance criteria for technikons and universities. (See Figures 5.16 and 5.17.)

Stellenbosch calls for a minimum of a higher grade C in maths, science and language, and holds interviews with prospective students. Students also sit an entrance test. This ensures that almost 100% of students entering in first year will emerge with a degree. This is the ideal in terms of tertiary education – facilities, lecture time, bursaries and the student's time are used optimally.

Tshwane University of Technology (TUT) has carried out substantial research and has found that simply using maths and English grades, or the Swedish rating, does not offer a very accurate guide as to whether the student will be successful. Historically there has always been a big drop-out in engineering at South African tertiary institutions. The key to success lies in being able to determine whether the potential learner can solve problems, rather than regurgitate facts, figures and formulae.

Over the past five years TUT has developed a comprehensive in-house set of tests that are proving exceptional for identifying applicants with potential, even if their situation had precluded them from achieving meaningful matric results, and conversely for identifying those candidates with excellent matric results who are not suited to engineering studies.

Many institutions use the Swedish rating system. When this system is applied rigidly, results are better than in institutions where no practical selection process is enforced.

Despite TUT's experience that maths and English marks were not reliable indicators, there was a correlation between the throughput rate and the minimum entrance symbols specified by each institution.

At technikons, entrance criteria for maths ranged from higher grade D and standard grade B to higher grade E and standard grade E. The English criteria varied from higher grade D to F and standard grade C to E. Universities did not have the same disparities. Higher grade C is regarded as the minimum standard in maths at all except two universities, which require higher grade D.

Although most of the historically disadvantaged institutions (HDIs) acknowledge that standard grade E for maths is a problem, this criterion has been accepted so that no applicant is denied access to tertiary education. Unfortunately, few students with such poor capacity in maths are able to cope. A clear distinction needs to be drawn between those who have the potential, but require nurturing in the challenging tertiary environment, and

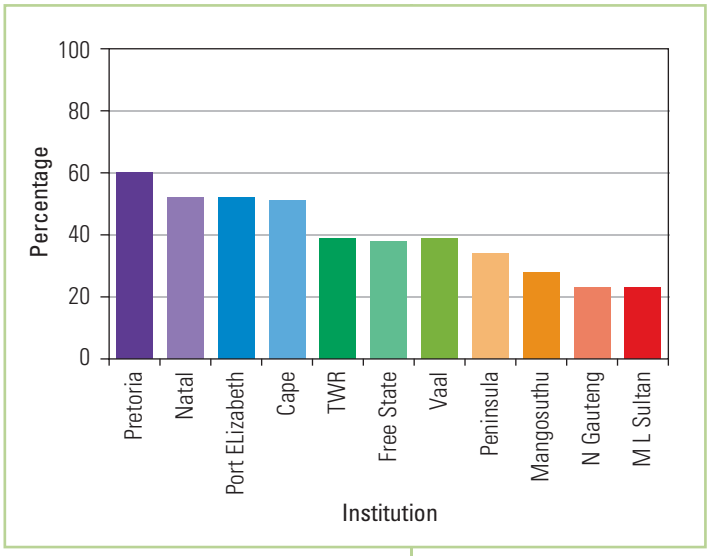


Figure 5.16 First-year engineering enrolment compared with graduations three years later at technikons

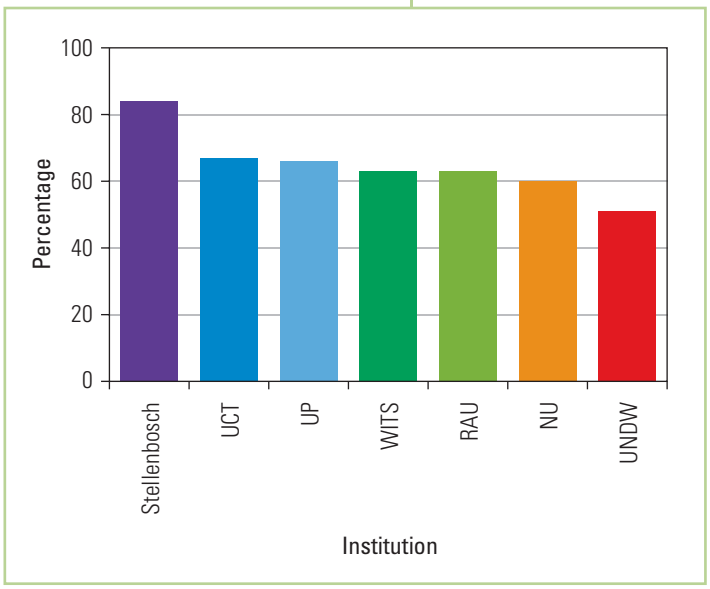


Figure 5.17 First-year engineering enrolment compared with graduations four years later at universities

those who apparently have no aptitude. Tertiary institutions cannot be expected to develop capacity if it is still lacking after twelve or more years of secondary education.

A similar debate has arisen in the USA:[3]

> *'… affirmative action leads to admitting lesser qualified people into colleges and jobs. Minimally qualified is a far cry from equally or best qualified. This begs the question of whether it is right to admit a student to a college who is minimally qualified, and thus, least likely to succeed. Would you want a minimally qualified surgeon, dentist or pilot? …'*

Students who do not pass their first year constitute more of a human drama than a problem to industry. Their expectations have not been met, they have spent time and money (in excess of R15 million per annum, often putting their parents into long-term debt) in fruitless attempts to reach an unattainable goal. They should have been precluded from failure in the first place.

Many institutions register students to make up the numbers and are unconcerned about the emotional and financial drain on weak students. Appropriate numbers need to be determined, and the DOE must be persuaded to increase funding for a reasonable and sustainable number of high-calibre students.

Professor Graham Zellick, Vice Chancellor of London University, attacked tertiary institutions globally for trying to open tertiary studies to all. He stated:[4]

> *'… too many students are not fit for university … I do not know of any evidence that such a high participation level is right …'*

At a time that South Africa is so short of artisans, operators and the like, resources should be better utilised. Young people should be guided into career directions that match their abilities. Students with potential for engineering careers, however, must be identified, attracted and retained.

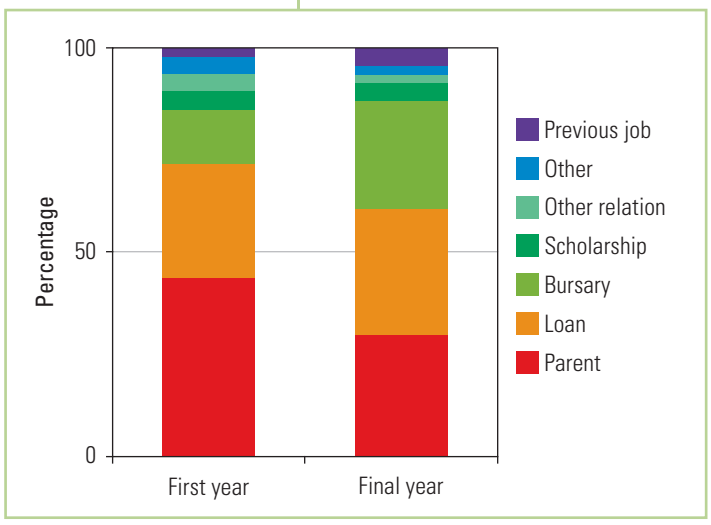
5.9.2 Foundation programmes

In the last ten years foundation programmes have been introduced to assist students to cope with the challenges of tertiary education.

This research highlighted many approaches to the bridging or foundation phase. Some institutions have dedicated foundation programmes for each degree course. Students are taught separately for a year before starting their formal degree studies. In other instances, the dedicated year is not linked to a particular qualification, but students who need assistance in a large range of scientific studies are taught together in the foundation year, and then make their career selections for the following year.

In other institutions the four-year degree is simply converted to a five-year degree and students are taught at a slower pace, particularly in the first three years – which effectively cover the first two years of the four-year degree.

Figure 5.18 Sources of funding



A similar approach was identified at technikons. Some offered dedicated foundation programmes, and others chose to teach the first semester over two semesters. At present DOE funding is not available in all civil engineering departments. It is essential that the DOE should be persuaded to support civil engineering foundation programmes throughout.

Some foundation programmes appear to achieve good results, while others apparently have little or no impact. All these courses should be comprehensively evaluated and an optimum curriculum developed for all to use.

As a result of the number of approaches, it was difficult to present registrations in these foundation courses in a meaningful way. Further, some institutions would not publish these figures as they are privately funded initiatives.

One of the most critical components of future engineering education seems to be the worst funded and least understood aspect of tertiary education.

One of the most critical components of future engineering education seems to be the worst funded and least understood aspect of tertiary education.

5.9.3 Funding

Many students are extremely poor. Without funding, they cannot hope to succeed. They require funding not only for tuition, but for accommodation and living expenses. Typical sources of funding are:

(a) Parents/family

When funded by parents or family, students from very poor backgrounds often cannot afford suitable accommodation or even food, hence their conditions are not conducive to studying and passing.

(b) Loans

National Student Financial Aid Scheme (NSFAS) loans are the most common. Students must pay back the loan after they have graduated and can earn a living. This type of funding is not continuous. If students fail a subject, they lose their funding and will not be able to continue.

For students who drop out, paying back the loan is a huge burden on the family. NSFAS loans do not cover off-campus accommodation or subsistence expenses.

(c) Supplementary funding

Where funds are inadequate, students attempt to fund themselves by working part time to the detriment of their studies, or drop out when they no longer have sufficient funds.

(d) Bursaries

The ideal solution is a full bursary from first year but it is common practice to offer bursaries only from second year. For example, Wits recently announced that it would be offering its bursaries only from second year, causing much unhappiness on campus.

The burden of first year therefore falls on the parents or guardians (see Figure 5.18). This means that many of those deserving students from disadvantaged backgrounds never have access to tertiary education.

By using screening tests such as those developed by TUT it would be possible to confidently offer first-year bursaries.

(e) Deposits

There is a further problem with funding that must be addressed. When students from poor backgrounds do get loans or bursaries, these are paid only towards the middle of the year. However,

institutions demand up-front deposits for tuition, accommodation and books before the student has access to funds. This results in many students abandoning their studies at an early stage.

5.9.4 Monitoring and support

To help ensure that disadvantaged students complete their qualifications, it is necessary to nurture them throughout their studies. Monitoring each student is an important component to ensure that progress is being made at all times.

(a) Supplementary lessons

Institutions need to understand cultural diversity issues. Many black students come from traditional backgrounds. They are not confident enough to ask for help when they were having difficulties, because their upbringing dictates that they must do as they are told, and accept what happens to them without complaining. Lecturers do not have time to ensure that each student is coping, but rely on students to approach them for help.

Students should therefore have access to senior students whom they can relate to, and

Table 5.3 SAICA requirements for nurturing black and coloured university students

Requirements for SAICA-funded programmes
Students will be fully bursared and will be placed in groups of between 50 and 100 at selected higher education institutions
These bursaries will include: ■ Registration fees ■ Lecture and tutorial fees ■ Accommodation and meals ■ Textbooks
The profession will require the following: ■ The students need to be accommodated together ■ The students need to be placed on special four year undergraduate programmes (the normal duration is three years)
These undergraduate programmes must include: ■ The development of literacy, numeracy and life skills ■ If possible, these students need to be worked with separately ■ If this is not possible they will then require separate and additional tutorial groups
The university will: ■ Be required to enter into a Memorandum of Understanding with SAICA as it relates to these students ■ Be required to appoint a project manager to take responsibility for the group and who will be in close contact with the relevant project manager at SAICA
The project manager from the university will: ■ Be responsible for the preparation of quarterly reports on the status of the students, problems encountered and advances made with the group ■ Work with the project manager from SAICA to appoint properly trained mentors to mentor the students. This will be closely monitored by SAICA
The aim of the undergraduate programme is to ensure that: ■ We increase the number of African black and coloured students entering higher education institutions ■ The throughput percentages of these students are equal to if not better than those of their white counterparts

who will assist them with difficult new concepts, complex tutorials, etc. Monitoring academic progress each month and ensuring that teaching interventions are put in place timeously are essential.

(b) The social environment

Another challenge is the dramatic change in the social environment from rural life to tertiary residences in a sophisticated environment. The South African Institution for Chartered Accountants (SAICA) found that the average pass rate in commerce for black students at university is only 20%. Mixing unsophisticated students with urbane students places too much pressure on new recruits who fail to cope socially or with course work. SAICA insists that their students are accommodated separately and has developed a structured monitoring and support programme for students that they sponsor. (See Table 5.3.)

The experiences are no different for civil engineering students. The following comment speaks volumes:[5]

> *'… as a coloured female from a rural town it was very difficult to come to the big city. Moreover, I was Afrikaans-speaking, and was, for the first time in my life, sitting in a class with "white people" who all spoke English. I was completely overwhelmed and I failed my first year outright. I was devastated, but my parents and bursars were also supportive. So I went back and repeated. The strangest thing happened; someone "switched on the lights". I became a very successful student and never failed again …'*

The South African Institution of Civil Engineering (SAICE) recognises this problem. To put less pressure on the SAICE 100 x 100 students, they are accommodated together in an underutilised school boarding establishment, where they can support one another in a less threatening environment. Senior disadvantaged students were also offered accommodation there to mentor and coach the new recruits. As a result, the students settled in very quickly.

Adopting the SAICA model could well improve the success rates of civil engineering students from disadvantaged backgrounds.

(c) Life skills

The life skills that require development are not limited to the ability to communicate, write reports and understand management and authority, but include such activities as opening a bank account, using a bank, credit card or cheque book, and managing personal finances. These skills are usually unfamiliar to students from severely disadvantaged backgrounds.

Students who are not familiar with computers and libraries need early help to use these facilities in their studies. Study methods and research techniques also need to be taught early on. Few disadvantaged students have attended schools offering design and technology (D&T), so few have ever done engineering drawing and consequently require substantial support with this subject. Professor Barney Pityana, Vice Chancellor of the University of South Africa (Unisa), captured the problem in a letter to the president:[6]

> *'… the schooling system … churns out more and more students who are not intellectually ready for the rigours of higher education …'*

In addition, few of these students have learnt to drive a car, which makes it difficult for them to get experiential training. Monitoring and managing student development and link-

ing students to mentors or role models are necessary to address many of these issues.

Sector Education and Training Authorities (SETAs) need to consider their roles in assisting with some of these weaknesses, particularly not being able to drive.

(d) The confidence to ask

Another major problem concerns culture. When problems arise, whether they are financial, personal or academic, students are reluctant to ask for help. Introducing students to young graduates as role models will offer a shoulder to cry on. Encouraging students to join institutions such as SAICE soon after registration also provides them with a group of people to turn to when they need help. Young graduates should be encouraged to link up with tertiary institutions that support students. This approach has been adopted in the UK, where the president of the Institution of Structural Engineers has called on branches and members to support students and encourage them to join the institution:[7]

'… it is for all members to assist … meet … all eligible students …'

Orientation at the outset is essential (as described in Chapter 4), as is ongoing monitoring and support of these students.

5.9.5 Lecturers

Although students experience many external difficulties, problems with staff/student ratios, lecturer quality and attitude were also highlighted.

(a) Student to staff ratio

The increase in enrolments (see Figure 5.12) has meant in some instances that classes are too large to be taught effectively. In some institutions the staff to student ratio was as low as one lecturer to 96 students. In other instances, additional staff with inadequate qualifications had been taken on, because of budget constraints.

Success story: The challenges facing a black civil engineering student

'I, being a young (black) African male, am in a very privileged position to have received a private school education. I am even more fortunate that I went on to attend one of the top-ranking universities in the country. High school was easy enough to get through with the school boasting a 100% matric pass rate every year, but at varsity I got a rude awakening. My first-year class consisted of about 50 students, of whom approximately half were African. Among them, I may have been the only PDI with a private school background; few of the white students had that privilege.

Only one African student from my first year managed to complete the degree in four years (with no more than five or six white students failing to graduate in record time). Moreover, he was not even South African. The remainder of the African students either dropped out along the way or took an extra year or two to complete the degree.

The majority of African South Africans, who did ultimately graduate, were eager to start working immediately rather than pursuing postgraduate studies. Only two of us African South Africans have gone into research. The greater number of full-time postgraduate students (PDI) are non-South Africans.

I've concluded that one's success at varsity is not contingent on high-school background as I would have thought. There seems to be more of a connection in the social/racial backgrounds of South Africans. This goes for the students who wish to pursue postgraduate degrees as well. It seems that young African South African students are more inclined to go out and start making money immediately, presumably to cart themselves out of their historical economic difficulties as soon as they are able to.'

Researcher: Marianne Vanderschuren

Civil engineering education is expensive because so many subjects need to be taught, including technical topics such as structures, water, sanitation, roads and transport, geotechnical, construction and environmental engineering. In addition, the softer skills such as communication, human behaviour, community liaison, economics, management and project management, and law must be developed. Civil engineering students have only one or two free periods a week, while some of their colleagues in other faculties attend only one or two lectures a day!

An adequate number of lecturers are required to address all these topics. After a major review of tertiary education by Hugo et al[8] in 1988, it was recommended that in order to have sufficient depth of knowledge in each field, university civil engineering departments should have an academic staff complement of at least 25. This was at a time that they were recommending that there should be a total of 300 graduates per annum to support a significantly smaller population and demand on development. Today only one institution has 20 academic staff members and the rest are in the low to middle teens. Various subjects are suffering as a result.

The technikons are worse off. Although they have more students, only one institution has more than 13 academic staff, and some have only five or six.

(b) Locality

The localities of several of South Africa's HDIs are not conducive to attracting highly qualified staff. While it is recognised that regional campuses are required to offer access to education for all, there are problems with the organisational and delivery structures in these institutions.

(c) Lecturer qualifications and experience

A comparison of the qualifications and years of experience of heads of department (HODs) in civil engineering reveals disparities. In several technikons the highest qualification of many of the lecturers is a national diploma – the programme that they are lecturing. By contrast, most university staff hold doctorates, and some hold master's degrees in the specialist field in which they are lecturing undergraduate students. There is a correlation between lecturer qualifications and student throughput.

Since technikons are developing practical hands-on graduates, many institutions demand that lecturing staff have five to eight years' workplace experience before joining academia, but not all. This presents a problem when young diplomates or young graduates teach practical subjects to undergraduates, but do not have the experience themselves.

(d) Lecturer salaries

It seems that the current breed of lecturers still comply with the image of 'absent-minded professors', as they are happy to teach, carry out research, and continue in the academic world for pleasure rather than gain. Salaries are generally much lower than those offered in industry. This has been a problem for a long time and was confirmed in the salary survey. Unfortunately a full sample per age group was not received; hence separate academic figures could not be extracted in Figure 7.30.

There is a severe shortage of academic staff and interventions must be established to attract and retain the top calibre. If government is unable to address this, then industry and perhaps SETAs should consider subventing lecturer salaries. In the USA and Canada significant funds are provided from the private sector to ensure that salaries are competitive. The Hugo investigation found that in both countries merit is rewarded through salary differentiation.

In South Africa various chairs in civil engineering subjects and project management are sponsored by the private sector, and other staff receive top-up payments from industries and suppliers in whose field they offer excellent service, but more interventions are needed. The accounting profession aggressively recruits and retains top candidates in academia through subvention. Because many institutions are extremely short of staff, scarce skill allowances should also be considered.

(e) Technocrats not teachers

Lecturers are not required to have teaching qualifications. Thus they are technical people who have not specifically been trained to teach. While some may be 'naturals', many cannot explain concepts, and students battle to understand what they are being taught.

A system of monitoring, evaluation and compulsory training for those below par should be implemented. Train-the-trainer types of course can be of immense benefit. One such programme (developed in the USA) has reported improved results. Called Excellence in Civil Engineering Education (ExCEEd), it was developed by Westpoint Military Academy to improve results in the engineering corps.

Some institutions have developed training courses, and lecturers are expected to compile a portfolio to demonstrate their proficiency. But these appear to be exceptions rather than the norm.

(f) Centres of excellence

It is possibly time to think about restructuring civil engineering departments to create centres of excellence. For example, at universities the curricula could remain the same for the

Table 5.4 BTech subjects offered per technikon, 2004

Institution	Construction management	Environmental engineering	Geotechnical engineering	Structural engineering	Transportation engineering	Urban engineering	Water engineering	Full time	Part time
Border									
Cape	✔			✔		✔	✔	✔	✔
DIT	✔			✔	✔	✔	✔		✔
Eastern Cape					✔		✔		✔
Free State					✔	✔	✔	✔	
Mangosuthu									
N Gauteng							✔		
Peninsula					✔	✔	✔	✔	✔
Port Elizabeth		✔			✔	✔	✔		✔
Pretoria	✔	✔	✔	✔	✔	✔	✔		✔
TSA	✔	✔	✔	✔	✔	✔	✔		✔
Vaal					✔	✔			✔
Witwatersrand	✔	✔	✔	✔	✔	✔	✔		✔

Technikon HOD forum

first two or three years, but the final year at least, if not the third and final years, should offer specialist training only in those subjects where there is sufficient expertise. Mechanisms would have to be set up to allow students to move from one campus to another, should they wish to specialise in a field that is not offered on their campus.

Similarly specific S3 and S4 courses should be offered only at those technikons with the appropriate expertise. This is happening to a limited extent at present at BTech level (see Table 5.4), but needs to be examined in the national context.

(g) Use of technology

When facing the challenge to address change and capacity problems, one is often told to 'think smart'. The need to change and think smart is also necessary in tertiary institutions. Little use is being made of technology to supplement lecturer capacity. Many excellent courses developed by international experts are available in multi-media format; and superb interactive courses are accessible on the web. These e-learning facilities should be considered.

(h) Attitude

Another problem is the attitude of certain lecturers from non-engineering departments towards engineering students. The need for students to attend maths, statistics and courses in other departments, particularly at universities, is of particular concern.

It appears that some of these lecturers enjoy telling students that they should not be in their classes as they are '*… not competent, too stupid, or only engineers …*'! This continues at second-year level, even when the student has achieved a good first-year pass. It undermines student confidence and means that no support is available for those who may need to ask questions. Taunts such as '*… if you need to ask that question you should not be in the class …*' have been reported!

As a result of this type of attitude many students have had to attend supplementary lessons. It is interesting to note that 40% of the practitioners who responded to the personnel survey failed to complete their studies in the prescribed time. A total of 15% complained of difficulty with maths. Attention to this problem is surely long overdue!

Given that most engineering students are unlikely to use maths in practice to the level of Maths II, it is possibly time to consider dedicated syllabi for civil engineering studies. (This will be addressed in more detail in 5.14 below.)

Research into school maths and science by the Centre for Development Enterprise (CDE)[9] yielded a series of observations entitled 'What good educators do':

- Create and adhere to a learning plan that is understood by the learners
- Cover the syllabus
- Adapt teaching methods to the needs and capabilities of learners
- Put in intensive effort at times that learners can give uninterrupted attention for example over some weekends or during vacations
- Find out each learner's results, analyse the pattern and plan to improve
- Update content knowledge regularly
- Actively maintain personal professional development

These guidelines should apply equally to lecturers. While there will be objections that students should not be spoon-fed, the school education system and the student profile have changed dramatically over the last 10 to 15 years and a large proportion of entrants into tertiary systems require additional support and nurturing.

(i) Lecturer ethics

Students complain that certain lecturers are never available to answer questions and that some arrive halfway through the lecture period or not at all. Heads of department complain of not being able to demand the discipline and dedication required of lecturing staff. National guidelines or contracts outlining staff duties and a code of conduct would ensure improved quality from all academic staff.

In particular there is a great deal of frustration in organisations that have merged and in which work ethics differ in the two cultures. Staff complain of being criticised unduly by overzealous new bosses, while HODs complain of less than satisfactory performance from their new staff.

5.9.6 Quality control

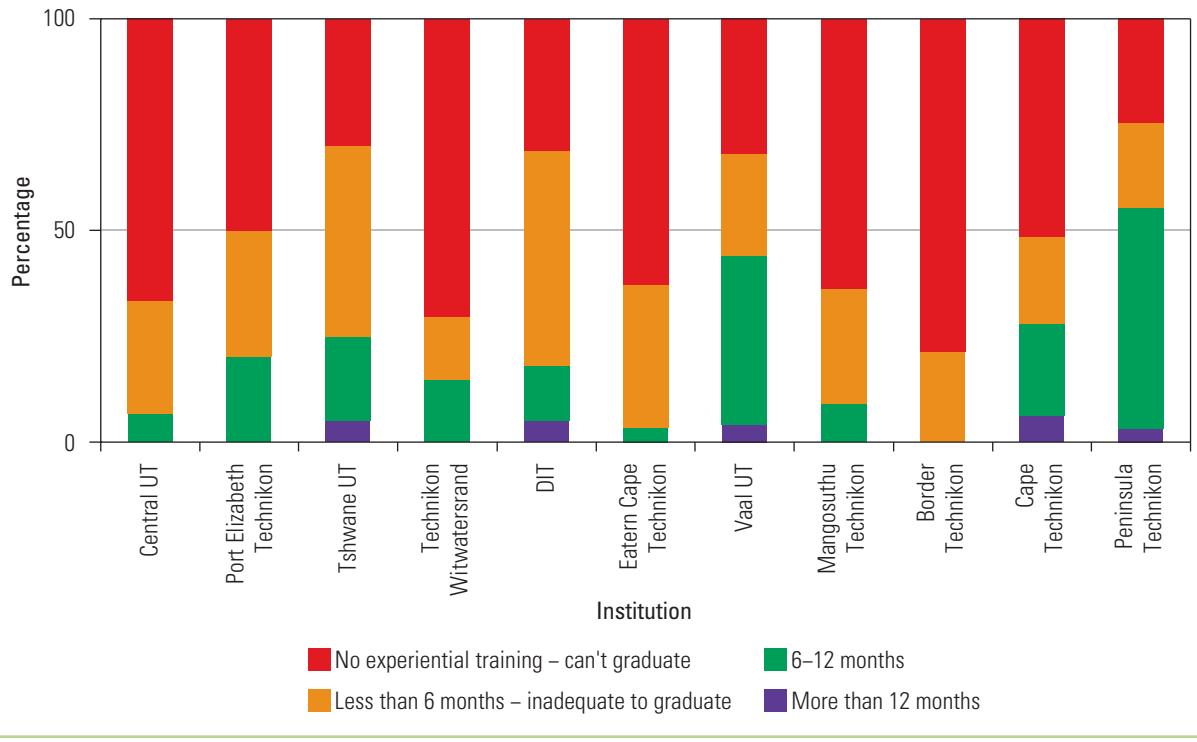
Another variable appears to be inconsistency in setting and marking exam papers. In some institutions the degree of difficulty may prejudice the students, while in others industry complains that marking is too lenient, and compromises standards.

5.9.7 Experiential training (work-integrated learning)

The national diploma qualification requires the student to spend at least twelve months in the workplace before graduating. The prescribed timing of this training is between S2 and S3.

The contracting industry appears to be happy to employ students with an S2, but consulting and the public sector prefer to employ students only after completing an S3 or even an S4. As a result, over 60% of final-year students who responded to the survey in October and November 2004 had not had experiential training and therefore could not graduate. Tom McKune of DIT confirms this problem:[10]

Figure 5.19 Final-year technikon experiential training status, November 2004



'… in the early nineties, approximately 80% of students were sponsored … and employed by their second year of study, compared with an estimated 20% at present …'

There are many reasons for this:

- **Too many?** There may be more students than industry can absorb (this will be discussed later)
- **Quality?** Industry expresses reservations about the quality of many students and hence hesitates to spend time and money on students who may not succeed
- **Far from work opportunities:** Technikons that are remote from major business centres present a challenge, as few experiential training opportunities exist in these regions, and many students do not have enough money to travel to major centres to seek work
- **Limited assistance from technikons:** Few technikons have the contacts or the capacity to assist students in finding employment opportunities, and students know so little about the industry after one or two years of study that they do not know where and how to look for these openings
- **Need experience:** Companies have increasingly resisted employing the inexperienced and call for staff to have at least five years' experience. Large numbers of students have therefore not been able to graduate (See Figure 5.19)
- **Labour Laws:** Revision of the Labour Laws over the past few years has added to the reluctance of employers to take on staff who add little value to their organisations

Conversion of the national diploma to a learnership was essential to ensure that industry is reimbursed for its training efforts, otherwise the number of technikon 'drop-outs' will continue. This constitutes a massive waste of money, effort and time for technikons, funders and students.

The challenge now is to promote this model and ensure that SETAs budget adequately for reimbursing industry for 'work-integrated learning' or experiential training, as it is more commonly referred to.

Industry complains that university graduates do not have sufficient practical knowledge. Although students are expected to have worked in industry during their holidays, it is difficult to get meaningful employment in the December holidays when the construction industry closes. Furthermore, if students do not have bursaries from companies, it is difficult to find suitable vacation employment.

It is therefore highly desirable that university students should be associated with an employer from the beginning of their studies. Not only could they be sure of gaining experience during their studies, but they would have a support system in industry, with mentors and role models, and it is hoped that they would be motivated to finish their studies in the shortest possible period.

5.9.8 The volume of work and complexity of courses

Further difficulties are highlighted in the responses from 1 500 students. Table 5.5 addresses the volume and complexity of work, which has always been a challenge in civil engineering studies.

For students from disadvantaged backgrounds where a culture of learning has not been developed through rigid homework discipline, knuckling down to volumes of tutorials and practicals is difficult. Similarly, for bright advantaged students who breezed through the schooling system by absorbing what they were taught in class, but did little homework, the volume of work is such that they need to apply themselves, but they have not developed the discipline to cope with all the work either.

Table 5.5 Reasons for not coping with studies – first- and final-year students, 2004

Reasons for not coping with studies	%
Volume of work	50
Complexity of subjects	25
Poor quality of learning material	15
Poor lecturers / lecturers too busy	13
Laziness	3
Too much partying	3
Personal problems	3
Poor accommodation	1

Those who had passed in the prescribed time gave their recipes for success as:

- Working extremely hard
- Being motivated and/or inspired by a lecturer or employer
- Using their own initiative
- Asking questions

This culture needs to be developed in all students, and is a challenge for lecturing staff, funders and parents.

Reasons for not coping were somewhat different for the older, gregarious group of professionals who responded to the personnel questionnaire. (See Table 5.6.)

Complaints about the volume of work are common to both age groups. The problem of the quality of lecturers has already been covered. This too has a direct bearing on the quality of learning material that is distributed (referred to in Table 5.5).

5.9.9 The duration of study

Many institutions in the USA and Europe offer five-year and longer civil engineering degrees. In many countries secondary education spans 13 years, and not 12 years as in South Africa. In many countries and institutions a move is afoot to extend the duration of the civil engineering degree. This is to allow more material to be added to the course, and acknowledges that a large proportion of students take an extra year to complete their studies for

Table 5.6 Reasons for not completing studies in the prescribed time – civil professionals

Reasons for not coping with studies	%
Social life/sports/taking it easy	32
Too much work to cover in period	25
Shortage of money/support	16
Battle with maths, science, English	17
Studied part time	12
Adapting after returning to studies from working environment	12
Could not get experiential training	10
Cultural adjustment	2

the above reasons. In South Africa around 30% complete their civil engineering degrees in four years.

South African industry, however, has suggested that the current duration of the qualification should remain to allow bright students to complete the course in the minimum time, but accepts that a large number will take longer. Leniency should therefore be given in terms of funding for those students who do take an extra year to complete their studies.

5.10 Recognition of prior learning

Where students find that university level maths and other theoretical subjects are more complex than they can cope with, but are borderline in terms of pass rates, recognition of prior learning (RPL) should make it possible for these students to transfer to national diploma courses without having to start again. Universities and universities of technology need to devise mechanisms for this at critical break points in the first year.

5.11 A long-term (longitudinal) study

The factors that have been outlined mean that students may be registered for many years. Technikons in particular were unhappy with simply taking the number of entrants and the number of graduates three years later as a measure of throughput, as they claimed that a large percentage of students eventually graduate.

To determine the actual throughput, it will be necessary to have access to student records for the previous five to eight years to trace individual student progress, or carry out a longitudinal study, commencing as soon as possible, over a period of five to eight years to track the progress of students through the system.

Such a study would give a much better understanding of the impact of each of the stumbling blocks.

5.12 Postgraduate studies

A large number of students register immediately for postgraduate studies.

5.12.1 University

Continuing immediately with postgraduate studies is most prevalent at university level. Industry has expressed its frustration with this phenomenon, stating that postgraduate studies are more valuable after graduates have gained some practical experience. Industry is naturally anxious to employ the increasing number of PDI graduates, and becomes frustrated when they remain in tertiary institutions for extended periods.

On the other hand, tertiary institutions are encouraged to increase the number in postgraduate studies and research, as the subsidy per student at this level is much higher. Institutions therefore encourage students to stay on, not only to gain further qualifications, but to increase departmental income.

5.12.2 Technikons

The situation at technikons is different. When job opportunities are limited, students continue with their BTech, in the hope that they will be more attractive to industry with a higher qualification.

However, industry feels that a BTech is too early at this stage and practical experience should be gained first. Several institutions have adopted the policy that at least two years' practical experience is necessary before allowing students to do a BTech, and others are considering the same requisite.

5.12.3 Articulation

A small percentage of national diploma graduates wish to continue with university studies. There are two methods for doing this:

- **BTech followed by an honours degree or Graduate Diploma in Engineering (GDE):** This allows BTech graduates to advance their studies and to continue with an MSc if they so desire. The honours degree or GDE does not allow technologists to register as a Pr Eng. They can still register only as a Pr Tech Eng.
- **National diploma followed by an undergraduate degree:** This route means that the technician will graduate as an engineer and will be able to register as a Pr Eng.

There is a great deal of concern in the industry that universities give students only one year credit for their national diploma. Technicians are well prepared to handle the engineering design subjects in the university second-year curriculum, but struggle with mathematics, statistics and other theoretical subjects.

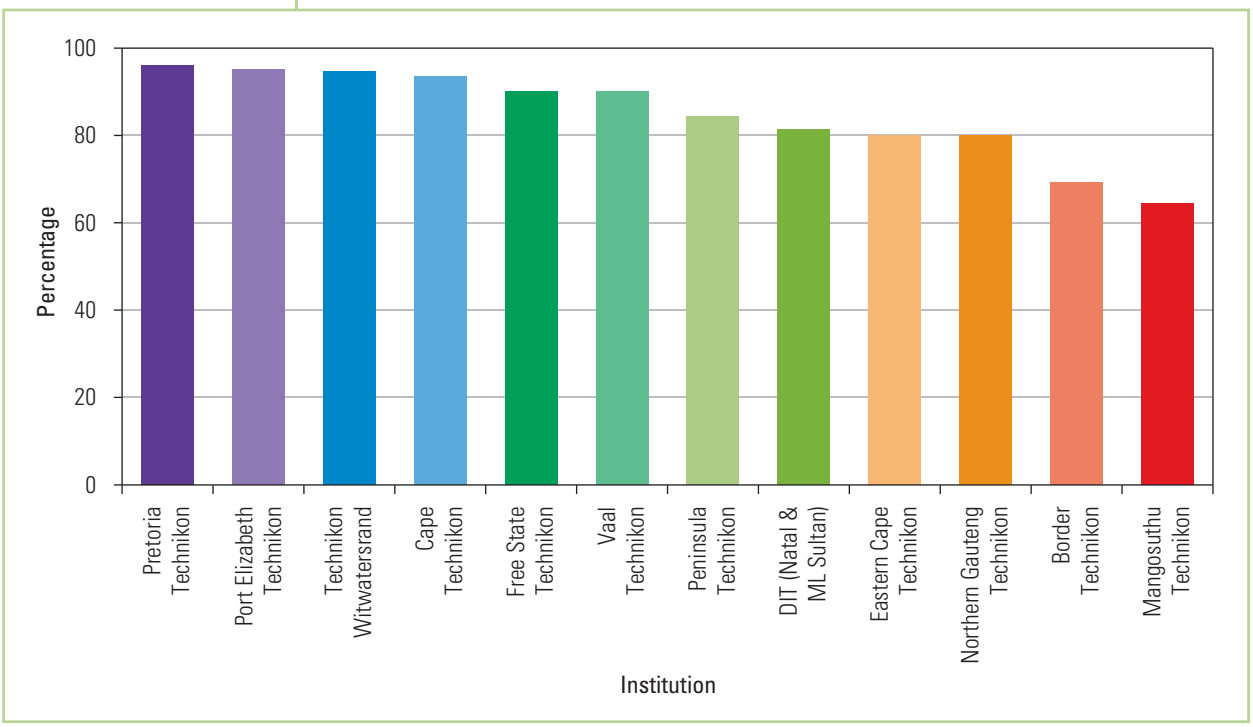
However, having passed their national diploma and being familiar with the tertiary education environment, most manage the remaining three years in the allotted time. If less than 30% of students complete their university qualifications in four years, the technician followed by the degree route does not appear to be unduly arduous. The national diploma serves as a comprehensive foundation programme for university education and generally costs the students no more than five years of tertiary education.

Graduates who had followed this route were not unhappy with the process. Some even felt that the one-year credit was more than they should have been given!

5.12.4 Engineering management

There is a perception that anyone with management training can manage an engineering project or asset. This belief has been widely applied to infrastructure management in

Figure 5.20 Percentage of employers who were satisfied with students from technikons



Historical = correct for the subject

the past decade. The resulting problems are now becoming evident in terms of failing services, inadequate resources and expenditure on operations and maintenance, etc. The problem is not restricted to South Africa, but is evident throughout the Western world.

The logistics of engineering projects or assets are complex and require an understanding of the technical aspects of the project or asset as well as the finances, staffing, scheduling and resources.

Postgraduate qualifications in engineering management should become as highly valued and recognised as an MBA in the business world to ensure that projects or assets are optimally managed and engineers are recognised as being of value to the process.

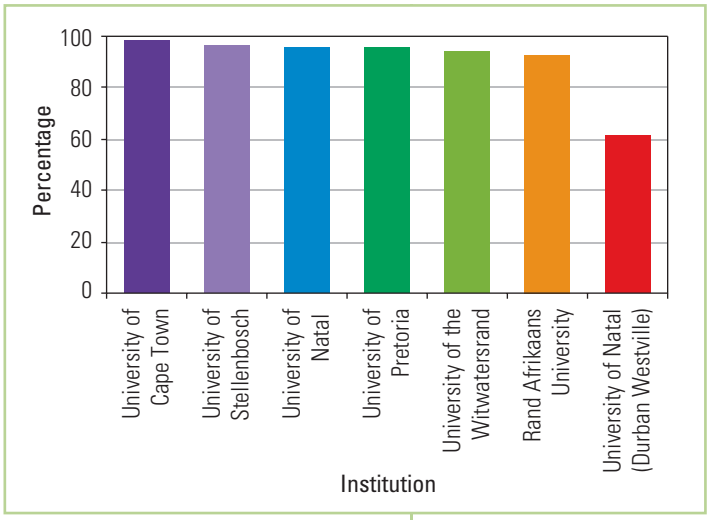


Figure 5.21 Percentage of employers who were satisfied with students from universities

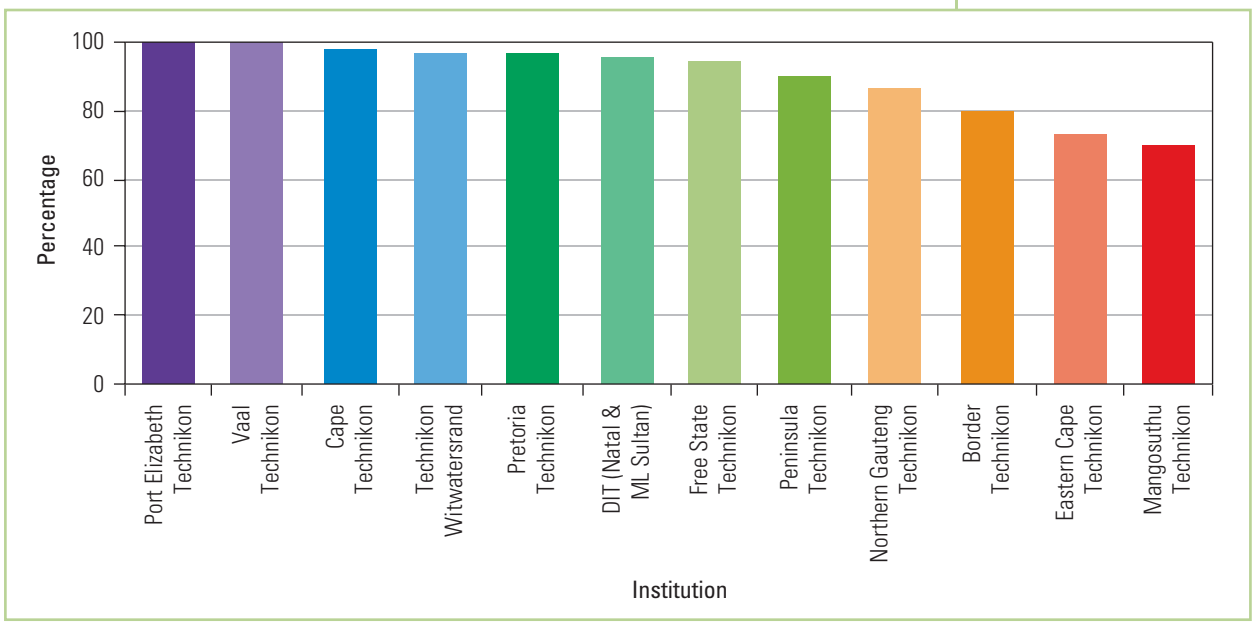
5.13 Industry assessment of tertiary institutions

Industry's views on which institutions produced satisfactory students (Figures 5.20 and 5.21) matched the successes of institutions in terms of throughputs (Figures 5.16 and 5.17). Generally respondents were unhappy with students from institutions with low throughput. However, in many questionnaires respondents stated that they had employed talented individuals from all institutions.

While industry was not happy with the quality of education from several institutions, the orders of preference for employing graduates differed, reflecting more on the calibre of students from each of the institutions than the quality of tuition. (See Figures 5.22 and 5.23.)

Research at the University of Natal in the sixties indicated that regardless of teaching quality or examination methods, the brightest students would always do well, and the

Figure 5.22 Percentage of employers who will employ from technikons again



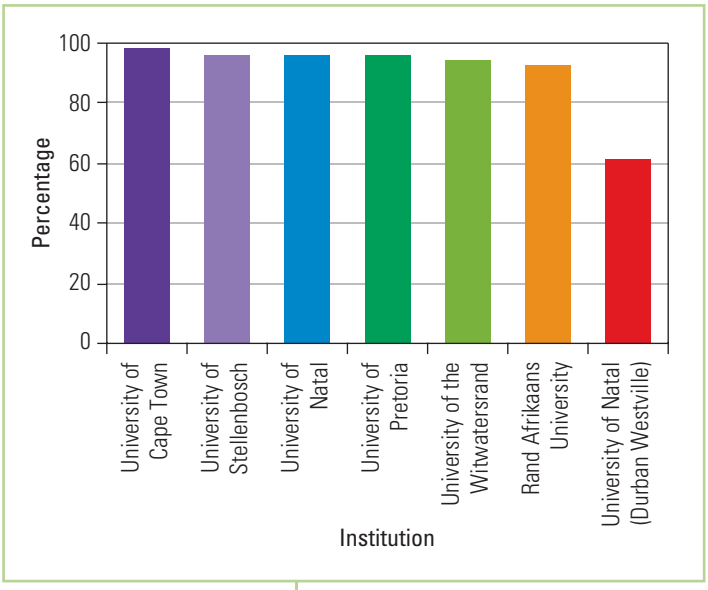


Figure 5.23 Percentage of employers who will employ from universities again

weakest students would always fail. It was those in the middle group who would move up or down, depending on the environment.

Given the numbers that are attending tertiary institutions, it is essential that the whole approach to selection, teaching and nurturing should be reviewed to ensure that a larger number of the students in the middle group achieve a sufficiently high standard to be of value to industry.

5.14 Industry review of curricula

Suggestions about subjects that should be added to or improved are listed in Table 5.7.

The comments from the public sector and the private sector show similarities. However, the public sector calls for more emphasis on communication and technical knowledge, whereas the private sector requires more business and project management skills.

Many suggested that the level of maths taught at university and the depth of chemistry were excessive. Because of the problems in second-year maths and statistics in particular, it is possibly time to review the appropriateness of the content of these courses for civil engineering. More advanced maths could possibly be introduced into MSc studies where required.

5.15 The numbers required

Four times more students are enrolling in civil engineering at technikons than at universities. If efforts are made to improve throughput, exactly how many technicians and technologists does the civil engineering industry require?

Industry is inundated and exasperated with letters and calls begging for jobs – the callers are usually technikon graduates. While the current ratio of university to technikon students enrolled in civil engineering is 1:4, consulting firms employ in the ratio of 1:1, and in the industry as a whole the ratio is about 1:1,32 (see Figure 5.24).

At the time of writing, local government as a whole employs 1:3, but complains that diplomates are not sufficiently trained in urban and rural engineering to be useful to them. In contracting, the ratio is 1:2,1, and contractors voice similar frustrations.

The consulting industry on the whole utilises technicians as 'excellent draughtsmen', and technologists for design in specific fields.

Local government utilises technicians at all levels in small authorities, and for operations, site work and maintenance in large authorities. They complain that the technician's theoretical knowledge is inadequate for design work.

Contractors utilise technicians extensively as foremen, supervisors and site agents and require them to have a better understanding of contracts, etc. However, they are prepared to offer experiential training after first year, and use students as foremen during the experiential year.

It is possibly time to consider job specifications and train technicians for specific tasks, ensuring that the courses are structured so that students can study further in other fields.

As a result of the dramatic drop in the number of artisans (described in Chapter 2),

Table 5.7 Industry input on additions and improvements required in tertiary curricula

Industry input – tertiary wish list – December 2004		University Improve	University Add	Technikon Improve	Technikon Add
Life skills	Literacy (good English)	1%	10%	10%	18%
	Numeracy	6%	1%	31%	6%
	Report writing	11%	17%	23%	33%
	Communication skills/negotiating	15%	14%	33%	30%
	Public speaking		1%		3%
	Computer literacy	8%	2%	18%	3%
	Time management	3%		3%	
	Thinking and problem solving skills	5%	2%	8%	3%
	Conducting meetings				3%
	Philosophy				3%
	General		6%	5%	6%
Business management skills and marketing	Economics, financial management, accounting and budgeting	27%	45%	21%	48%
	HR	4%		3%	27%
	General business	18%	9%	18%	21%
	Quality management	3%	2%		
	Marketing	1%	7%	3%	6%
	Strategic thinking and planning	1%			
	Industrial psychology		1%		12%
	Change management	1%			
	Management skills		8%		15%
	Value engineering		1%		
Construction/ contractual/legal and legislation	Project management	27%	6%	31%	39%
	Construction and contract management	6%	2%	18%	3%
	Contract law	18%	2%		9%
	OHSA	1%	3%	5%	12%
	Municipal Finance Act, etc	1%			
	Legislation	1%	7%		6%
Technical know-how	Structures	6%	6%	18%	3%
	Urban		1%		
	Water and sanitation	9%		10%	
	Roads, earthworks and stormwater			8%	
	Transport and traffic	10%	1%	10%	9%
	Geotechnical	5%		18%	
	Materials	8%			
	General improvement required	14%	1%	21%	3%
	Planning		2%		6%
	Maintenance		3%		
IT	CAD	3%	3%	13%	12%
Environmental		14%	7%	3%	12%
Communities / social and labour-based issues	Social and community engineering	3%	23%	5%	9%
	Labour intensive courses	3%	1%		6%
Improved content and standards		4%	5%	10%	9%
Insufficient theory			2%	21%	
More practical experience		11%	13%	5%	6%
Other	Survey		2%		3%
	Other (including ethics, history of engineering, HIV, lecturers from the industry		5%		6%

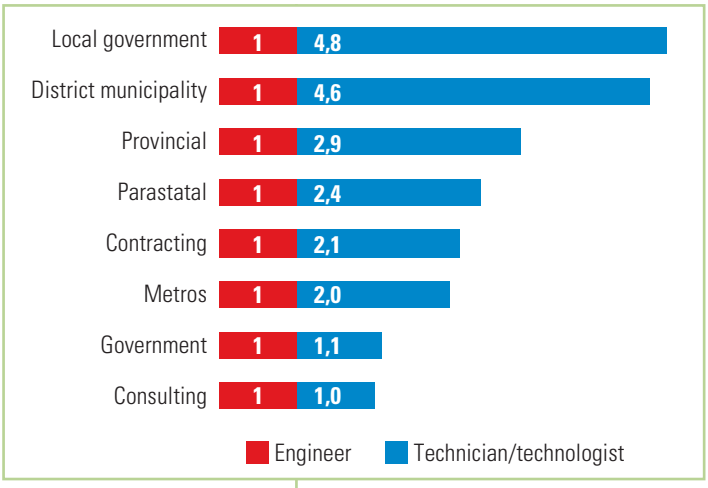


Figure 5.24 The ratio of technikon-trained to university-trained professionals in various sectors

technicians are seen as a fast-track route to providing the junior management level that artisans held in the past.

The following additional opportunities are now available to technicians:

- Contracting – site foreman, supervisor
- Local government – site foreman, supervisor, operations and maintenance
- Consulting – CAD draughting
- Consulting – those with potential can continue with a BTech and rise in the ranks as a specialist

5.16 Employment opportunities

Understanding the composition of the professional team in industry gives some insight into the next vexing problem, of many graduates being unable to find employment.

Generally civil engineering students from universities have no difficulty in finding employment, regardless of gender or race. Figure 5.25 captures the status of the 2004 final-year students in October 2004. The 35 or so university students who did not have work at the time declined assistance as they were going to 'chill' over Christmas and start considering their future in the new year.

The situation was significantly different at the technikons, where over 70% were unable to secure any form of employment. About 20 were employed on the EPWP programme as a result of the problem being highlighted through this project, but many continue to struggle to find employment opportunities.

This seems to indicate a mismatch between the numbers of technikon and university graduates and the requirements of industry. The quality problem also means that industry resists employing young diplomates. The ILO reports that youth unemployment is twice as high as the total rate. Their success depends on their *employability* and the *availability* of appropriate and productive employment opportunities.[11]

Given that industry complains of not being able to find suitable staff, these issues could be addressed as follows:

- **Quality – employability**: Entrance criteria, and issues of orientation, curriculum and teaching methods must be addressed to improve quality and make graduates more attractive to industry
- **Compulsory appointment – availability**: Since site training is a key component, when inviting tenders state departments could make the training of one or two technicians a condition of the tender, provided that additional funding and coaches are made available.
- **Learnerships – availability**: By developing learnerships for the training phase, industry would be compensated for experiential and workplace training and would be more willing to take students and graduates

Implementation of all the suggestions in this chapter will make little difference unless students are assisted in finding work opportunities. Few tertiary institutions have dedicated units that place students. Since students have been cloistered in academia and have had little or no exposure to industry at this stage, they do not know where or how to find opportunities. They only know of the large companies that are visible through their advertising; hence these companies are bombarded with employment requests. The thousands of other potential employers are not targeted.

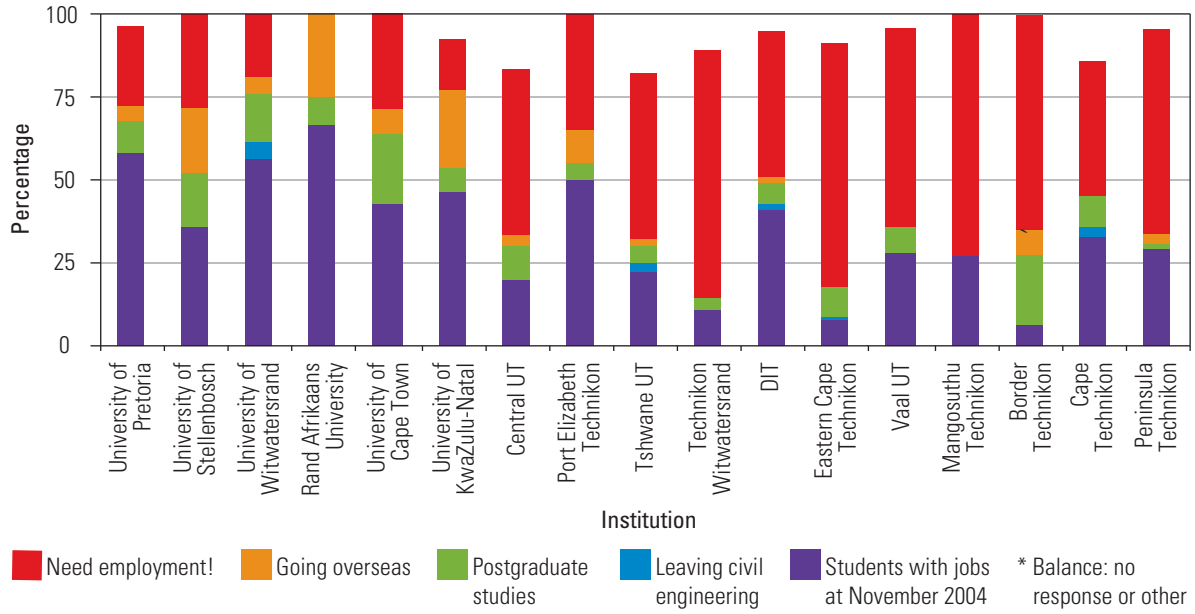


Figure 5.25 Success in finding employment for 2005 – final-year civil engineering students, October 2004

In an assessment of technical college training,[12] respondents listed the same frustrations over their inability to find employment. They were also left to their own devices to solve the problem. (See Table 5.8.)

Table 5.8 shows that almost 50% of students rely on personal contacts and relatives to help them find employment, rather than on more formal means.

If the country is going to spend vast sums on developing skills, then funds must be allocated to setting up more comprehensive systems for placing students and graduates with employers.

5.17 Going overseas

A significant percentage of university graduates go overseas. Unlike the emigration of senior staff, this is not cause for concern, but constitutes a pattern that has been in place for many decades, particularly among white graduates. Generally these graduates return after three or four years and are snapped up by industry.

5.18 Accreditation

The needs of industry cannot be the sole consideration when structuring new or modified curricula. Engineering courses at universities and technikons are accredited by the Engineering Council of South Africa (ECSA) as required under Engineering Professional Act (Act 46 of 2000). They are obliged to consider industry needs, and align their qualifications with international qualifications.

South Africa is a signatory to the 'Washington Accord', which was originally signed by the USA, Britain, Canada, Australia, New Zealand and Ireland. Countries agree to mutual accreditation of one another's degrees based on accreditation decisions of each organisation. This agreement requires all countries to cooperate on the development and modification of engineering curricula to address the needs of the time collectively. Certain minimum content is required in each qualification for accreditation.

Table 5.8 Methods used by technical college graduate to find employment

Means of finding employment	%
Through personal contacts	29,5%
Through relatives	18,5%
Through a newspaper advertisement	17,4%
Through my employer coming to the college to find employees, talk about jobs in that company	7,8%
Through an employment agency	6,7%
I am working for the same employer for whom I worked before my studies	4,6%
I joined the family business	4,1%
Through college teaching staff	2,8%
Through holiday jobs during my period of study	2,4%
With the help of the college	2,4%
I am self-employed	1,4%
The college gave me a reference	1,1%
Through paying back a loan I received from an employer to study	0,8%
Through placing my own advertisement in a newspaper	0,2%
Total	**100,0%**

HSRC / Jet Education Services

The ECSA accreditation process looks at all aspects of each institution, including curricula, lecturer qualifications and registration, facilities, selection, throughput and industry needs. It seems that industry and ECSA are currently 'out of sync'. To determine the needs and address the many problems outlined in this chapter, a major think-tank needs to be convened with the institutions, ECSA, CHE, DOE, SETAs and industry. In the sixties and seventies annual conferences of this nature on engineering education and training were held. After the initial think-tank, similar annual events should be convened.

At the technikon heads of department meeting in Bloemfontein in December 2004 it was agreed that a re-curriculation workshop was needed for all technikons to realign and update their curricula. A great deal of work is urgently required, but this event is not taking place owing to lack of funding.

5.19 Funding

This chapter would not be complete without a reference to funding. Blanket approaches to policy development do not address the many problems. More funding is clearly needed in terms of identifying, selecting and educating civil professionals at South Africa's tertiary institutions. At the beginning of the chapter the Minister was quoted as saying:

'… we need to focus on those skills that we need most …'

Since civil engineering capacity is the key to developing and sustaining infrastructure it would be appropriate to use civil engineering as a pilot for adopting a new approach to funding, staff appointment, training and retention of staff, curricula development, use of technology, and student selection and support. Without a radical change in approach and

commensurate funding to develop these most-needed skills, non-delivery will continue, or foreign skills will take over existing job opportunities.

CONCLUSIONS

South Africa requires a substantial number of high-calibre graduates. Disparate efforts are clearly not producing the results. Government, industry and academia need to review all the bottlenecks and successes and develop a strategy to maximise the output in civil engineering from tertiary institutions. A Marshall plan must be developed and implemented based on the key factors that must be in place and the recommendations outlined below.

Building blocks

For tertiary studies to adequately feed industry the following must be in place:

- High-calibre entrants
- Appropriate curricula
- Improved number and quality of lecturing staff with commensurate remuneration
- Experiential training opportunities
- Employment opportunities

RECOMMENDATIONS

Reconstruction required

Interventions to ensure that the building blocks are in place are numerous. These include:

- **Appropriate numbers:** The numbers being trained do not match industry's needs. A final model of graduate qualifications and the numbers required must be developed
- **Entrance criteria – to address the high attrition rate:** Technikons must raise their entrance criteria. The number entering is four times the number graduating
- **Introduce entrance testing and counselling:** The best entrance tests ought to be combined and adopted nationwide
- **Increase subsidy:** Negotiate with the Department of Education to increase the subsidy for civil engineering students. If numbers are reduced, this will mean reduced income, which will be resisted by tertiary institutions and could further decrease resources
- **Foundation programmes:** Foundation programmes appear to assist those from disadvantaged backgrounds in particular. The Department of Education has provided funding for foundation programmes, but not all departments were fortunate enough to benefit from these funds. To obtain the best results from foundation programmes the following are required:
  - Research all programmes and results to determine the best
  - Ensure all foundation programmes have appropriate staff and sufficient funding
- **Monitoring and dedicated support:** At institutions where CETA and other organisations are funding large numbers of students, criteria should be set regarding:
  - Dedicated residences or areas in residence where PDI students can be nurtured and managed
  - Availability of staff to assist with extra lessons

  and a project manager should be appointed to:
  - Continuously monitor results
  - Meet regularly with students to identify problems

- Meet with students who are struggling to ensure that appropriate action is taken
- Organise assistance from lecturing staff, or arrange for extra lessons from tutors

- **Link with role models and companies:** Students should be linked with young graduates who would act as role models and possibly increase motivation by taking students to the workplace and sites from time to time
- **Curricula reform:** Industry was very critical of the scope and quality of many courses and in terms of technikons, curricula were not always conducive to finding employment. It is time to:
  - Organise re-curriculation conferences with heads of all subjects, heads of departments, industry, ECSA, the Council on Higher Education (CHE) and DOE to align what is offered with what is required.
  - Debate the merits of experiential training and develop a solution to the current problem.
  - Develop articulation guidelines.
  - Debate the required level of complexity of maths education at undergraduate level.
- **Improve the number and quality of lecturers:** The staff to student ratio is unacceptable and quality is a problem at times. To address these issues:
  - Reduce the number of students
  - Increase the number of well-qualified staff
  - Improve salaries
  - Develop lecturer training programmes
  - Invite and fund the ExCEEd[13] (Excellence in Civil Engineering Education) team to carry out lecturer training in South Africa and transfer the programme expertise to South African trainers
  - Develop a national code of ethics
  - Make more use of technology
  - If departments cannot be fully resourced, set up centres of excellence to ensure those wishing to specialise have access to experts in the field
- **Experiential training, learnerships and placement:** Few tertiary institutions have placement units, and even in those that do, effort is directed at placing students in the well-known larger organisations. It will be necessary to:
  - Set up a student placement service
  - Appoint dynamic young HR personnel to talk to all final-year students each year about their future, the need to follow the ECSA training guidelines and to create awareness of a national placement service
  - Develop a database of all companies that can offer experiential training and employment for young graduates
  - Develop an ongoing marketing strategy to ensure that all graduates are employed
  - Communicate the national diploma learnership and the associated financial benefits for the employer to the industry as a whole
- **Drivers' licences:** The lack of drivers' licences precludes many students from experiential training opportunities. SETAs should consider setting up a programme to assist with teaching students to drive and become licensed.

Suggested Construction Charter activities

- **Role models and support for students:** Students should be linked with young role models in the industry for mentorship, coaching and support. Companies could be called upon to donate time to perform this function.

- **Salary subvention and sponsorship:** To attract and retain high-calibre staff, industry could sponsor posts or contribute towards merit or bonus schemes for lecturers.

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CHAPTER 6

Graduates

INTRODUCTION

Having progressed through tertiary education does not mean that the next step is easy for young graduates.

The Skills Development Act (Act No. 97 of 1998) aims to develop and improve the skills base of the South African workforce. Two objectives of the Act as stated in Section 21C are to encourage employers to:

- Use the workplace as an active learning environment
- Provide employees with the opportunities to acquire new skills

However, in the civil engineering workplace this is not happening.

It's simple,
No skills – no work, no work – no skills.

Many graduates do not succeed in getting work because they have no experience! The government has created systems to promote training at all levels, yet millions of rand from the skills levies are accumulating in SETA (Sectoral Education Training Authority) coffers.

These funds should be used to train qualified, but inexperienced engineers, technologists and technicians. This chapter will explore how training should be carried out.

THE STATUS QUO

As indicated in Figure 6.1, 60% to 70% of the 2004 final-year university students had already found employment in the South African civil engineering industry prior to graduating, but only 20% to 30% of technikon graduates had found work at that stage. From industry employment figures it is evident that at least 30% are unlikely to ever find employment. This under-utilisation of human capital must urgently be addressed, particularly given the anticipated increase in activity in the civil engineering industry.

The drop-out rate within the initial few years after graduation is also alarming. Interviewees cited lack of training and career prospects as their main frustrations.

THE CHALLENGES

A great deal of effort is required to develop sound training regimes which will stimulate young graduates and grow the capacity required. Few companies carry out structured workplace training any longer (see Chapters 2 and 3). Owing to pressure on profit margins, and little capacity or time to train young staff, all wish for instantly trained or fast-tracked staff, that is, they want the product but are not prepared to take responsibility for the process. As a result job hopping and poaching of comprehensively trained staff are rife, especially among previously disadvantaged individuals (PDIs).

6.1 The myth of fast tracking

Many theories have been expounded and many books written on fast tracking skills

'… All genuine knowledge originates in direct experience …'

– Chairman Mao

Mao Tse-Tung

Table 6.1 Proposed unit standards for Stage II learnerships

Stage II Engineer	Stage II Engineering technologist	Stage II Engineering technician
Management	Management and two of:	Management
Design and planning	Design and planning Investigation and reporting Operations management	Design and planning or Investigation and reporting
Investigation an reporting		Construction management or Operations management
Plus one elective	Plus one elective	Plus one elective

ECSA

development. US mentoring programmes are designed to do just that. Based on the premise that traditional senior managers and leaders had the same experiences many times over, the process seeks to expose protégés to each necessary experience only once, and then ensure that they move on. Furthermore, some of the steps are explained rather than experienced.

6.1.1 A process

Education and training in civil engineering is a two-stage process. Initial education takes place at university or technikon. Thereafter, industry is expected to offer the graduate workplace training. Having developed sufficient competence to be able to handle projects on his or her own, the graduate may then register with the Engineering Council of South Africa (ECSA) as a professional engineer, technologist or technician (Pr Eng, Pr Tech Eng or Pr Techni).

The workplace training phase lends itself to formalisation as a learnership. The development of the so called Stage II, candidate qualifications for registration with the South African Qualifications Authority (SAQA) are under way, and will replace ECSA's voluntary 'Commitment and Undertaking' system.[1]

Unit standards have been suggested as per Table 6.1.

At the time of graduation, the candidate civil engineering professional has had little or no experience and needs to experience as much of the project cycle as possible, in order to become proficient.

In terms of sustainable development, the graduate must not only develop technical skills as described in Figure 6.2, but must also understand many more facets in the project cycle. These include political, socio-economic, institutional, environmental, health, legal, financial and management issues.

It is rarely possible for graduates to develop this range of skills in more than two fields of civil engineering. Furthermore, graduates seldom repeat experiences in terms of planning, design, or site work, as the training phase is relatively short. As a result there is little scope for fast tracking the practical experience phase. On the contrary, it needs to be as intense and as comprehensive as possible, and in complex processes it is dangerous to generalise the process from a single experience.

In addition, skills in communications, negotiations, leadership, and handling inter-personal relationships must be honed during this phase.

6.1.2 The ten-year rule

One thing that all experts have done is to practice. In the book *Deep smarts*[2] Professors Dorothy Leonard (Harvard Business School) and Walter Swap (Tuft University) posit that the amount of practice is not a predicator of expertise, but that extended periods of concerted effort with self-reflection build expertise. Having studied many companies in the USA the writers conclude:

> *'… most evidence suggests that it takes at least ten years of concentrated study and practice to become an expert. The ten-year rule places some inescapable limitations on the development of expertise in management or any other knowledge-based, complex domain, limitations that are frequently ignored or minimized by those trying to accelerate the process …'*

They conclude that the failure of the dotcom companies was caused by the inexperience of the young technology whiz kids who headed up the numerous hatchling companies at the dawn of Internet trading. They have traced many other failures and catastrophes to youthful management and inexperienced technical personnel.

They do concede that developing competence in complex processes – as opposed to expertise – takes a little less time, about five to seven years. Many of the targets set in the Construction Charter concern positions of management and ownership that require expertise and not merely competence. One can only hope that South Africa will not experience a similar bubble as a result of inexperienced staff being fast tracked to managerial and ownership levels before they have developed the necessary expertise.

6.2 Graduate training in the past

Before the introduction of information technology, the design office production team included tracers, draughting staff and detailers. They produced working drawings for every project. The engineer explained his or her requirements to these members of the team, who would produce the final drawings. In this way the production team became a knowledge centre for the organisation and could support the training of young graduates.

Table 6.2 Excerpts from the Anglo American civil engineering training scheme of the eighties

Design office
The period to be spent here will normally be 12 months … this period will be split as follows:
■ Approximately one month will be spent on the drawing board preparing concrete layout drawings and steel reinforcement details and schedules … the graduate will be guided by experienced draughtsman and detailers … this period enables the graduate to learn the standard methods of detailing, departmental procedures, codes and specifications, and to gain an appreciation of the close liaison necessary between the designer and detailer
■ Approximately three months will be spent on detailed design … Supervised by a qualified engineer …
■ Approximately three months will be spent on the detailed design of a series of different structures, supervising detailer and draughtsman. The graduate will be guided by a chief designer and supervised, but to a lesser extent by a qualified civil engineer, deputising for him or her when necessary
■ Approximately five months to be spent in charge of a design project … all under the supervision of the divisional civil engineer … etc

Anglo American

SACPE (the South African Council for Professional Engineers), which was a forerunner of ECSA, called upon companies to define and register their training procedures for assisting young graduates to attain registration. Each company submitted detailed programmes outlining the disciplines to be mastered, the activities to be carried out and the staff at various levels who would contribute to the training of the young graduate.

For example, the Anglo American 'Formal training programme' covered activities, durations and responsibilities (outlined in Table 6.2). This was typical of the training process at the time. Many successful black civil engineering company owners today owe their success, at least in part, to the solid grounding given them by Anglo American.

6.3 The demise of training programmes

In the past 15 to 20 years the effort put into formal training has been greatly reduced, and in many instances has completely disappeared as a result of a number of factors including:

6.3.1 Withdrawal of tax benefit for training

In the seventies and early eighties employers could claim tax relief for staff training. Once this was withdrawn, it was perceived that there was no economic benefit in training, so many companies reduced their training schemes or closed them altogether.

6.3.2 Information technology

Productivity gains from the introduction of IT have meant that the size of the technical team has been reduced. Draughting staff, whose responsibility was to produce working drawings and who had an invaluable wealth of practical knowledge, were the first casualties. CAD systems and design programs that automatically generate working drawings meant that engineers and technologists could produce drawings as a by-product of their design work.

The size of companies, however, has not reduced substantially as a result, because the number employed in the IT section has replaced the lower levels of technical staff. Unfortunately the IT section is process oriented rather than output oriented, and technical staff capable of training juniors have been replaced by process staff.

6.3.3 Time and capacity

The development of information, communication and technology (ICT) has resulted in the 'instant' world. The World Wide Web (www) means that information is always available. E-mail and fax communication allow information to travel around the world in a matter of seconds. As a result, the business environment expects instant answers. There is little time to reflect or spend quality time on training or matters of detail. Senior staff are expected to work at an exceptionally high pace and simply have no time to train their young graduates. In addition, there is a shortage of experienced staff, placing even greater pressure on their time.

6.3.4 Declining industry and margins

The twenty-year decline in the industry has been outlined. Little effort was put into long-term planning or training. Margins were squeezed as companies competed for work to survive, leaving little on the table for training.

6.3.5 Non-technical senior staff

In many quarters senior technical staff have been replaced by staff trained in other fields, such as marketing, management, law, finance, town planning, teaching and in some instances

individuals with no qualifications. As a result there are fewer or sometimes no senior staff with engineering knowledge capable of training young graduates. This is particularly prevalent in government departments, provinces and municipalities.

6.3.6 Equity targets

Insufficient black graduates are entering the engineering profession to meet the ambitious equity targets. The industry requires all age groups and levels of experience and the strict enforcement of affirmative appointments in engineering posts has meant that young black graduates are placed in very senior posts, for which they are not yet equipped. They battle to cope and often leave the profession. This is not fair on them.

The older professionals who have lost their posts or have been bypassed as a result of affirmative action are often not prepared to train their successors. This means that organisations lose not only the experience, but also the chance to develop their young employees into competent professionals for the future. Chairman Mao spoke wise words in 1937 when he said:

'… All genuine knowledge originates in direct experience …'

Young black graduates must be given the opportunity to gain experience in a controlled environment. The barriers that have been created and the lack of cooperation that results at times from equity policies are reducing capacity, rather than building it.

South Africa needs all civil professionals currently in the industry. Job security should not be cause for concern.

All capacity should be used, and all should feel that they are adding value to the national agenda. The seniors should be retained with a specific brief to train, grow capacity and help the country develop. If they experience increased stature from being identified as an expert or a coach they may be more receptive to such requests.

Juniors should be motivated by the awareness that dedicated efforts are being invested in their development. They need to understand the process and the long-term benefits of thorough training so that they can confidently take up their positions as competent civil engineering professionals.

Competence takes time to develop and the ten-year rule applies to expertise. Even Bobby Fischer, the acknowledged chess prodigy, needed nine years of intensive study and competition to become an international grandmaster.

To ensure that knowledge transfer takes place, longer-term transformation targets should be set. Tertiary statistics are available to predict the number of black and female civil professionals that will be available per age group. These statistics should be used to set realistic targets. This will ensure that the senior group do not hold back the development of the junior group, and the juniors are given time to go through the entire skills transfer process and not be catapulted into positions that they are not prepared for.

The Employment Equity Act states in clause 15(2) that measures include 'numerical goals' but exclude quotas. Realistic goals must be set and systematic training must take place.

6.3.7 The public sector no longer trains

In the past the public sector was a major training ground for civil professionals. The former South African Railways and Harbours, Department of Transport, Department of Water Affairs and Department of Public Works, the provinces and local authorities provided huge numbers of bursaries in the sixties and seventies, canvassed widely for appropriate learners, and

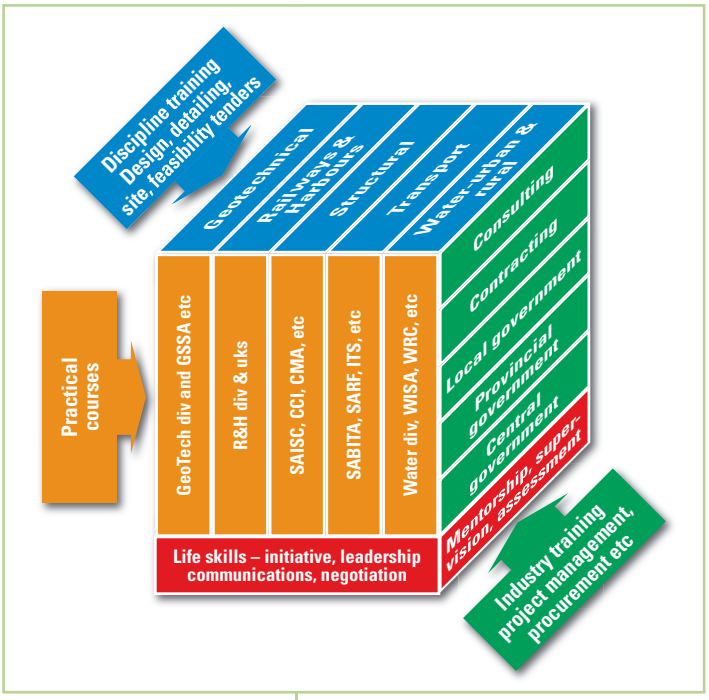


Figure 6.1 The multi-faceted training cube

offered training. Many of the leaders in the industry today owe their position to the sound training they received on 'The Railways' and in government.

Today these organisations spend little on bursaries, and do not have the capacity to train the large numbers that they did in the past. This responsibility has been transferred to the private sector, but funding for the purpose does not come from the state, but from the private sector in the form of skills levies.

At a time that companies are being squeezed and margins are significantly lower than in the past, something must suffer. Regrettably it is the education and training of civil professionals.

The same trend has developed in much of the Western World. In the USA alarm bells are ringing and states are reviewing the folly of the many structural and funding changes of the past 20 years. The Washington-based Transportation Research Board[3] recommended in its Special Report 275 on the workforce challenge that:

> *'… more federal surface transportation program funds should be eligible for use by state and local transportation agencies for education and training activities …'*

If South Africa is to address its development needs, a return to public sector investment and involvement in training is essential to supplement the efforts of the private sector.

6.4 Actions required

All organisations must provide intensive graduate training to re-establish skills development at the required level.

6.4.1 Develop learnerships

Converting workplace training into learnerships will offer companies incentives to train, as they will receive funding from their respective SETAs as the graduate achieves certain milestones or credits.

Typically candidate learnerships will consist of five components:

- Technical experience in the workplace
- Specialist short courses
- Industry-specific training
- Development of business and life skills
- Mentorship and coaching

Learnerships will be adaptations and formalisations of the training programmes of the past. Qualifications are being developed to cover the graduate-in-training, known today as the candidate phase for technicians, technologists and engineers.

Having been registered with SAQA, it would then be the employers' responsibility to define the curriculum and develop training material. This would mean that each company

would need to expend considerable effort developing curricula. A more practical approach would be for SAICE to cooordinate the development of generic curricula per field for the industry as a whole and identify appropriate courses for candidates to attend to supplement their workplace training. Figure 6.1 gives an indication of the scope of such an exercise.

In terms of workplace training, it would seem that training material would generally not be needed. However, as a result of the huge loss of experienced senior staff, it is time that a team of 'wise fathers' develop the 'Practical encyclopedia of civil engineering' covering all the practical advice that was previously passed on from senior to junior – such as manholes must be big enough for a man (or woman) to enter!

It will be necessary to resurrect the standards of the past that are now forgotten because of IT. The practical tips are missing, engineering judgment is not being developed, and an understanding of the whole project process needs to be reinculcated.

Development work in all fields of civil engineering would be required. A starting list of fields has been generated, but this will grow as industry becomes more involved.

- **Structural**
  - Steel
  - Concrete – reinforced and pre-stressed
  - Timber
  - Masonry
  - Coastal/water retaining
  - Bridges
- **Local government**
  - Water resources
  - Water supply
  - Sanitation
  - Solid waste
  - Roads
- **Geotechnical**
- **Environmental**
- **Materials**
- **Transport**
  - Road
  - Rail
  - Harbours
  - Airports
  - Traffic management
  - Planning
- **Management**
  - Construction
  - Consulting
  - Local government
  - Etc

This material would be an invaluable investment for the future wellbeing of development in South Africa.

For formal courses, training material would typically include slide presentations and course material that delegates keep.

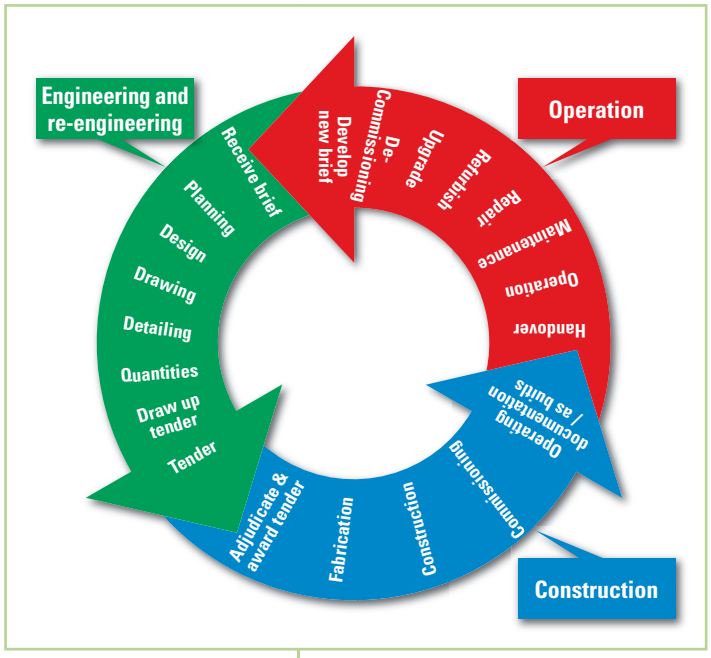


Figure 6.2 Technical activities in the project cycle

6.4.2 Implement detailed training programmes

The Stage II qualification should cover technical skills such as planning, design, draughting, detailing, investigation, troubleshooting, reporting, the procurement phase, time on site and exposure to aspects of operations and maintenance, plus many softer skills. Young graduates are not being given adequate training and support to be able to register with ECSA. They must again be transferred from department to department, or from function to function, and be given sufficient support to learn.

Figure 6.2 covers the project lifecycle. If necessary, secondment must be reintroduced to ensure that all graduates gain experience on site as well as in the design office.

In addition, if they are found to be weak in an area, supplementary coaching or courses must be considered. For instance, written language is a problem area for PDIs and computer/TV generation graduates. There are excellent web-based literacy courses, spanning two to four months, that require daily exercises and submissions, ensuring ongoing improvement in literacy.

6.4.3 Implement mentorship and coaching programmes

A great deal is currently being written about mentorship and mentorship programmes have been called for in the Construction Charter. The term 'mentor' implies personal counselling and career path development, whereas the term 'coach' implies knowledge transfer and skills training.

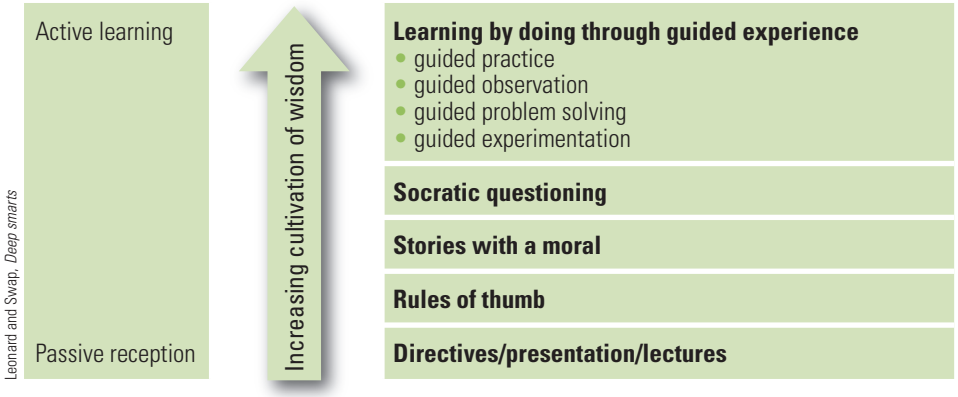
The ECSA policy statement on 'Acceptable Engineering Work for Registration' draws the distinction between mentors and supervisors. Mentors 'give guidance to trainees regarding their career path planning' whereas supervisors undertake 'direct supervision of daily tasks'. The graduate will not progress unless his or her work is continuously evaluated; hence the supervisor becomes the coach and plays a very important role in developing the young protégé.

(a) Coaching

Professor Dorothy Leonard[4] of Harvard Business School and Walter Swap of Tuft University coined the phrase 'deep smarts', meaning the ability to make smart decisions about complex situations, a characteristic all wish to see in their staff. This cannot be learned from PowerPoint or best practice websites, but from 'knowledge coaches' – experts who are motivated to share their knowledge or 'deep smarts' with their protégés. The coach or supervisor acts as a teacher who transmits experience-based expertise.

Their view is that while all methods of learning shown in Table 6.3 are useful, the less interactive modes transfer much less real knowledge than those involving interaction and guided experience. Since the human brain remembers something longer if it struggles with the topic before finding the solution, experiential training under the guidance of an expert or knowledge coach is far more beneficial than attending course after course.

Table 6.3 Modes of knowledge transfer



Leonard and Swap, *Deep smarts*

With the introduction of SETAs, many organisations complain that their staff are always on training, but have not developed the necessary competence. Table 6.3 explains why this has happened. The development of deep smarts requires a mix of the above activities and experts to manage the guided experience process.

Because the age distribution in the construction industry is skewed, few experts in the industry are available or have time to train young protégés; hence many students or graduates cannot find employment. (See Figures 7.43 to 7.45.) Where young people are employed, they rarely have the luxury of a coach and either do not learn at all, or learn on prototypes, sometimes making very expensive mistakes. The young people who have been employed in local authorities in particular complain of no training or opportunity to grow. They refer of course to lack of coaching and guidance in their projects.

From the research it appears that coaching and knowledge transfer are inadequate. Even with the best career development plans in place, competence only comes with technical experience and input. Retired personnel should be redeployed to carry out the role of supervisor/coach when production staff are too busy to develop young people. SETAs should set funding aside for this type of skills development.

(b) Mentorship

Mentors are generally responsible for the career path development of their mentees. A mentor may be a senior person in a company, an HR team member or even an external person to whom the young person can turn. To be meaningful, mentorship should not be a token quarterly meeting between a senior and a junior. Mentoring is a structured relationship between a learner and a person with more experience, with the purpose of growing personal and professional proficiency.

The mentor may also be the coach, but generally the coach changes with the phase of training (the coach in the design office may not be the same person as the coach on site). The mentor, however, may be the same person throughout the graduate training phase.

The mentor needs to:

- Assist with career path planning and guide the graduate through the process required to register as a professional with the Engineering Council of South Africa (ECSA)
- Guide employees to do for themselves, that is, promote self-development and self-sufficiency
- Ensure that line managers motivate graduates to learn, grow, work hard, work as a team, use their time effectively, be productive, and do quality work

- Ensure that workplace coaches and supervisors are available to check, explain and supervise the protégé's work. This may be achieved in the following ways:
  - By the mentor, who may have the time and technical knowledge to do all supervision and checking
  - By staff in the department, who may have the capacity to do this, but the mentor must ensure that it is happening
  - By resources elsewhere in the organisation, if necessary
  - By hiring external staff with appropriate skills to oversee work and carry out training
- Identify appropriate external courses for the protégé to improve his or her technical and business skills where necessary

Staff used to assist with training could be a team of in-house, external active, or external retired people, including draughting staff, detailers, technologists, engineers and suppliers.

A fascinating document covered the proceedings of a 1977 conference held by the Federation of Societies of Professional Engineers.[5] The 'post qualification' training of engineers was discussed. It was stated that:

'… it is not difficult to foresee that in time … the post qualification areas of engineering training will be of equal magnitude to initial training. Furthermore, the existence of adequate post training will influence the form of initial training which should ensure a proper standard of fundamentals.'

It continued:

'… in view of the long lead times involved in training, the importance of good forecasts regarding manpower requirements cannot be overstressed …'

The dedicated effort expended on training in the seventies and early eighties and the monitoring and evaluation that took place annually at this conference contributed to the comprehensive training and calibre of senior engineers still in the industry today. A return to this approach to training is urgently required.

SAACE

The *SAACE Young Professionals Forum (YPF)* is a forum which caters for the needs of built environment graduates under the age of 35. It was formed to empower and develop young professionals in the industry, fast track their development and ensure the sustainability of consulting engineering as a profession.

The YPF is operated under the auspices of SAACE and aims to:

- Promote the industry and SAACE amongst under 35 year olds
- Attract new recruits and to position engineering as a profession of choice amongst the youth
- Share information amongst young professionals in the built environment
- Create networking opportunities for young professionals
- Create training and development opportunities for young professionals, to ensure that a new generation of quality South African engineers are equipped for taking the industry into the future

Industry should consider branding this coaching role and develop a creative name for the project or title for the coach/protégé team that captures the imagination of all concerned and achieves buy-in for coach/protégé relationships to blossom.

6.5 Staff retention

Industry complains about the cost and effort of training staff, only to have them poached. Staff retention has become a major concern.

Gone are the days when professionals remain with their companies for many years. It is not uncommon for young people to have tried at least three careers by the time they are 30 and it is estimated that 70% of the young generation are not working in the field in which they were trained.

Most of the mechanisms that kept people in jobs have been lost as a result of the current 'lean-mean' approach to business and downsizing trends. Companies explain that owing to competition and the economic climate, they cannot afford to train. However, without skilled staff companies cannot exist, so greater investment in staff should be taking place – in the name of efficiency, effectiveness has been forsaken.

The keys to retention follow:[6]

6.5.1 Variety

The instant gratification generation have become accustomed to pressing a button and getting action. They get bored with an activity very quickly. If graduate training is limited to one or two activities, graduates will soon move on for other experiences.

Companies claim that they cannot afford to transfer graduates in-house as they do not have enough work. All projects proceed through a cycle. Therefore, instead of keeping graduates in a particular department, it would be better to link them to specific projects, so that they can experience the variety required for their development and retention.

Young graduates require help not only with technical development, but also with personal and business development. Companies need to devote considerable time to understanding their staff and investing in them at all levels. The supplementary courses proposed in learnerships would contribute toward this development.

6.5.2 Communication

Young people thrive in an environment with lots of information, hence ongoing communication is essential and the company must provide as much information about projects, the organisation and the environment as possible. They also require access to decision-makers and to feel that they are contributing.

John Naisbitt, in his book *Megatrends*,[7] which looks at future trends, including the culture of industry, recognised the need for employees to be nurtured and valued, and coined the phrase:

'… High tech – requires high touch …'

which speaks for itself.

6.5.3 Flexibility

Today's young people have been called the latch-key kids. They were left at home by their workaholic parents. This generation values personal quality of life over loyalty to

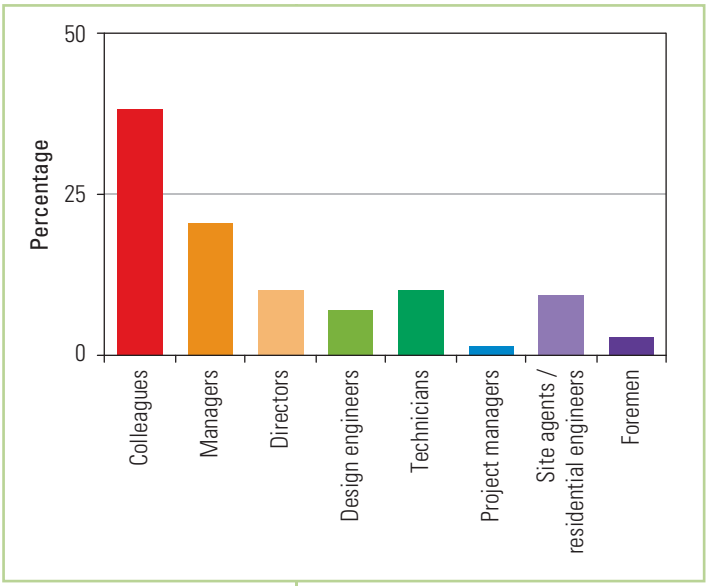


Figure 6.3 Percentage of respondents who were assisted with graduate training by others in the office

the company, and is desperate to balance work and home life. Flexible working hours are highly sought after. Home offices should also be offered as an option to retaining 'bright young things'.

'Work-life-balance' has become so important in today's hectic society that a new breed of consultants has been spawned, to offer guidance and support in this arena.

6.5.4 Responsibility

The young generation has been over-protected by parents who were concerned about alcohol abuse, drugs, violence, abduction or rape. Young people wish to prove that they are quite capable of 'making it' on their own, and desperately need to be given responsibility.

Graduates of the past were given responsibility from an early stage (see the Anglo American training programme outlined in Table 6.2). It is time to 'drop our graduates in at the deep end', but be sure that senior staff are there to support, supervise and coach where necessary.

Figure 6.3 indicates how many of today's senior professionals learned from team members other than their direct supervisors or mentors.

Many young people complain that they have not been integrated into project teams, but have been left to carry out repetitive tasks in isolation. This flies in the face of fast tracking, and does not give the graduate the added benefit of access to many 'knowledge coaches'.

6.5.5 Recognition for performance

The old approach to evaluating performance was to punish mistakes rather than reward achievements. Having been raised in an outcomes-based environment, this generation is driven by outcomes, and needs to understand the big picture but also to have specific goals and outcomes defined. Further they need to be recognised and rewarded for achieving their goals.

Professional registration is additional recognition of their achievements, and companies would be well advised to support graduates to achieve this. If an improved working environment is created, graduates would be less likely to move on.

6.5.6 Recognition of personal drivers

The other challenges to retaining staff are:

- their need to study further (see Chapter 7 – Supply professionals)
- their desire to start their own businesses (see Chapter 7 – Supply professionals)
- their need to work for a cause

Companies should recognise and support these needs.

(a) Postgraduate studies

If study needs are considered in relation to the needs of the company, a win-win situation can be negotiated. Over 40% of all senior respondents had postgraduate qualifications. The National Research Foundation (NRF) recently launched a significant initiative, 'The PhD

as driver', as one way of addressing the challenge of regenerating the scientific workforce. South Africa's annual doctoral graduates constitute only 0,002% of the South African population, compared with 0,01% in India and 0,02% in the USA.[8] Companies could accommodate staff by developing a specialist project into a PhD project.

At the Human Resources for Knowledge Production Conference it was suggested that tax incentives should be offered to encourage industry to invest in R&D. The civil engineering industry should lobby for this.

(b) Own business

When wishing to start their own businesses, graduates should be encouraged to retain links with their companies for major contracts and act as sub-contractors where possible. Companies will then benefit from an ongoing relationship with those whom they have trained. The new company may even eventually merge with the parent, to the benefit of both.

(c) Working for a cause

Survey respondents often stated that they wished to become the best, or to help their companies to be the best, or to make a difference to society. If their passions are recognised and harnessed, staff can be moved to heights of performance and satisfaction that a big salary would never fulfil.

6.5.7 Relationships

Reinstating the graduate-in-training process and ensuring that graduates are moved among departments will ensure variety. Coach and mentor relationships will ensure communication and access to decision-makers. However, relationships are also extremely important.

The new process cannot simply be a new set of rules, it needs to be much more than just a commercially astute approach for a company to take. A whole new culture and approach to graduates must be implemented based on the very powerful truths expressed by Josh McDowell, theologian and family advisor, below:

'… Rules without relationships lead to rebellion …'

'… I don't care what you know, until I know that you care …'

Most graduates felt that they were not valued and little time was invested in their development. Young black and female graduates in particular complained of the lack of integration into the environment, companies or project teams and the lack of career path planning.

To change the culture of suspicion and lack of cooperation, mentor/mentee and coach/protégé workshops with motivated leaders will go a long way towards breaking down barriers and setting the new, more structured training process in motion. The book *Mind the gap, understanding why we don't understand* states:[9]

'… it is the lack of understanding of different generations that leads to much of the conflict in the workplace … and the loss of the talented bright young things …'

In the light of the personal responses and of current generation theory and guidelines, it was interesting to read 'The Workforce Challenge',[10] a USA publication that outlined retention actions set up by Departments of Transport as follows:

Dr Tjaart van der Walt, president of IMESA (Institution of Municipal Engineers of South Africa) from 2004 to 2006 commented: 'The two most important aspects of being a good manager, parent or custodian are to be fair and to care. We seem to fail in both respects. We bring up our children with enormous effort and care from primary school through to university, yet we abandon them when they need us most. Medical students cannot even hope to become doctors without practical experience; neither can engineering students become engineers without acquiring the practical skills.'

'… States … are increasing salary levels, developing flexible employment arrangements for employees with special physical or family needs, and establishing employee satisfaction programs that include frequent communication with supervisors … they are also instituting bonus programs ... providing incentives to complete education while working … establishing distance learning opportunities for advanced degree programs …'

The workforce is any company's most valuable asset – in order to keep this asset operational at an optimal level, development and maintenance is required, just as with any other asset. Companies would do well to heed the above guidelines, not only for their young people, but for all staff.

CONCLUSIONS

Without comprehensive workplace training programmes, incorporating ongoing supervision, mentorship and career path planning, graduates will not become effective professionals and, worse still, they may be permanently lost to the industry.

Because the margins are inadequate and few professionals in industry have time to take on and manage the training of young graduates, mechanisms must be put on place to increase funding and capacity to employ and train. Stage II learnerships must be developed and external capacity must be employed and funded through the SETA learnership processes to train young graduates.

Understanding the character of and the needs of the young generation is of vital importance to addressing retention problems facing the industry.

Building blocks

To train graduates the following are required:

- Structured training programmes
- Supervisors with time to manage and coach graduates regularly
- Mentors to manage career path development
- Sufficient work and income to cover the training costs

RECOMMENDATIONS

Reconstruction required

Training approaches and techniques must be redefined:

- **Candidate learnerships**

  Develop and communicate details of Stage II learnerships. This will:

  - Give graduates guidelines on what experience they can expect

- Allow graduates to become professionally registered on completion
- Give companies guidelines on the process to follow to comprehensively train young graduates
- Allow companies to be compensated for credits achieved
- Allow companies to be compensated for expenditure on coaches
- Help companies grow capacity

- **Orientation courses**
  Identify and fund orientation courses to prepare graduates for the world of work
- **Convene industry and tertiary institution re-curriculation workshop**
  In developing the learnerships, industry needs and the scope of national diploma and degree courses must be considered and adjusted as necessary
- **Develop a pool of coaches**
  Develop a pool of knowledge coaches from the ranks of the recently retired to offer support to smaller companies and local authorities with insufficient senior capacity to supervise and train young staff
- **Develop the concept of coaching as a post-retirement appointment**
  Educate companies of the value of retaining experienced staff to act as coaches and mentors
- **Train coaches and mentors**
  Train senior and retired staff on approaches which should be adopted and techniques for dealing with young people
- **Payment of coaches**
  Develop guidelines on payment for coaches and mechanisms for claiming these costs from the SETAs
- **Knowledge transfer**
  Invite Professor Dorothy Leonard from Harvard Business School to launch knowledge coaching in South Africa for coaches and mentors
- **Postgraduate studies**
  Encourage graduates to continue with their studies
- **BTech**
  Support national diploma graduates to continue with a BTech
- **CPD**
  Provide opportunities for continuing professional development

Suggested Construction Charter activities

- **Workplace training**
  Work place training is well recognised in the Construction Charter, with targets being set for skills development, learnerships and mentorship programmes. A major challenge still to be faced is how to cost workplace training in terms of claiming a value against the skills development target.

NOTES

1 Engineering Council of South Africa (ECSA), *Bulletin*, 6 April 2005, p 3.

2 D Leonard and W Swap, *Deep smarts*, Harvard Business School Publishing Corporation, Boston, Mass, 2005.

3 Transportation Research Board (TRC), The workforce challenge, Recruiting and retaining qualified workers for transportation and transit agencies, Special Report 275,TRC, Washington DC, 2003.

4 Leonard and Swap, op cit.
5 Federation of Societies of Professional Engineers, A Review of All Aspects of All Aspects of Engineering Training in the Republic of South Africa, Eighth Conference on Engineering Training, University of Natal, Durban, 7–9 September 1977.
6 Bright Young Things Conference, tomorrowtoday.biz, Johannesburg, 2004, www.tomorrowtoday.biz.
7 J Naisbitt, *Megatrends: ten new directions transforming our lives*, Futura MacDonald, London and Sydney, 1982.
8 National Research Foundation, The PhD as driver, cited in Human Resources for Knowledge Production Conference, 23–24 June 2005.
9 Graeme Codrington and Sue Grant-Marshall, *Mind the gap, understanding why we don't understand*, tomorrowtoday.biz, Johannesburg, Penguin, 2003, www.tomorrowtoday,biz/content/blogcategory/103/93/, accessed on 13 September 2005.
10 TRB, The workforce challenge, op cit.

CHAPTER 7

Professionals

INTRODUCTION

There is a major shortage of experienced mid-career professionals (Figure 7.1).

The large older group of senior professionals carry a significant portion of the load. Until the young group can start picking up more load, the older group must continue to work very long hours.

Further, the middle group, having gained extensive experience under challenging South African conditions are highly sought after by other industries and internationally, since many countries also have an ageing workforce and declining capacity.

This chapter looks at the supply and the many factors that need to be addressed to attract and retain sufficient capacity for current needs.

'… Among the issues on our agenda … would be infrastructure, capacity building …'

– Nelson Mandela

THE STATUS QUO

7.1 Boom and bust

Graduations figures over an extended period yield interesting trends. Figure 7.2 represents the full working career of a typical engineer who graduated in 1960, would have turned 65 in 2004, and would be retiring soon if he or she has not already done so.

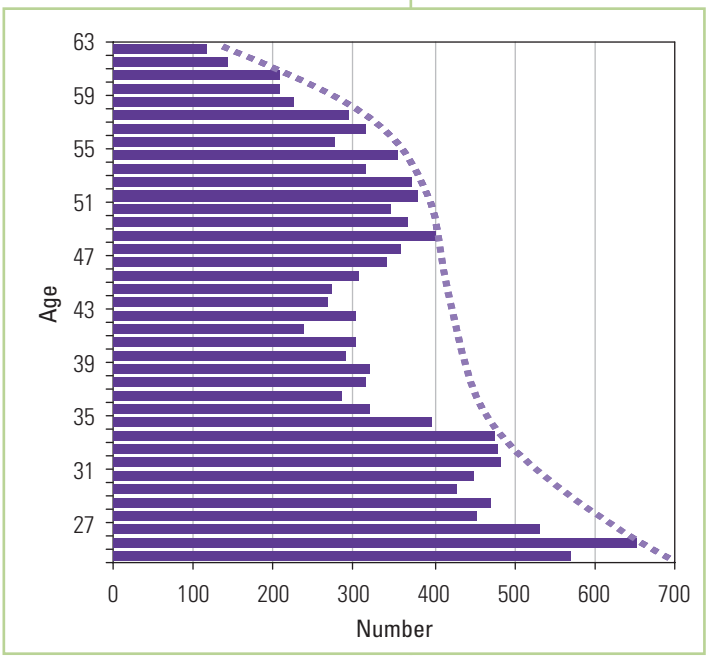
Up to the late seventies, when technical colleges provided draughting staff and detailers, universities were graduating large numbers of civil engineers in support of the boom years in South Africa.

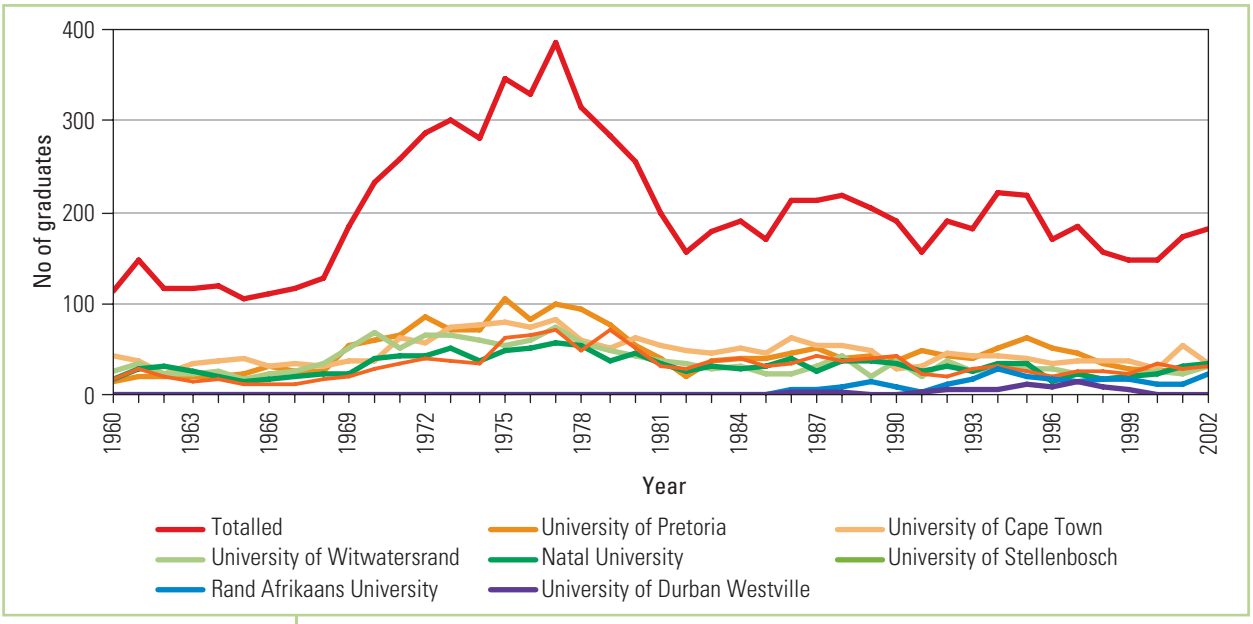
The number of civil engineering graduates dropped when the economy slowed down in the eighties. At that time the affordable PC came to the market. In parallel, technikon qualifications were enhanced, and a change of thinking took place in terms of the ratio of technical staff to degreed professionals.

In 1988 Hugo et al[1] suggested that the ratio of engineer to technikon-trained personnel should be increased. The figure discussed in the industry at the time was 1:3 to 1:4, based on the ratios observed in Europe and the USA. Tertiary institutions have now achieved this ratio, but the increased number of technikon graduates is not being absorbed into the industry.

The above ratio was propounded when computers were slow, were a central resource, and software was not so sophisticated as it is today. Today, with a personal computer on each desk, it is possibly time to review this ratio and the roles

Figure 7.1 Overall profile of civil engineering professionals by age and number, 2004





Department of Education, Universities

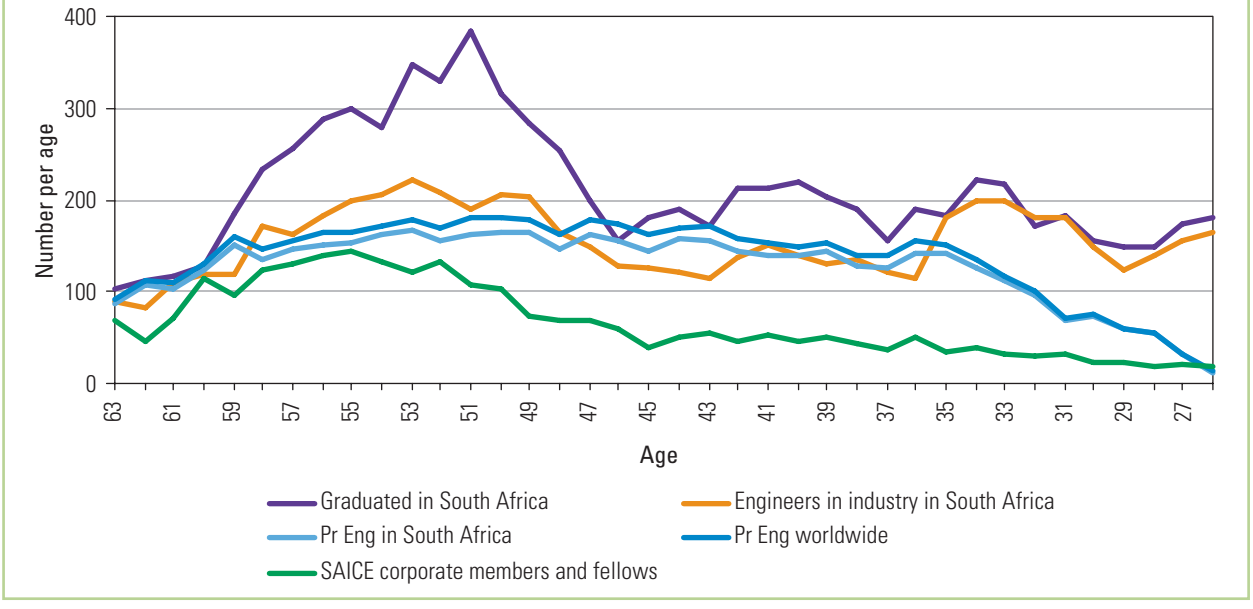
Figure 7.2 Civil engineering graduations from South African universities, 1960–2002

played by engineers, technologists and technicians. In developed countries engineering staff are involved in operation and maintenance rather than development, whereas in developing countries, as the name suggests, a great deal of new infrastructure is being developed and requires the strategic direction given by engineers.

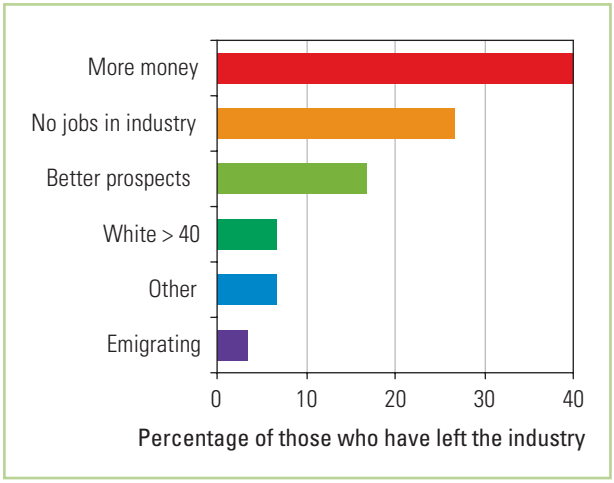
When one studies graduations, professionals in the industry and the age profile of those still registered with the Engineering Council of South Africa (ECSA), it can be seen that the excesses trained in the late seventies and early eighties are no longer in the industry. Many are no longer in the country.

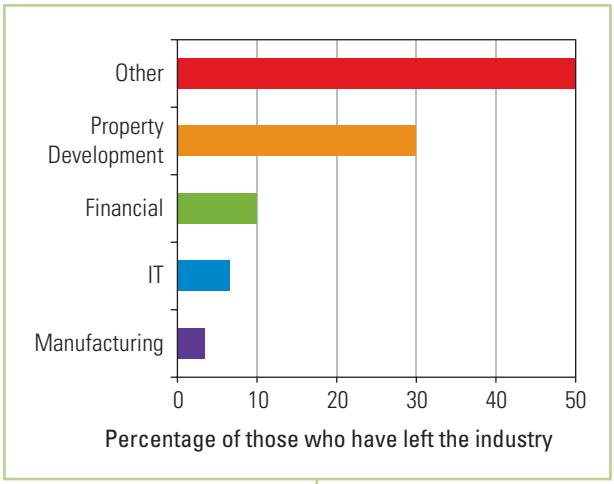
Figure 7.3 confirms many facts gleaned during the study:

Figure 7.3 In the industry versus graduates, ECSA and SAICE membership by age



Department of Education, ECSA, SAICE





Left Figure 7.4 Reasons for leaving the civil engineering industry
Above Figure 7.5 Fields into which civil professionals have moved

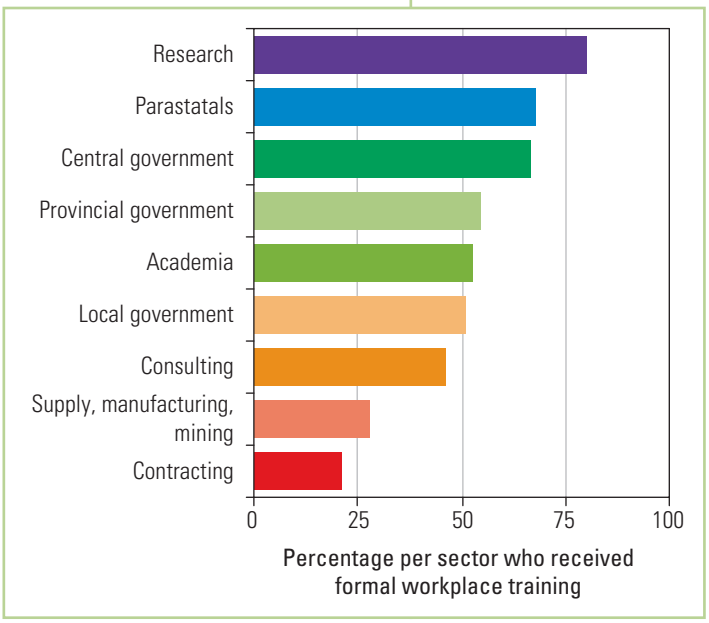
- When people leave the industry but stay in the country, they generally resign from the South African Institution of Civil Engineers (SAICE), but retain their ECSA registration in case they wish to return to the industry
- Where members have travelled overseas but plan to return, they cancel their SAICE membership, but retain their ECSA registration
- When people permanently emigrate they generally cancel all local memberships and registrations
- Young people do not value or in some cases do not understand the benefit of belonging to voluntary associations
- Staff in many public sector departments do not belong to SAICE as the state does not contribute towards their membership subscriptions. In addition professional fees no longer qualify for a tax reduction.

While SAICE clearly has a great deal of promotional work to do to increase its membership, the older ECSA civil engineering professionals between the blue ECSA lines and SAICE membership shown in green represent a portion of the people that have left the industry but remained in the country, and those working overseas who are planning to return. This would offer a source of staff, if it were possible to establish and remedy their reasons for leaving the industry or the country.

E-mail and postal surveys were carried out in order to understand the dynamics of those who do not belong to SAICE.

It was found that around 10% of those who are registered with ECSA but do not belong to SAICE have left the industry. The reasons for leaving and the sectors into which they have gone are shown in Figures 7.4 and 7.5. 'Other' covered a host of activities such as charity work, entering the ministry, travel, and starting their own businesses in many other fields.

Figure 7.6 Percentage of senior respondents who were trained and mentored after graduation



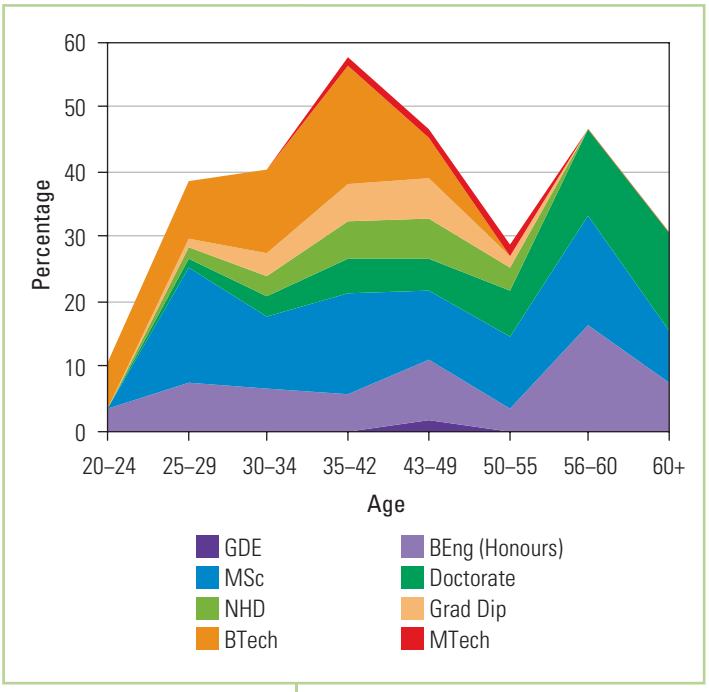


Figure 7.7 Percentage per age group with further technical qualifications

7.2 Training and ECSA status

Senior professionals can reflect on rich careers, having been trained by some of the pioneers of twentieth-century infrastructure development.

Government departments were fertile training grounds for developing young engineers. Departments were managed by the autocratic chief engineers of the day, and training programmes were strictly adhered to and monitored. Figure 7.6 reflects the involvement of the public sector in the training of young graduates in 1960–1985. Over 50% of those involved in research or employed by parastatals, central, provincial and local government were offered structured training after graduation.

Registration with the South African Council for Professional Engineers (SACPE, the forerunner of ECSA) was considered part of professional development and staff in these departments were expected to register. This can be seen in Figure 7.3 where graduations and registration with ECSA up to 1970 are almost coincident. The same is not true today. Over 35% of the civil engineers in contracting, local and provincial government are not registered with ECSA.

7.3 Qualifications and further studies

A great deal of debate has taken place over the content and duration of basic civil engineering tertiary qualifications. Many countries are adding an extra year to their degree courses.

Industry would like instant professionals who can tackle any project immediately after graduation without going through the workplace training process.

Academics have argued that they cannot teach all subjects to specialist and/or 'workplace ready' level, because students would have to study for many more years, only to discard large portions of subject matter when they specialise in one or two disciplines in practice.

Professionals appear to agree with this philosophy and have developed as specialists by gaining further qualifications, as their careers have dictated.

7.3.1 Technical

Figure 7.7 shows that almost 40% of all respondents had an additional technical qualification. In the younger age group the BTech has become important to technicians for career development. Technikons report that about one third of the national diploma graduates return to study further.

For university graduates, the master's degree has always been popular and allows the graduate to specialise in his or her field of interest.

The sample and an analysis of the Department of Education figures both show a drop off in the number of research students working towards their doctorates. This arouses concern.

To maintain the expert knowledge that is necessary in the industry, companies should encourage their 'whiz kids' to register as PhD students, to challenge their intellect and hone their particular expertise into meaningful reference material.

7.3.2 Business and project management

Figure 7.8 shows that 25% and more of all respondents have an additional business-related or project management qualification.

Internationally, the MBA is becoming a popular career choice for engineers. In European business schools the number of engineers increased from 24% in 1998 to 30% in 2001.[2]

The values shown in Figures 7.7 and 7.8 were established from responses to the various workshops. Almost identical profiles were received from 559 postal respondents to the salary survey, few of whom were common to the workshop audiences.

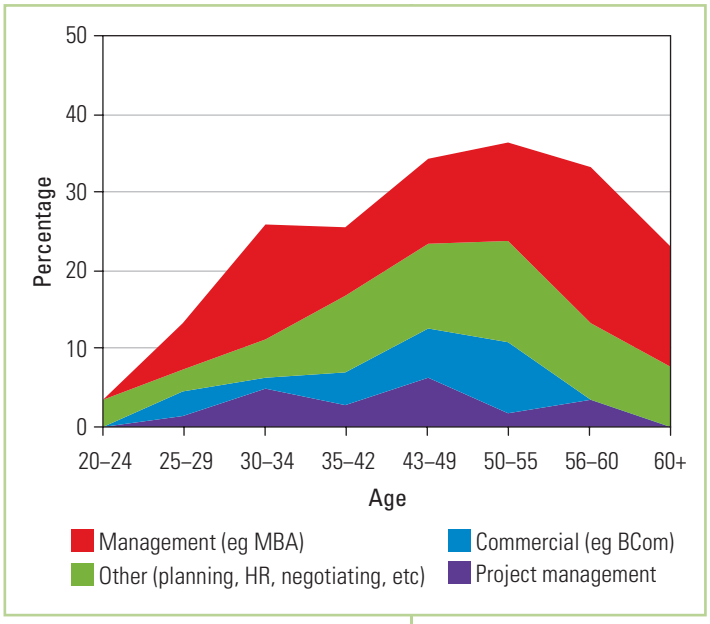


Figure 7.8 Percentage per age group with further business and related qualifications

7.3.3 CPD

The 'lean-mean' model of business popularised in the eighties has resulted in little time or investment being made in developing professionals. This gives rise to frustrations at the more senior level.

Learning is now critical for everyone. In the same way that radioactive materials become half active in a set time, people's skills have a half life. At the beginning of the 21st century, it was estimated that the skills 'half life' had reduced to three years. That is, half the knowledge that has accrued will no longer be relevant in three years time, and it will be necessary to keep on learning to keep abreast of these changing times.

For senior professionals to keep pace with changes in technical, political, socio-economic, institutional, environmental, health, financial and management approaches, not only are higher qualifications valuable, but they must be encouraged to attend workshops, seminars, courses, site visits and continue with self-study. Continuous professional development (CPD) will be compulsory from 2006. All registered with ECSA will be required to keep records of their CPD activities to maintain their registration.

This will put further pressure on staff. If they fall behind and feel inadequate, they will be demotivated and may consider moving to organisations where they are better supported and their needs are met.

The Minister of Trade and Industry[3] recently stated:

> *'… to improve our technological capabilities we should also be promoting greater levels of further education and training among employees …'*

Senior professionals have continued to study. It is now time to ensure that similar opportunities are available for the younger generations. Companies should realise the benefit of their staff keeping up to date. The Organisation of American States outlined the factors for 'an effective technical workforce'[4] as:

- High quality engineering education
- Experience
- R&D
- Quality assurance
- Lifelong learning for professional engineers

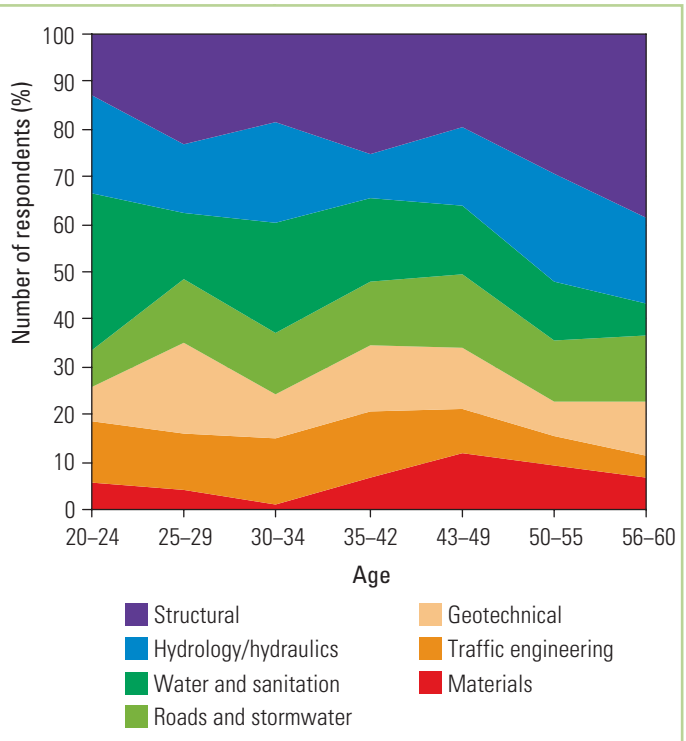


Figure 7.9 Final-year specialisation

The engineering profession and SETAs need to develop a method of including short courses in the workplace skills plans.

7.4 Discipline distribution

Figure 7.9 relates to the final-year specialisation of professionals during their tertiary studies.

There is currently a cry for structural engineers and material specialists. The profile from the respondents explains the problem. The activities of the seventies and eighties required large numbers of structural engineers, hence older professionals initially specialised in structures.

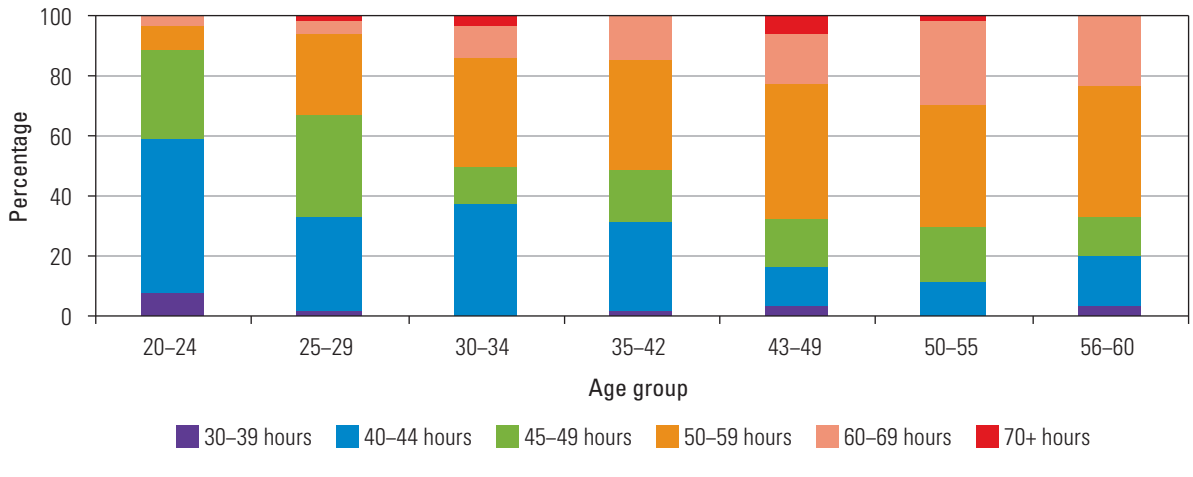
Development of social infrastructure in recent times has seen specialisation move towards water, sanitation, traffic and geotechnical engineering – all issues relating to sound township development.

There is now a shortage of younger structural and material engineers. Tertiary institutions are urged to encourage more students to specialise in these fields and ensure that there is sufficient capacity in their departments to address all topics.

But many departments are no longer able to offer final-year structural engineering, and few students are sufficiently competent in or excited by mathematics to consider specialising in that field. This problem is not restricted to South Africa. According to the London-based Institution of Structural Engineers (IStructE):[5]

'… many universities are doing away with structural engineering departments. Many academics have repeatedly expressed disparaging views on the proficiency of school-leavers and university students in physics and mathematics, the pre-requisites for pursuing structural engineering studies …'

Figure 7.10 Percentage of respondents working overtime vs the age profile



South Africa is contemplating centres of excellence to meet many specific education needs. Centres of excellence in civil engineering disciplines should also be considered.

7.5 Hours worked

Figure 7.10 should start the alarm bells ringing. This represents the percentage of time that each age group spends at work. The young group, enjoying life to the full, are not yet sufficiently competent to be loaded. They generally work a 40-hour week, although 25% work 45–49 hours and about 8% work 50+ hours. In comparison, more than 60% of age 43 and older spend 50+ hours at the office. A hefty 20% work 60+ hours a week.

Just over 43% of the most senior staff appear to be carrying almost 60% of the workload! (See Figure 7.11 in which directors, department managers, project managers, supervisors and the self-employed work long hours.)

Burn-out is a problem. Causing particular concern are the number of people who said they would or might leave the industry owing to ill health and, in particular, problems related to stress (see Figure 7.12).

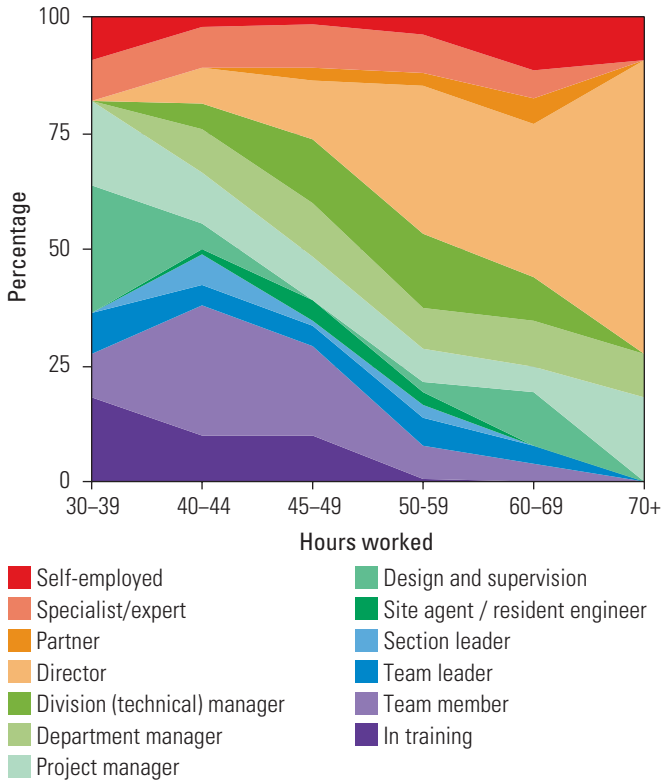


Figure 7.11 Percentage of respondents by job category and hours worked

The number of recent failures also arouses concern, some apparently because work was not checked. Lack of concentration owing to exhaustion and lack of staff to check work have become commonplace through skills shortages.

The young generation are adamant that quality of life is of prime importance – they are particularly family conscious. In calculating the numbers needed for the future, their abhorrence of 60-hour working weeks must be factored in!

Salaries throughout civil engineering are low in comparison with other professions, but particularly at junior level. This discourages young people from putting in long hours, as there are few or no related rewards.

Apart from Gauteng and the Free State more than 50% of the sample who worked overtime put in 50 hours or more per week. This confirms reports from the regions that it is difficult to attract experienced staff, hence the long hours worked by those currently employed.

The civil professional salary bill is currently about R3,5 billion per annum, and few professionals are paid overtime. If professionals belonged to a trade union, the hours worked in addition to those stipulated in their employment contracts would cost the industry an extra R1,1 billion at normal time rates and at least R1,6 billion at overtime rates.

This would render the industry totally unprofitable unless fees could be drastically increased. Civil professionals should be valued and respected for their complementary contribution of R1,6 billion to the industry and the economy.

7.6 Unemployment and unfilled posts

From anecdotes before the research began it appeared that many civil professionals could not find work. This claim was supported by employment agencies which had many applicants

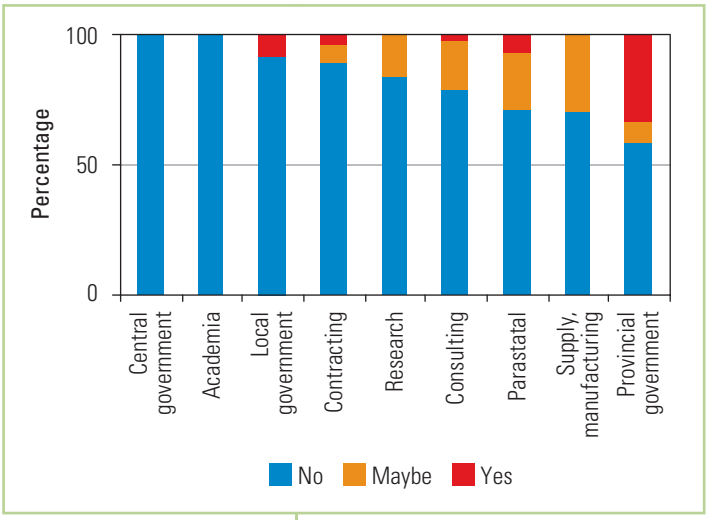


Figure 7.12 Percentage of respondents due to leave industry in next five years owing to ill health/stress (51% at workshops responded)

on their books and websites who could not find work. At the same time there were complaints about how impossible it was to find staff. Indeed both sides of the story proved true.

Agencies reported that they had no difficulty in placing mid-career experienced engineers, and are actively recruiting overseas, employing both foreign nationals and returning South Africans. However, placing young technicians with little or no experience is proving a nightmare. There is a problem with the calibre of some of this group and the numbers as industry does not have time to train the numbers that require workplace experience.

It is necessary to distinguish between scarce skills and skills gaps. A 'scarce skill' is simply not available, whereas a 'skills gap' exists where there are qualified people, but they do not have appropriate experience. Civil engineering suffers from both problems.

The most brisk movement of staff takes place in the 24–30 age group, where companies consistently poach good staff as soon as they are trained by others. All expressed frustration with this phenomenon. The private sector deplored the effort put into training young black professionals, only to have them accept middle and senior management posts in all levels of government. Industry also felt that these young people were moving into management too early in their careers to be able to offer appropriate technical or strategic leadership to their new employers.

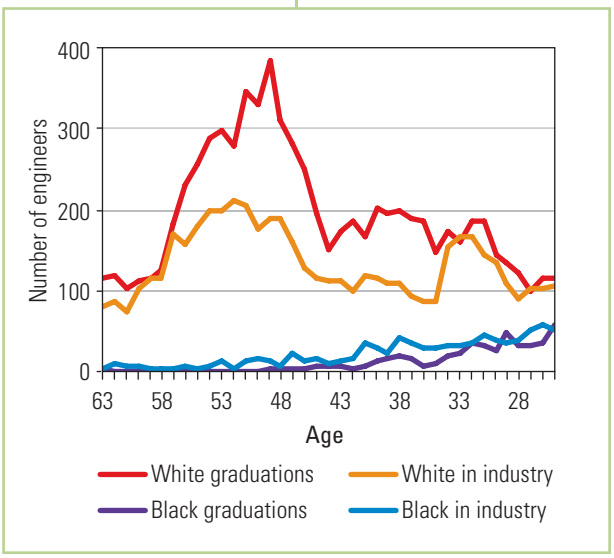
The large private sector companies recognised that they would be the training ground for the whole industry, but lamented that government was not contributing towards this training.

7.7 Immigration

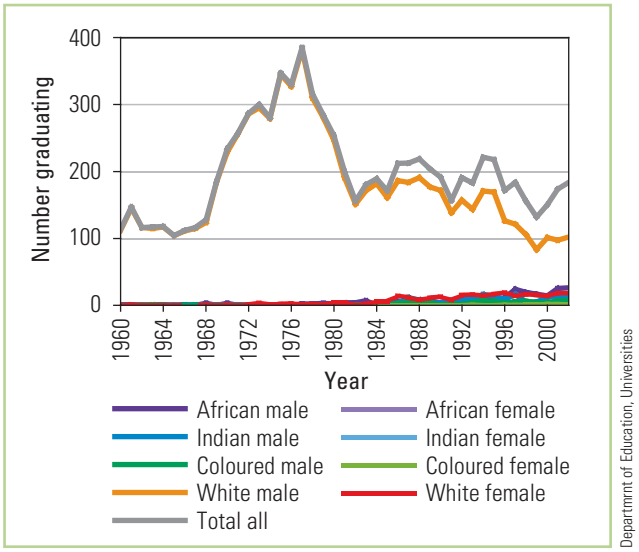
The sixties to early eighties saw an influx of foreign nationals into the sector to supplement local staff during the boom times. These immigrants were largely from Britain, Belgium and

Below *Figure 7.13 Transformation in industry versus graduations from South African universities, by age*

Right *Figure 7.14 Transformation in BEng/BSc civil engineering graduate profile*



Department of Education, Universities



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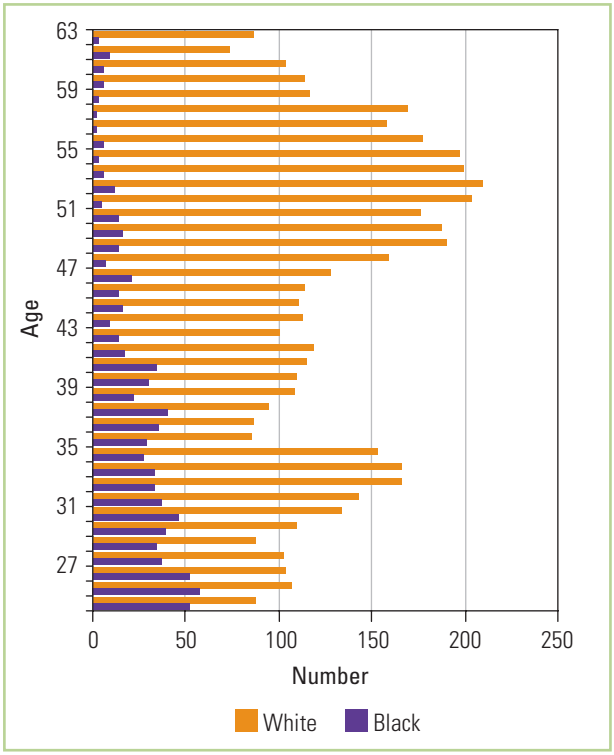
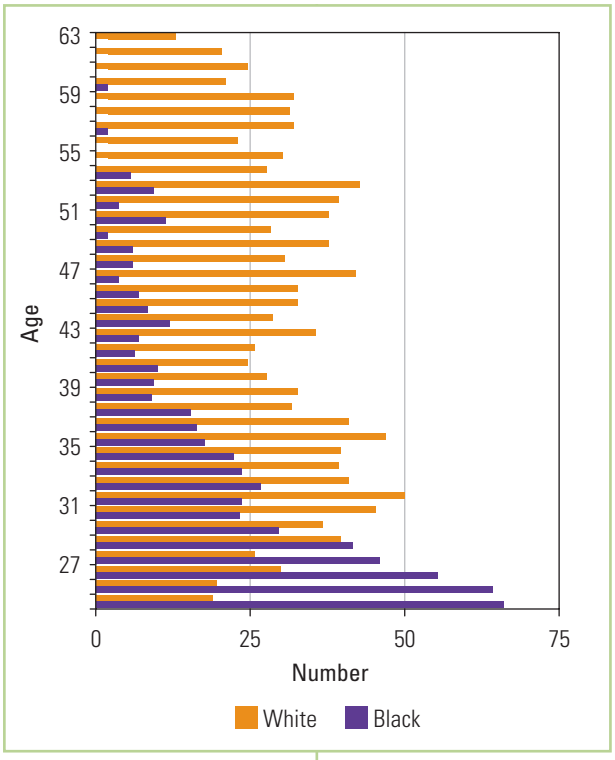




Above *Figure 7.15 Civil engineers, transformation by age, 2004*
Right *Figure 7.16 Civil technologists, transformation by age, 2004*

the Eastern Bloc. Few Belgians have remained, but many British and Eastern Europeans made South Africa their home and are still here.

In Figure 7.13, the number who graduated in South Africa and the number in industry between age 55 and 59 are coincident, not because South African graduates have not left the industry, but because a number of engineers who came to this country in the seventies and eighties are still here.

Since the early nineties, the change in policies in South Africa has made the country attractive to professionals from the rest of Africa – offering a culture and lifestyle that they are familiar with and a much more sophisticated professional environment that permits more career growth and greater prosperity than any other African country. This movement is seen as the 'brain gain' and is of extreme concern to their countries of origin.

Just under 600 black civil engineers have graduated from South African universities but there are between 900 and 1 000 black civil engineers in industry. The remainder are Africans from further north and South Africans who were educated overseas from choice or while in exile. (See the difference between the purple and blue lines in Figure 7.13.)

Although there is a steady flow of immigrants, it does not match the tide of emigration (discussed in Section 7.12).

7.8 Transformation

To complete the civil engineering picture, transformation – when plotted against the society of the sixties – makes interesting reading (see Figure 7.14).

Although transformation looks impressive in Figures 7.15 to 7.17 in comparison with the original all white male industry, there is a worrying trend in that although most graduates have registered as candidates (with the Engineering Council of South Africa, ECSA),

female graduates and black graduates have been slower to register professionally than their white male counterparts.

Graduates cited lack of interest and involvement by their employers in spending time with them on career path planning, and inadequate supervision, mentorship and coaching as major frustrations.

Young graduates complain that they have been taught a particular skill and have then become locked into production in this area as it is most cost effective for their companies.

Without developing all-round abilities, these young people will not become the leaders of tomorrow. When one analyses each grouping separately, it is apparent that substantial effort is required to address development and integration issues.

Equity targets have been set in the Construction Charter, so it is essential that the barriers to progress for young black and female graduates should be addressed urgently.

7.8.1 Under 35

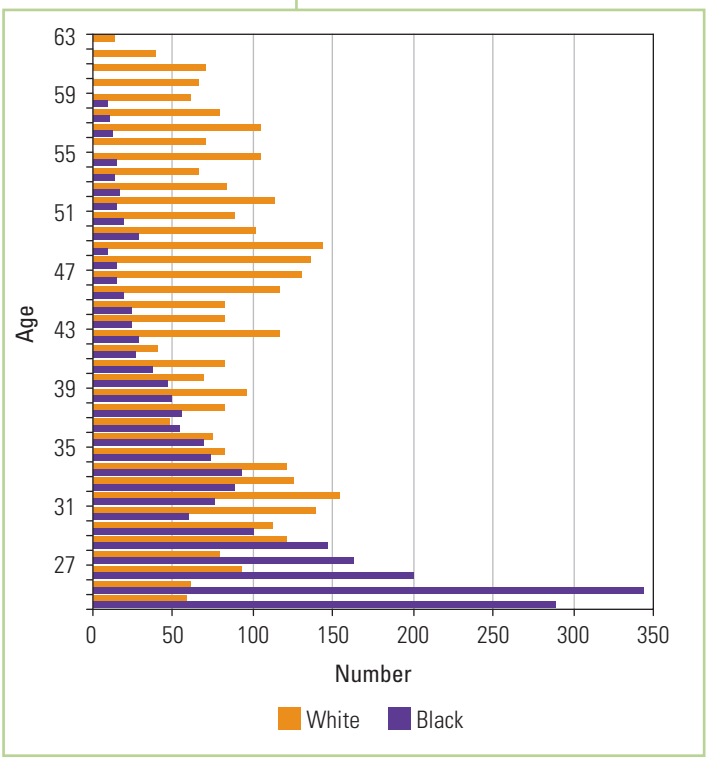
The future of civil engineering lies in the hands of the under-35 age group. Responses from hundreds of young people cite many challenges.

This age group have always had problems with their conditions of employment and the lack of value placed on them, but it seems that they are facing more acute problems in the 21st century.

(a) Low salaries

The biggest complaint was poor salaries. Despite having studied for three, four or more years, the under-25 group are offered starting salaries lower than or equivalent to those of the junior secretarial staff in the front office.

Figure 7.17 Civil technicians, transformation by age, 2004



Employment agencies confirm that starting salaries are low, so young people job-hop for the slightest increase. By changing jobs many times, training suffers.

The agencies also report that those from about 26 to 29 years are in greatest demand and are the most exploited group, as they have developed competence in one or more activities but still represent cheap labour.

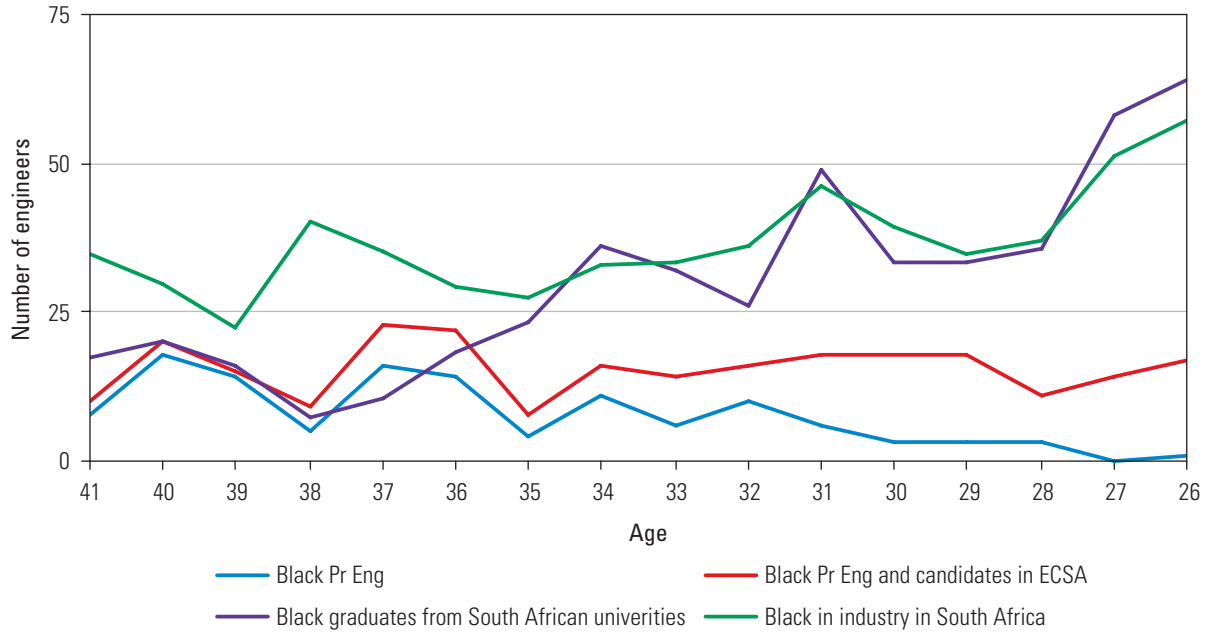
Twelve per cent of the respondents felt that SAICE should lobby for increased salaries for all in the industry.

(b) Lack of training

Many complained of the lack of training. This was evident at the workshops as well as from the e-mail survey. As a result few register with ECSA within three to five years of graduating, which was commonplace until the eighties (see Figure 7.18).

(c) Diversity challenges

The responses were a sad reflection of prevailing attitudes in South Africa. Each e-mail stated:



Departmmt of Education, ECSA

Figure 7.18 Black civil graduations vs black Pr Eng and candidate registrations in ECSA, February 2005

'*… I am not making progress because …*

- **I'm black and …**
- **I'm white and …**
- **I'm female and …**
- **I'm too young and do not have enough experience …**
- **I'm too old and no longer valued …**
- **Etc …**'

It is time that industry recognises all graduates as future professionals and invests in them accordingly. South Africans must stop categorising people and develop and utilise the whole skills base. For example, senior black professionals complain of instances of not being introduced to colleagues when they join companies, or of administrative staff assigned to them being reluctant to do their work. Young professional women still complain that they are asked to make the tea or stand in for secretaries.

A major resource utilisation and motivational campaign must be initiated to break down barriers between age and ethnic groups to ensure that all young graduates are trained and integrated and all skilled people are retained.

(d) Image and status

It has not taken the young people long to stumble on to industry's 'hardy annual' bone of contention. Many said:

'… we should make the government and public more aware of our work so that they will value us … etc …'

'Proudly Engineering', ECSA's planned campaign to brand engineering professionals, needs to be put in place urgently and be given encouragement and support.

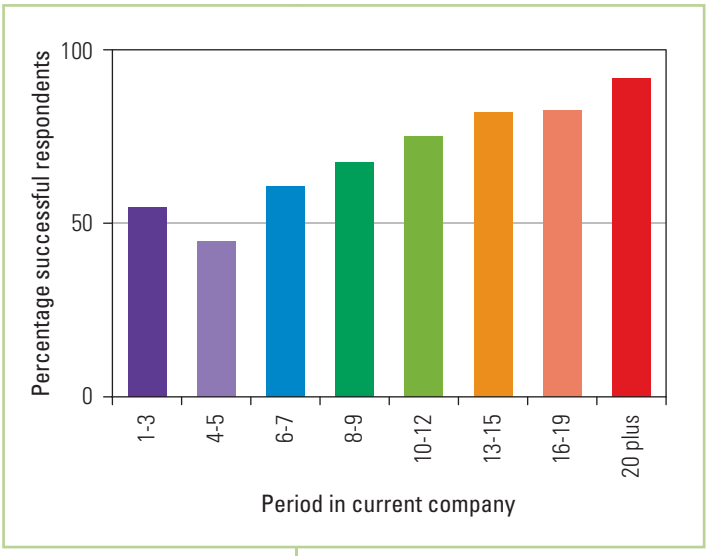


Figure 7.19 Percentage of successful professionals in terms of the number of years in their current company

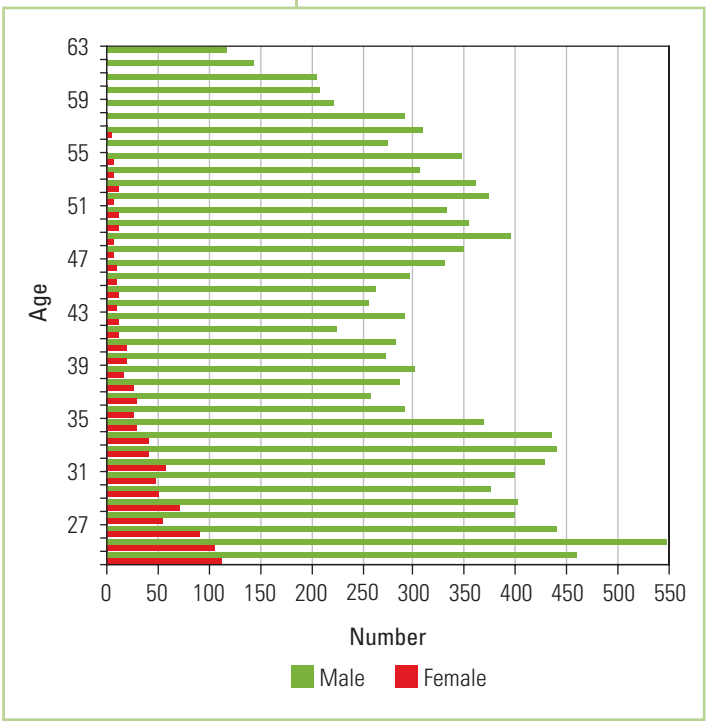


Figure 7.20 Women in civil engineering

Twenty five per cent of respondents felt that SAICE should take responsibility for raising the image.

(e) The establishment

The under-35 respondents complained about the inflexible 'establishment'.

Indeed, analysing the age profile in consulting, there is a large group of senior people, mostly baby boomer 'control freaks'. Many are not ready to relinquish control. Hence young people cannot see any hope of rising in the ranks in the short to medium term.

The older group correctly say that they can do things faster or better themselves and indeed most of the senior group rated themselves successful (see Figure 7.19).

Young graduates do need to understand that it takes time to develop the expertise seen in the senior groups. Sadly, the seniors have forgotten how senior staff nurtured *them* and gave ***them*** responsibility at a young age!

Graeme Codrington describes the problems between the generations as follows:[6]

> *'… lack of commitment by adults to adapt to new generations of young adults, lack of desire to leave comfort zones by young and old …'*

All in the industry need to realise they are part of a team, celebrate their differences and tackle training and delivery problems urgently together.

(f) Leaving the industry

Despite the many gripes, only 13% of respondents said they would consider leaving the industry, mostly for better salaries. Although this is a low percentage, it represents 500 to 600 young people in the under-35 group with significant experience that the industry cannot afford to lose. The retention challenge is real.

(g) Future plans

The future aspirations of young graduates shed light on incentives that could be used to address retention issues. Just over 28% hope to start their own businesses. In part they are looking for better financial prospects, but also for greater responsibility, flexibility and status. This is a challenge for established companies to consider. Fortunately many want to improve their current positions, to become specialists and be successful. Similar responses came from the Women in Civil Engineering survey.

(h) Willingness to help

Most respondents indicated willingness to help. A significant 58% offered to assist with career guidance visits to schools and 42% offered to nurture tertiary students through their studies.

7.8.2 Women

The number of women entering the industry is increasing (see Figure 7.20 and Figures 7.22–7.24).

Women represented 25% of all students registered in civil engineering in South Africa in 2004. This is impressive when compared with international figures of about 15% in the Netherlands,[7] 15% in Australia[8] and 14% in the US.[9,10]

However, when one tracks the number of women in the industry, the figure is significantly lower.

Figure 7.21 is of interest in that a large percentage of the senior women in the industry are immigrants – many of whom came to the country in the busy eighties. Most of those who remained are from the Eastern Bloc.

In the UK[11] and Australia[12] women constitute 5% and South Africa women constitute 4% of professional civil engineers. This phenomenon has been studied in detail in Australia and is documented in a paper entitled 'Did she jump or was she pushed?' (referred to above).

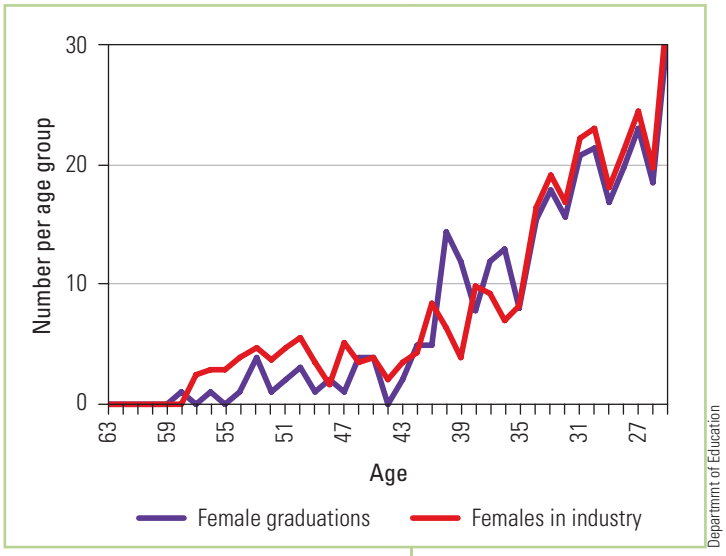
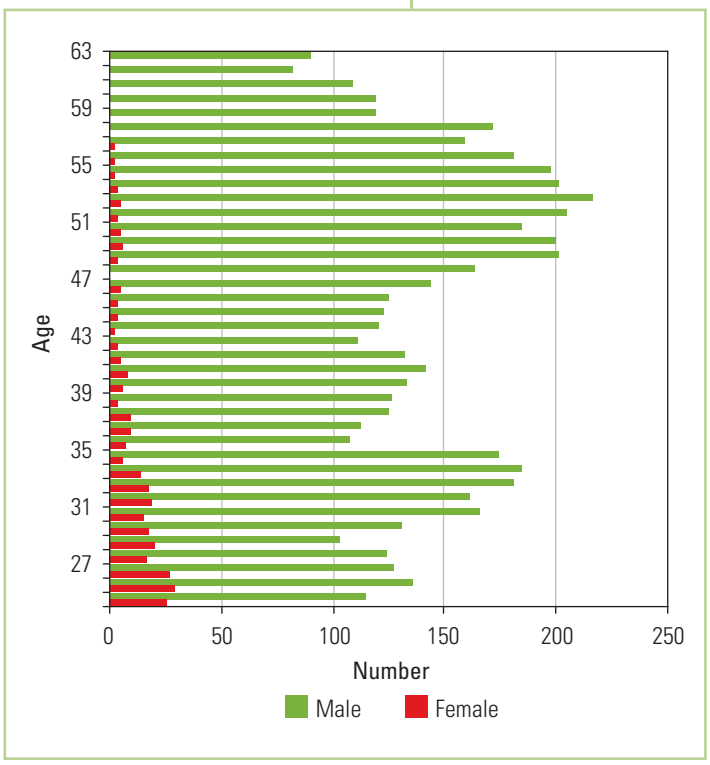


Figure 7.21 Female civil engineering graduations versus females in industry, 2004

Figure 7.22 Women engineers in civil engineering



(a) Problems per age group

Research into the problems associated with being a woman in civil engineering matched many of the Australian findings. The mixed bag of findings can broadly be broken into three groups.

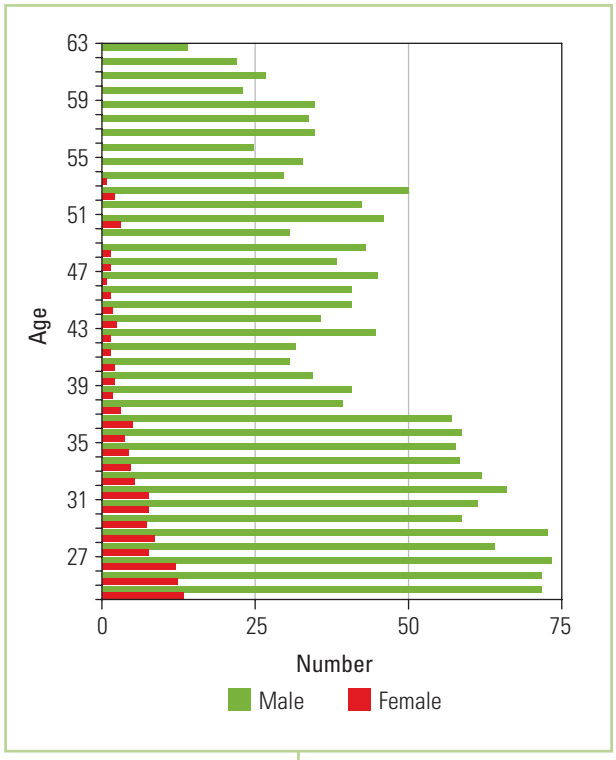
(i) Over-40s

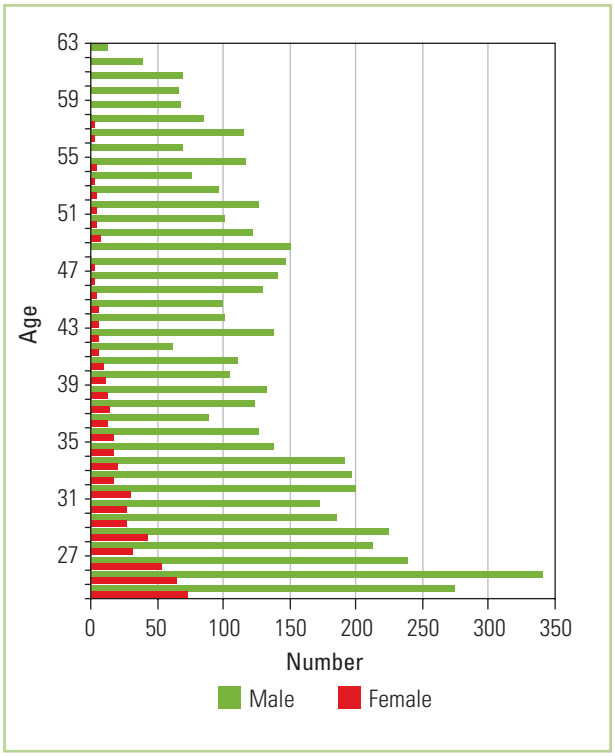
The over-40 group is extremely small and appears to have largely escaped the discrimination experienced by the other groups. This is mostly owing to the curiosity factor of being new contenders in the field. Industry was so intrigued by these new entrants that they were given opportunities to prove themselves.

If they proved mediocre, inferior, or too demanding, discrimination issues arose, but these were the exceptions rather than the rule. There is roughly one woman per 40 men in this age group and most of these women have been extremely successful.

(ii) Mothers

Generally this group ranges in age from 27 to 40. Although companies appear to understand that





Above Figure 7.23 Women technologists in civil engineering
Right Figure 7.24 Women technicians in civil engineering

mothers need time off for maternity leave, and have to leave the office on time to collect children, these responsibilities preclude them from making progress up the corporate ladder.

Many have been told that they can never expect to become associates, partners or directors! Given that women have a strong sense of duty, and generally take work home to ensure that they do not let the team down, this type of discrimination is unacceptable, and is very short-sighted.

(iii) Young graduates

The group below 27 years has largely transformed. Black female members of SAICE outnumber white females by 2:1.

Young black women have the double challenge of breaking into the male and predominantly white world of civil engineering.

The larger numbers of graduates are now such that the female has become a threat to the young male graduate and the slightly older group. As a result the well-known male–female competitive dynamics have kicked in and young women complain of a very hostile and challenging environment.

Many other frustrations and aspirations were aired by the group as a whole.

(b) Salaries

Not surprisingly, salaries were high on the list of complaints. Many women felt that they were not as well paid as their male counterparts. Again this is an international problem. In Australia it was found that male total salaries exceeded female salaries by up to 40%. The Australian article reports similar differences in the UK and US. The International Labour Office[13] states:

'… whereas men are more likely to be hired in core or regular and better-paid positions, women are increasingly being hired in … less-value jobs …'

They add:

'… women everywhere typically receive less pay than men … one of the reasons for the wage differential is women's lack of bargaining power …'

They suggest that the worldwide average difference is in the order of 10%. Figure 7.25 shows that apart from the handful of senior women in engineering, men in engineering in South Africa tend to earn significantly more than their female counterparts.

SAICE / IPET salary survey 2004

Figure 7.25 Salaries in all engineering by gender

(c) ECSA registration

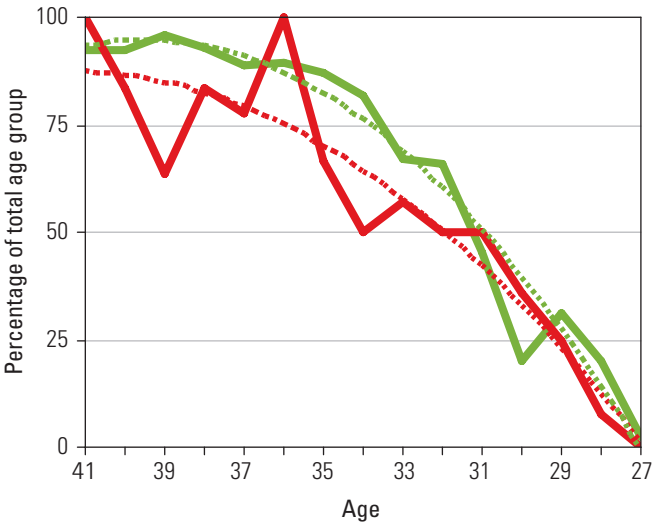
Because they are not being adequately integrated into the environment, younger women do not seem to be registering at the same rate as their male counterparts (see Figure 7.26).

This may partially be the result of family commitments. However, the corporate attitude of keeping female civil professionals in the production team and offering little chance of progressing in the organisation means that young women have not much need to register with ECSA.

(d) Own businesses

Twenty six per cent aspired to starting their own businesses. This desire partly reflects the ambitions of the young generation, but is largely a result of the 'glass ceiling' that prevents young women progressing up the corporate ladder.

Figure 7.26 ECSA Pr Eng registration by age and gender, February 2005



ECSA

(e) The lack of integration

Women have many attributes that are valuable to the business world and can contribute significantly towards the humanitarian and socioeconomic aspects of civil engineering, but a great deal of effort is still needed to encourage and retain women in the industry.

These attributes are not valued when selecting and developing staff, however. All too often well-qualified women are offered employment provided that they agree not to fall pregnant within the first three years of employment. It is also made clear that promotion opportunities are limited if they are planning to start a family at any stage. (This is in direct contravention of Chapter II, clause 6 of the Employment Equity Act, Act 55 of 1998.) Their male counterparts are rarely

Table 7.1 Long-term goals of female civil engineering professionals

Long-term goals	%
After professional registration start my own business	26
Become an expert in my field, become a reputable engineer	17
Contribute to the company and make the best of my life	14
Become a director of the company	11
Do postgraduate studies, research, lecture	9
Improve people's lives and careers, inspire young people	6
Become a competent project manager	6
Obtain my Pr Eng	6
Move away from engineering	5
Remain in my company until retirement	3

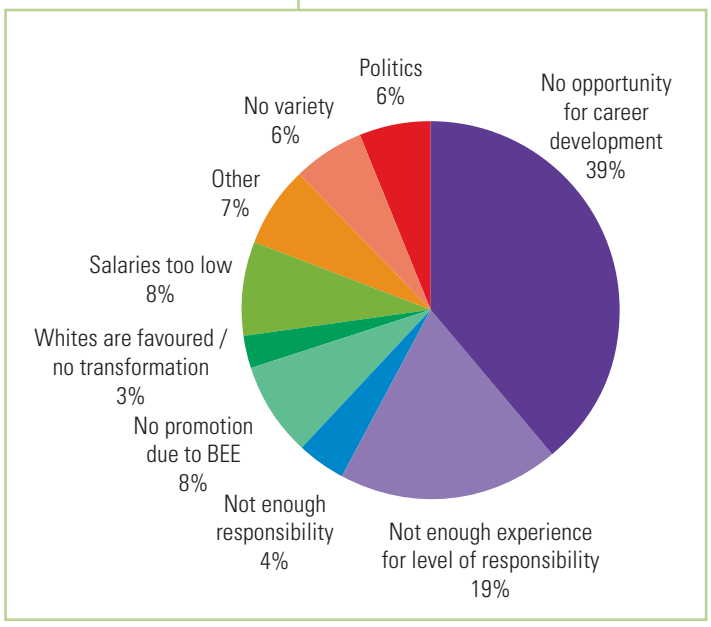
offered employment with the proviso that they remain with the company for a minimum of three years.

Research has shown that women have to work 260% harder than their male counterparts to achieve the same levels of promotion. This is further proof of their willingness to work hard. However, in South Africa there have been only two female 'town engineers', and there are few female senior technical partners or directors in consulting firms or contracting companies.

Guidelines or policies should be developed to allow women to take their place in the industry and awareness campaigns are needed to encourage women to enter the profession. Companies must then employ women appropriately.

Problems of integration and reaching the top are not limited to civil engineering. The Grant Thornton Business Owners Survey of 2003 showed that although only 7,1% of board directorships were held by women in South Africa, the figures for Australia, Canada and the US were only 8,4%, 11,2% and 13,8% respectively. These are very low figures when one takes into account that these countries had been addressing gender mainstreaming for much longer than South Africa.

Figure 7.27 Reasons for unhappiness with current position



7.9 Satisfaction and future plans

The personal surveys carried a number of questions relating to satisfaction or frustration with career choices and current positions, and solicited input on future plans.

It was encouraging to note that although a huge range of complaints were aired, few established professionals were considering leaving the industry. The unhappy ones had a long list of grievances that reinforce many issues acquired from the individual age

group research projects (see Figure 7.27).

Those respondents who were happy with their jobs expressed greatest satisfaction with facing new challenges and seeing results, but listed many frustrations which describe the whole spectrum of experiences in the civil engineering industry today (see Table 7.2).

Some respondents also indicated that they would consider leaving the industry as they had been passed over for promotion (see Figure 7.28).

THE CHALLENGES

Companies – and particularly all levels of state – indicated that they could not find suitably qualified or trained staff. The current resources therefore need to be fully utilised and retained within the industry. A number of factors threaten the survival of the existing group.

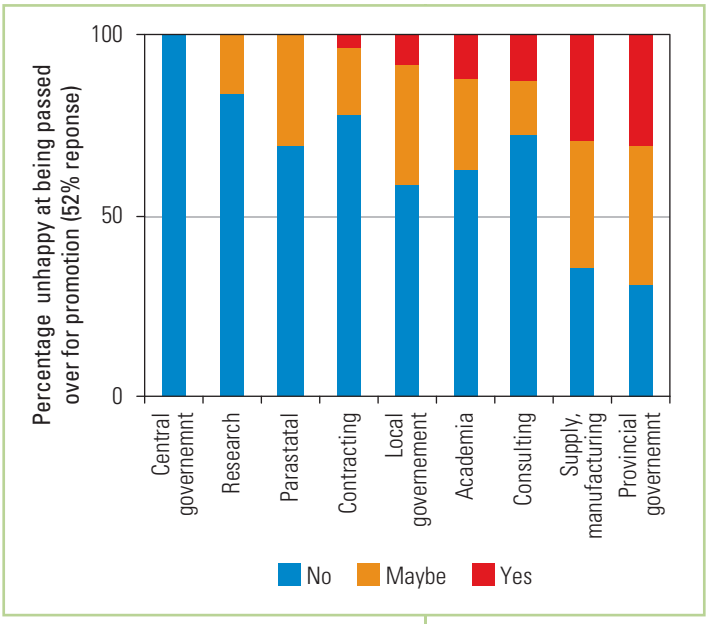
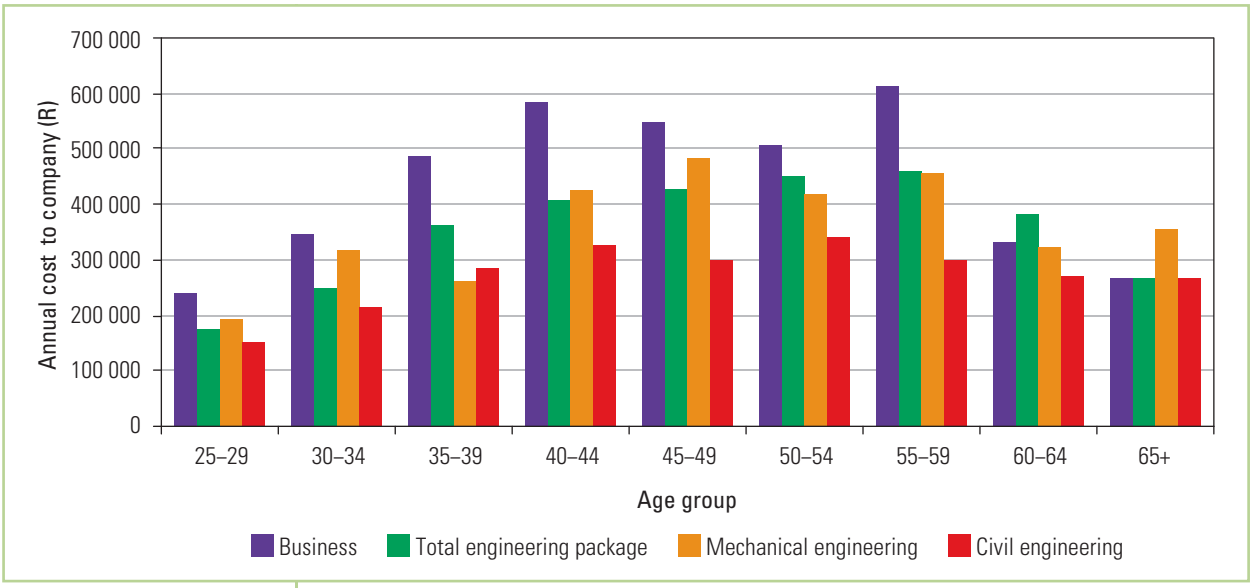


Figure 7.28 Percentage of respondents who may leave industry owing to being passed up for promotion (52% at the workshops responded)

Table 7.2 Repondents' frustrations with their jobs

Frustration	Ages most affected
Politics in public sector	>=35
Unrealistic work load/demands	<30
Low salaries	<35 and >55
Too much paperwork, non-technical duties	>=35
Finding and retaining staff	>=30
No career advancement possible	<42
Ability not recognized	<35 and >60
Transformation and change issues	A few in each age group
Little training offered	<35
Red tape	>=30
Everyone too busy to communicate	<35
Too little work/fluctuating	Most
HR conditions of service issues	<25 and >55
Poor work attitude of juniors	>=35
No future planning	>=25
Repetitive/dull projects	<35
Poor quality of graduates	>=42
Lack of autonomy	<30
No budgeting or funds available	>42
Customer demands	<30



SAICE/IPET Salary Survey 2004

Figure 7.29 Annual cost to company in rand by age group and field

7.10 Salaries

In each of the surveys a major source of unhappiness was salaries.

7.10.1 Salaries by comparison with other professions

A salary survey indicated a major disparity between earnings of fully trained and registered civil professionals and other engineering professionals (see Figure 7.29).

This disparity appears to be most dramatic in the younger groups, another reason that the industry battles to retain its bright young stars.

The 'business' earnings shown in Figure 7.29 refer to the earnings of those respondents who obtained a business qualification after graduating in engineering. Many have moved away from pure engineering into more commercial environments and are earning significantly more than their technocrat colleagues.

A comment from a 28-year-old black male engineering graduate encapsulates the situation:

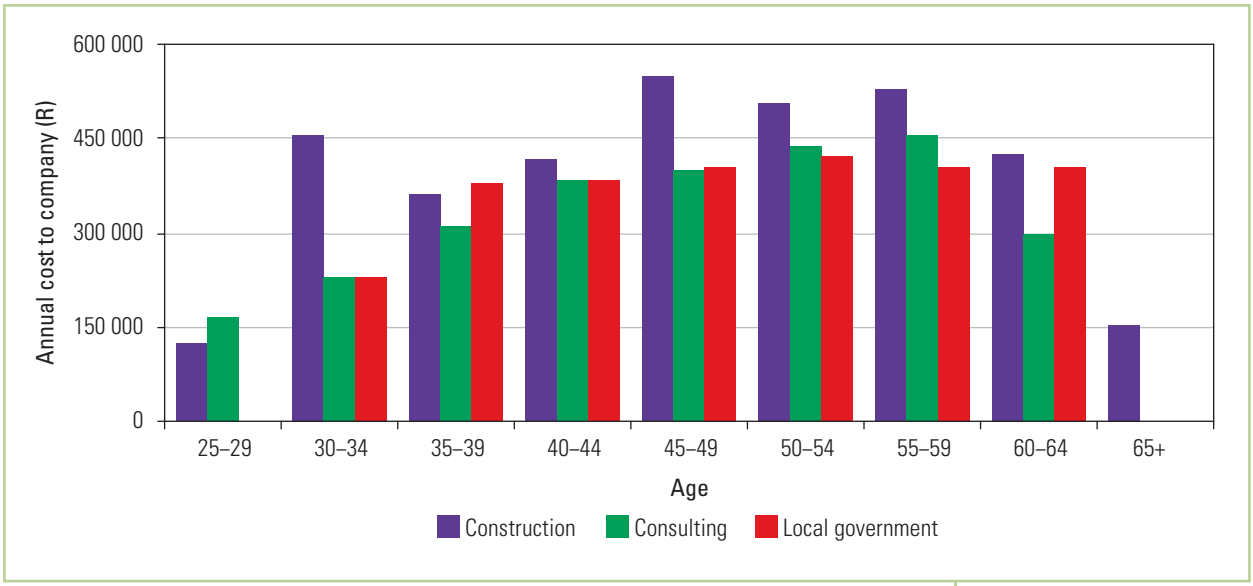
> *'… as an engineer I would still be earning a minimum wage. I'm glad that I went the commerce route followed by an MBA. Technical knowledge is good, but it doesn't reward financially by comparison with accounting …'*

The industry cannot afford to lose graduates, least of all black males with excellent academic results.

Another response from an experienced professional stated:

> *'… remuneration in respect of professional and commercial risk is far too low …'*

This is not a unique to South Africa. A recent survey carried out by HESA[14] (the Higher Education Statistics Agency) in the UK found that more than half engineering graduates defect to other careers. The main reasons were quoted as being money, status and image. Graduates in the UK could command double the starting salary offered to them in engineering by joining the finance and business sectors.



SAICE / IPET salary survey 2004

Figure 7.30 Annual cost to company in rand by age group and sector

7.10.2 Salary differences between various sectors of civil engineering

When one studies the various sectors in civil engineering, more patterns emerge. The most striking is the difference between the average salaries in consulting and local government and in contracting (see Figure 7.30).

There are several possible reasons for salaries in contracting being higher:

- **Overtime payment:** Overtime earnings are common, as few major sites operate within the boundaries of normal office hours. For example, when pumping concrete, the day is only done when the pour is finished.
- **Regional allowances:** Regional allowances are paid to employees working in remote areas.
- **Profit for shareholders:** The major contracting companies are listed companies and have a responsibility to their shareholders to make profits. Jobs are therefore priced to make sufficient profit for shareholder satisfaction. Senior staff are consistently paid higher salaries in order to retain their calibre and ensure profitability is sustained. By contrast, in consulting owners are generally also the senior staff members, who sacrifice margins to ensure an even flow of work, hence driving the salaries down.
- **EPCM (Engineering Procurement Construction Management) contracts:** When the contractor is appointed for an EPCM or EPC (Engineering Procurement Construction) project. The contractor is responsible for appointing consultants and will negotiate fees downwards to reduce the overall project price.

Unfortunately there were insufficient responses from central and provincial government and others to study further variation per sector. However, the personal survey carried out at the workshops gives some indication of salary levels. There appears to be a major problem in many levels of government. In response to possible reasons for leaving the industry, over 30% of those in central and provincial government indicated that they would consider leaving the industry for a better salary (see Figure 7.31).

In Chapters 2 and 3 numerous vacancies were highlighted in provincial structures. These vacancies are hardly surprising when advertisements in the Sunday press call for applications from qualified engineers on salary scales of R60 000 to R76 000 per year. These levels are lower than those of office secretaries.

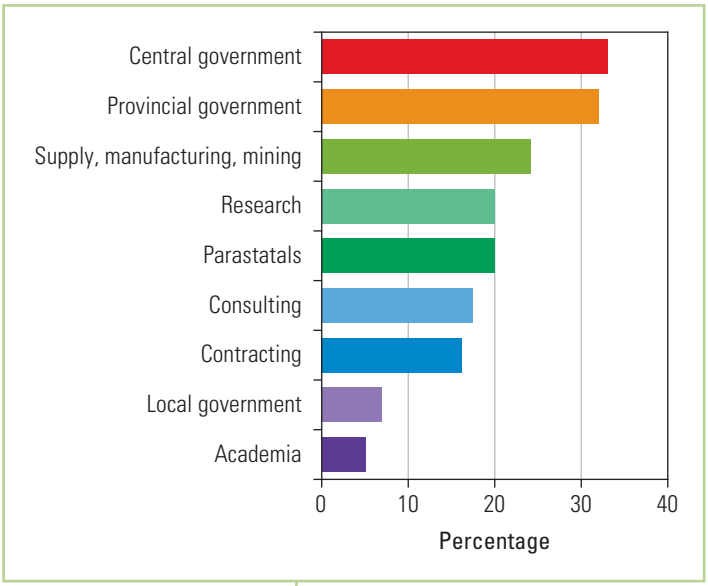


Figure 7.31 Percentage of respondents who may leave industry for better salary (70% attending the workshops responded)

An advertisement for an assistant director of a local municipality stipulated that he or she had to have 'six years' experience, be technically qualified, and act as director civil services when required' for a salary of R133 427 a year.[15] The same advertisement called for applications for a superintendent with four years experience at a salary of R121 071. While this may be low for a 'supe', the disparity between the qualifications and levels of responsibility is such that the salary of the assistant director should be substantially higher. Clearly civil professionals in local government need to be far more highly valued in order to redevelop adequate capacity.

Comparing the results with the SAICE 1994 survey,[16] apart from the self-employed, civil professionals in the JSE listed companies were the highest earners, followed by local government then consulting (18% below local government). Clearly the local government salary advantage has been eroded over the last decade.

7.10.3 Scarce skills and regional allowances

The concepts of 'scarce skills' and 'rural allowances' should be introduced. Advertisements from hospitals state the salary (for example anaesthetist, R453 147, with six years' experience) then add 'excluding Scarce Skills Allowance of 15% and Rural Allowance of 22%'. The salary for the municipal assistant director (above) would at least approach R200 000 if scarce skills and rural or regional allowances were added – an improvement, but still inadequate for that level of responsibility.

7.10.4 Salaries in relation to qualifications and registration

In terms of salaries versus qualifications and registration, professional engineers were the highest earners, followed by technologists, then technicians. Figure 7.32 refers to all engineering disciplines. It can be seen that the average Pr Eng is earning R450 000 to R500 000, experienced technologists command R300 000 to R400 000 and technicians earn between R200 000 and R300 000.

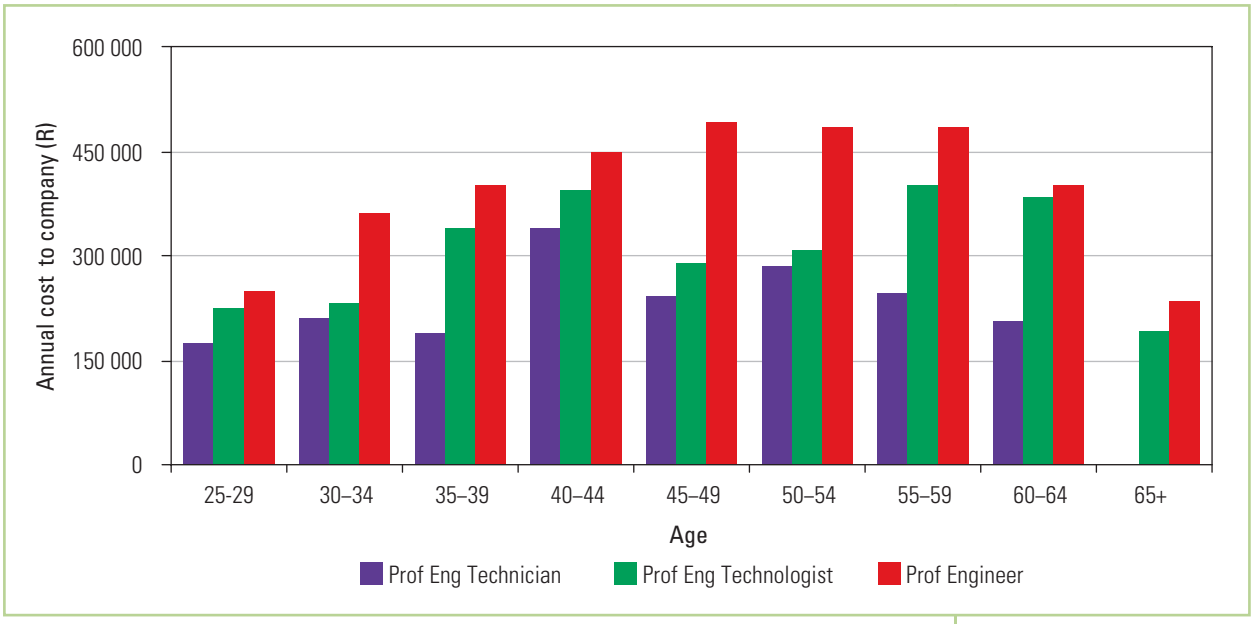
These figures contrast with those in Figure 7.33, where the earnings shown are for civil professionals only. Here, the average engineer is earning R400 000 to R450 000, while experienced technologists command R250 000 to R300 000 and technicians R200 000.

7.10.5 Salaries and the Construction Charter

Unless profit margins on projects improve, the increased skills and corporate social investment (CSI) spend dictated by the Construction Charter could result in salary increases being kept to a minimum to make ends meet. This is of great concern at a time that it is clearly necessary to dramatically increase salaries.

7.10.6 Overtime

The Basic Conditions of Employment Act (BCEA) (Act No 75 of 1997) defines working hours but excludes 'senior managerial employees, employees engaged as sales staff who



SAICE / IPET salary survey 2004

travel and those employees who work less than 24 hours a month'. The BCEA does not apply to anyone earning over R115 572.

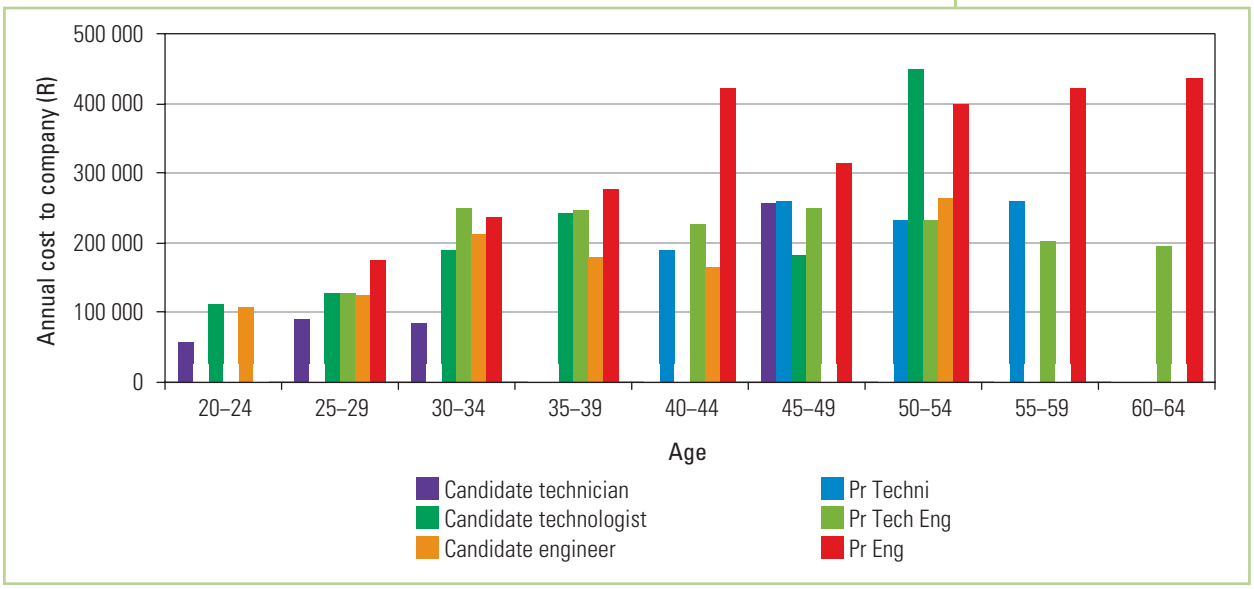
Junior staff at least should be allowed to claim for all the hours they work. If this is done, it will push up salaries and slightly increase fees, and clients will be forced to pay an appropriate amount for services. This will also assist with staff attraction and retention.

Ironically the BCEA also specifies that the employers may not permit an employee to work more than three hours overtime a day, or ten hours overtime a week. In Section 7.5 it was shown that a large percentage of staff work significantly more overtime than ten hours a week.

In defining a weekly rest period the Act states that:

Figure 7.32 Annual cost to company by age for categories of ECSA registration for all engineering

Figure 7.33 Annual cost to company by age for categories of ECSA registration for civil engineering



SAICE/IPET Salary Survey, 2004

'… an employee must have a daily rest period of 12 consecutive hours and a weekly rest period of 26 hours, which unless otherwise agreed must include Sunday … '

The number of people who work on Saturdays and Sundays and put in more than ten additional hours a week clearly indicates that the industry has a skills shortage. Most civil professionals would feel that they were on holiday if they kept strictly to the hours recommended in the BCEA.

7.11 Fees

Another vexing problem concerns consulting fees. Although the fees for a project represent only a fraction of the overall cost, the custom of negotiating fees, instead of the deliverables, has resulted in fees remaining low. Discounting fees puts pressure on salaries and at times compromises the quality of the service.

The delay in rolling out many major infrastructure projects in the last ten years has resulted in large and small consultants and contractors competing for numerous small jobs. Because smaller companies have lower management and overhead structures, price cutting and counter-offers have become common.

The public sector is particularly guilty of ignoring recommended fee levels in a bid to save a percentage or two. This practice has the knock-on effect of depressing salaries and making the industry unattractive to those currently employed and to potential entrants.

According to the Institution of Civil Engineers (ICE) in London, competitive tendering for design plays a key role in perpetuating the skills shortage. Lowest-cost design contributes directly to shortages by preventing companies from providing attractive careers.[17]

Fee cutting by clients has thus reduced the ability of the built environment to offer competitive remuneration. Engineers, however, should not allow it to happen. It is time to be firm on this matter. Victor Lopes,[18] an engineer participating in the 'numbers and needs' debate said:

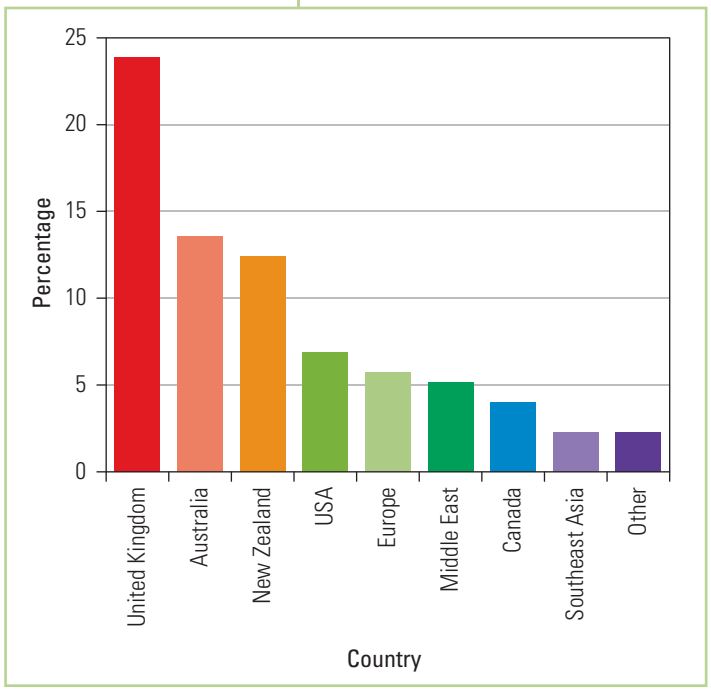
'… have you ever tried to negotiate the price of a filling with your dentist? Or asked for half a filling? Of course not …'

Lawyers, solicitors, doctors and architects (to a large extent) stick to their guideline fees. They recognise that they are professional people. Engineers are often forced to cut their fees to a fraction because of client pressure. Engineers know that if they do not comply, the client will go to someone else who will. He added:

'… it is up to someone like yourself (the SAICE president) to address the above at international level ...'

The practice has also affected the quality of work. Attention to all aspects of design and sustainable development has suffered enormously and prejudiced the principles of good engineering.

Figure 7.34 Destinations as a percentage of all registered civil professionals living overseas



7.12 Emigration/globalisation

The quality of established secondary and tertiary education in South Africa is world class and the volume and range of developments are such that civil professionals are exposed to a wider range of experiences earlier in their careers than in much of the First World.

South Africans are reputed to be extremely hard working and creative people. The *'boer maak 'n plan'* problem-solving approach of experienced South African professionals places them in high demand internationally.

As the growth in GDP in Australia and other countries increases, capacity is inadequate to maintain this growth. Opportunities in countries with growing economies are being aggressively marketed and the packages and benefits are luring South Africans abroad. Some are emigrating permanently, while others are accepting two-, three- and five-year contracts, and expect to return to South Africa at the end of their contracts.

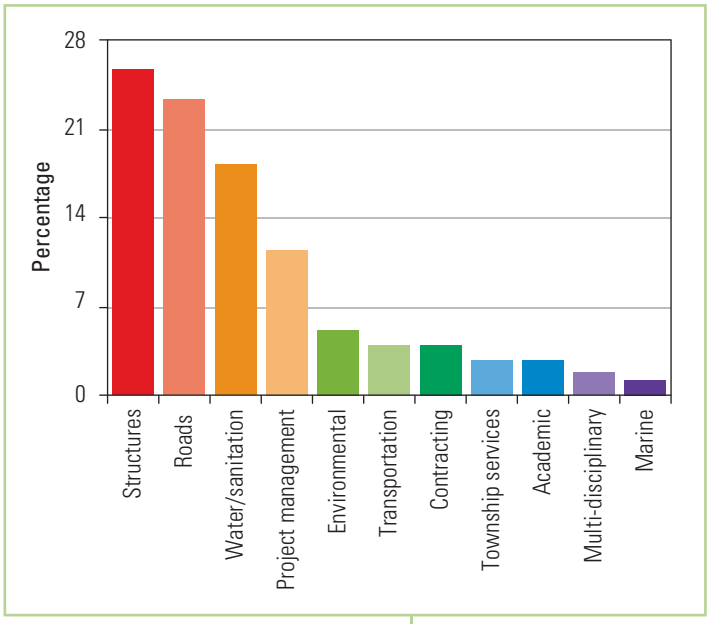


Figure 7.35 Emigrant field of expertise as a percentage of registered civil professionals living overseas

The trend is similar for other professions. The R&D survey[19] listed the top emigration destinations for R&D workers as the UK (27,7%), Australia (16,2%), New Zealand (10,1%) and the USA (9,8%). (See Figure 7.34 and 7.35.)

To comprehend the 'brain drain', South Africans who live abroad were contacted via the ECSA and SAICE databases and websites. More than 600 civil engineering professionals who are living outside South Africa are still registered with ECSA. Some of them left South Africa as far back as the early seventies. Access to those who left 15 or more years ago is limited, as they are no longer registered with any organisations in South Africa. ECSA reports, however, that over the past eight years 1 400 engineers resigned because they were emigrating.

In the late sixties white South Africans who did not agree with the apartheid policies of the time began to emigrate. The initial movement was slow, but accelerated as apartheid appeared to gain a stranglehold over the country and the dissenters felt a sense of despair.

Emigration slowed significantly in the early nineties. However, a new group who were not happy with the new dispensation decided to move when it became clear that democratic elections would take place, hence emigration increased again from 1993.

The introduction of affirmative action policies saw accelerated emigration from 1995 onwards. Many South Africans living abroad indicated that they would love to return home, but they were over 45, white, and male, and there were few

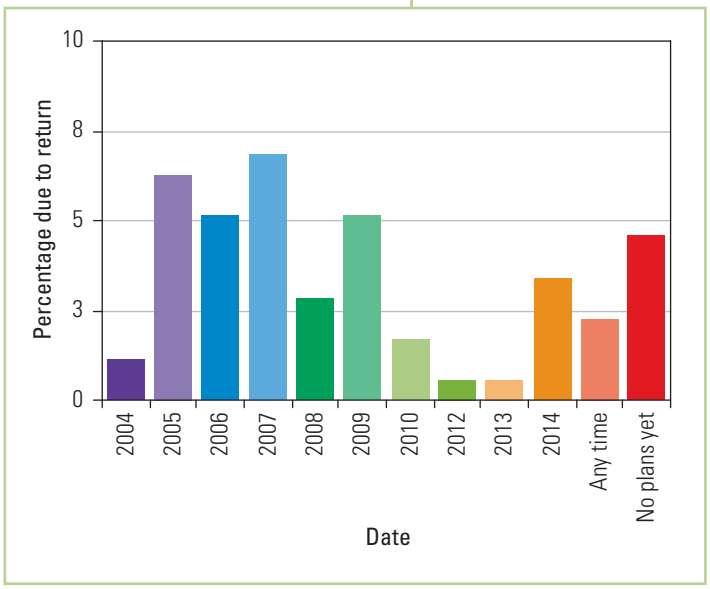


Figure 7.36 Expected return date for those working overseas as a percentage of those who are planning to return

career opportunities for them in South Africa, particularly in the public service where their expertise lay.

Many felt banished or exiled, longed to come home and signed themselves

'Displaced engineers' or *'South African forever!'*

The questionnaire probed many issues, including date of departure, destination, field in which respondent operated and reason for leaving, and asked whether they would consider returning to South Africa. (See Figure 7.36.) The responses revealed six distinct groups discussed below.

7.12.1 Those who did not support the apartheid regime

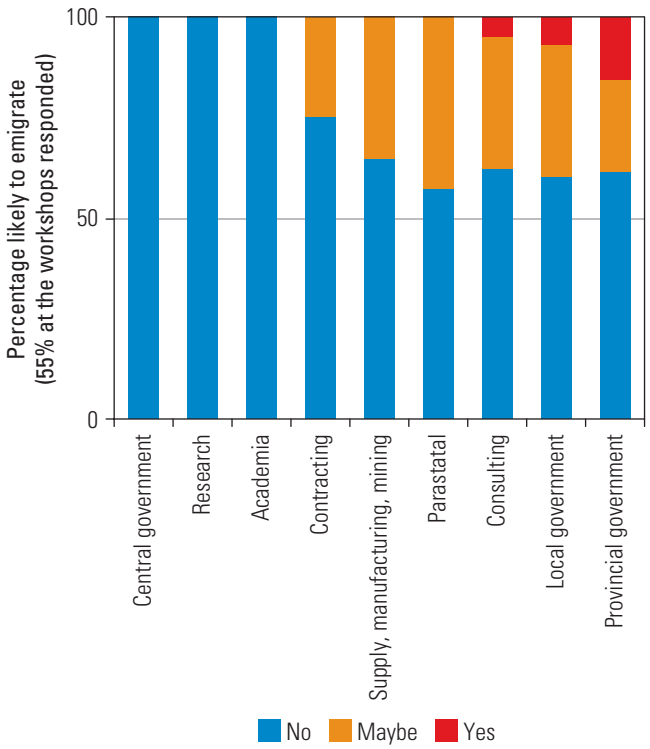
Many who left the country as far back as the sixties belonged to banned movements and were forced into exile. This movement increased in the seventies. Many returned in the nineties.

Emigration in the seventies and eighties was driven largely by abhorrence of apartheid. This group of people made new lives for themselves more than 20 years ago, have integrated into their new society and are nearing retirement. They are unlikely to return to South Africa, except on holiday.

7.12.2 Those who were not happy with the New South Africa

Few complained about the politics of the 'New South Africa'. The main complaints related to issues such as crime, the economy and the declining standard of education.

Figure 7.37 Percentage respondents who may or will emigrate by sector



7.12.3 African professionals

About 20% of respondents who are registered with ECSA but live elsewhere in Africa are graduates who studied in South Africa, gained experience here, then returned to their home country.

Alternatively they studied overseas but, having returned home to an African state, had to register with ECSA, because registration is a measure of competence in their country, or they are involved in South African projects or with South African companies.

7.12.4 Young graduates

Young graduates travel overseas for excitement and experience. Almost all under-35 respondents who were working in the UK or Ireland expect to return home after a few years. This is not a new phenomenon and this returning group are normally snapped up by industry because of their experience and maturity.

Many employment agencies confirm that overseas experience 'does them no harm', is 'invaluable' and is 'seen as a plus' when employing young people.[20] This phenomenon is known as 'brain circulation.'

7.12.5 White male in the prime of his career

A large proportion of the emigrants are white men, particularly from local government and state departments, who feel threatened by, or have been retrenched because of, restructuring and creating opportunities for affirmative action, or who were frustrated with the bureaucracy and changes which have taken place.

Ages in this group range from 35 to the early fifties and emigration has increased over the past ten years, with many still considering going overseas. Those who emigrated from the private sector cited a number of reasons for leaving the country (see Figure 7.37). Forty per cent said that they would return if the particular reasons for their departure were addressed.

This is the group that one hears most about. They moved to Australia, New Zealand and, to a lesser extent, Canada and the USA. They represent about 35% of registered professionals living outside South Africa. Many respondents who left on contract indicated that they would remain overseas if conditions in South Africa precluded them from suitable employment locally.

7.12.6 Soon to retire

Many senior South Africans have accepted posts overseas for the final five to ten years of their careers, but plan to return home to retire in properties they developed during their careers in South Africa. Most of this group are to be found in the UK, African states and the Middle East. They would not contribute to capacity on their return.

(Interestingly, the e-mail survey and drew an 82% response. E-mails were also passed on to many who were no longer recorded in databases in South Africa but wished to contribute.)

7.12.7 The nett effect

To summarise, the total number of civil engineering professionals that left the country in the past 20 years appears to be of the order of 3 000 to 4 000. This group possibly consists of 2 000 to 2 500 engineers, 500 to 800 technologists, and only 500 to 700 technicians, as their qualifications are not so exportable as those of engineers and technologists.

The outflow is still taking place. South African engineers are now being actively sought to augment the British teams that are preparing for the 2012 Olympic Games in London.

Given the challenges ahead and the shortages, future losses should be discouraged. While it is necessary to integrate into the global production process, the ILO calls on economies to:

> *'… continuously increase their skills and knowledge base …'* [21]

South African needs to develop and retain all its graduates.

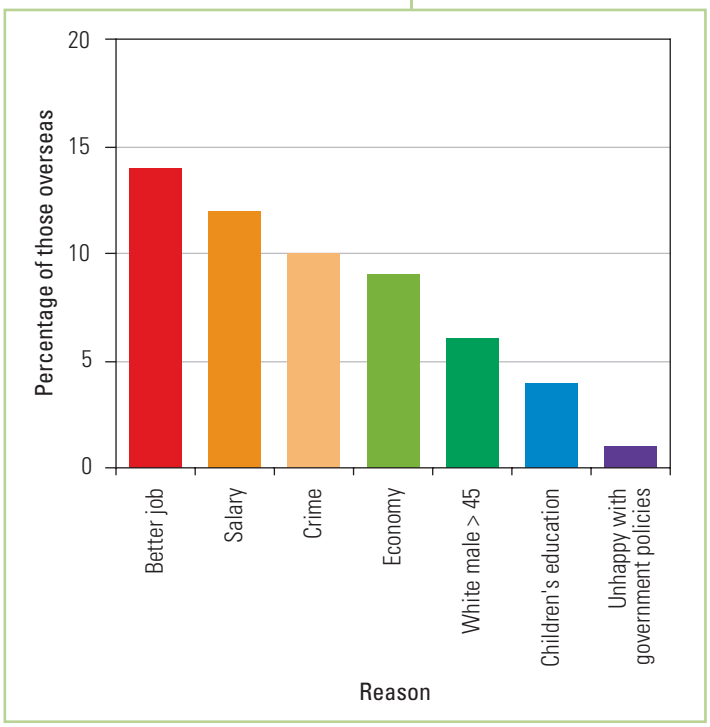
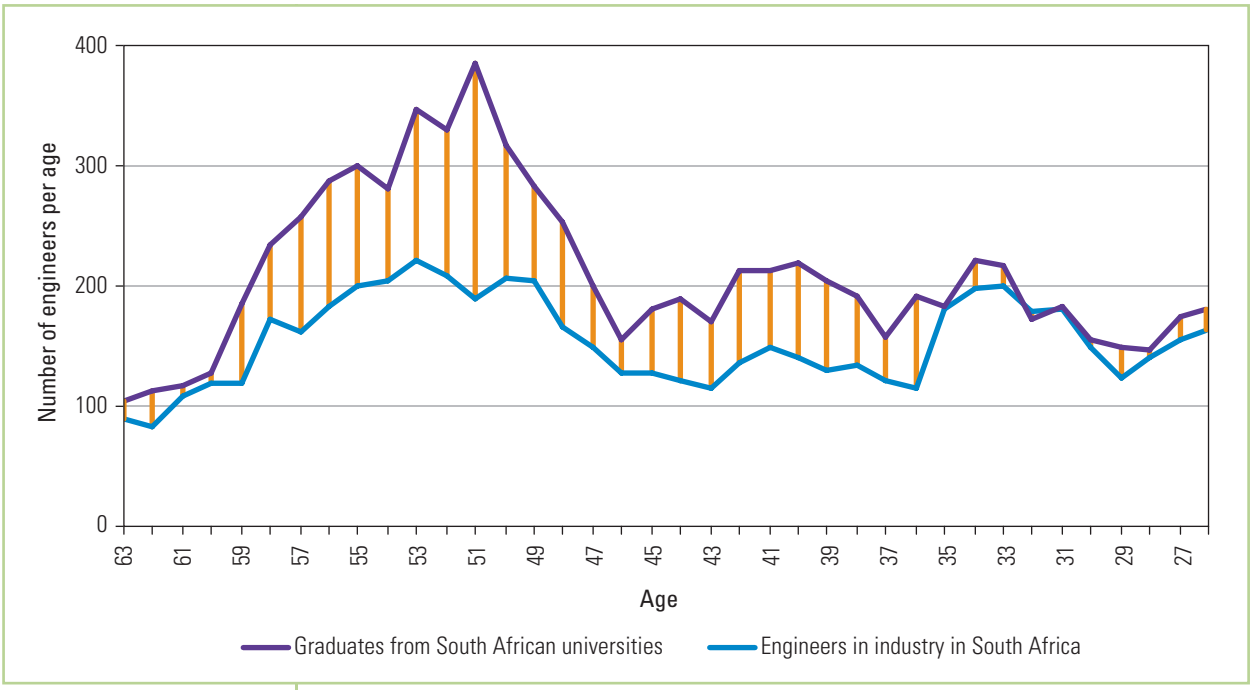


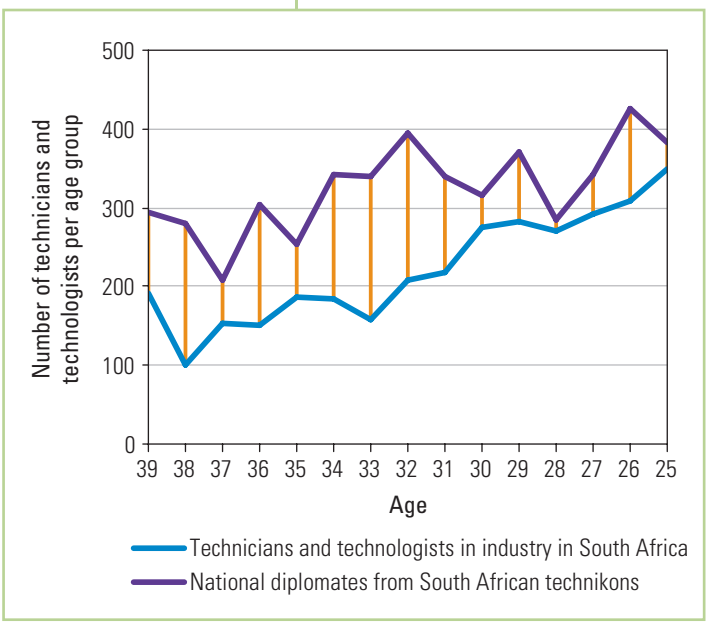
Figure 7.38 Reasons for emigration



Source: DOE, Research results, Universities

Figure 7.39 Civil engineers – graduates and in industry

Figure 7.40 Technicians and technologists – graduates and in industry



7.13 Leaving the industry

Without contacting all economic sectors and asking for information relating to civil engineers on their staff, it was not possible to measure this aspect accurately. From contacting those members of ECSA who did not belong to SAICE, it was found that 10% had left the industry but retained their registration in case they wished to return to the field.

According to responses the most popular fields were financial, insurance and property development. Few said they would return to civil engineering, as they were significantly better off financially and worked fewer hours (see Figure 7.44).

7.13.1 Total losses

The most depressing graphs are Figures 7.39 and 7.40, which show that from age 35 upwards for engineers and 30 for technicians and technologists a significant portion of those who trained at South African institutions no longer work in South African civil engineering sectors.

The nett loss equates to at least 2 100 engineers. However, South Africa gained some 400 to 500 engineers from Africa, 400 to 500 from further afield, 100 to 200 South African engineers studied overseas, and 200 to 300 foreign students who have studied in South Africa have returned home. This means that the loss of South African educated and trained engineers is probably more than 3 000, that is, 37% in the employable age bracket.

Considering the estimates of emigration (above), in the order of 2 000 to 2 500 live overseas and the remainder work in other fields in South Africa. The correlation between graduation and industry in the 28 and 33 age group in Figure 7.39 does not mean that South African graduates are still in the industry, but that this is the age group of immigrant engineers from elsewhere in Africa.

Losses of technicians and technologists across all age groups also equate to 2 500 to 3 000. This represents 500 to 800 technologists and 500 to 700 technicians overseas plus 1 500 or so who moved into other fields. Reasons for moving were lack of work during the decline years and low salaries. Civil technicians are to be found in every walk of life from selling furniture to politics – South Africa's Minister of Finance holds a National Diploma in Civil Engineering.

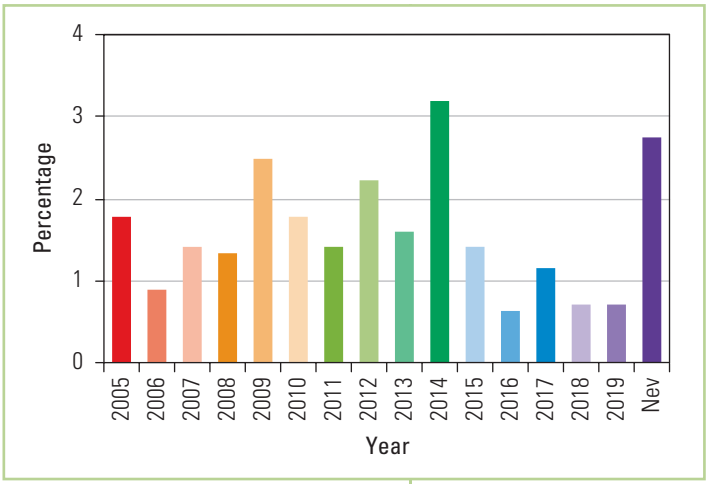


Figure 7.41 Percentage of total due to retire per year

South Africa has invested an enormous amount of money in educating and training these staff. The loss of engineers, technicians and technologists means that the total wastage on education and training of civil engineering professionals is about R1 billion in today's terms. In addition, since job creation in the sector requires civil engineering management, these losses have reduced the potential for at least 100 000 jobs.

The importance of turning the tide cannot be overemphasised.

7.14 Retirement

There is growing concern about the large group of senior professionals who are approaching retirement date.

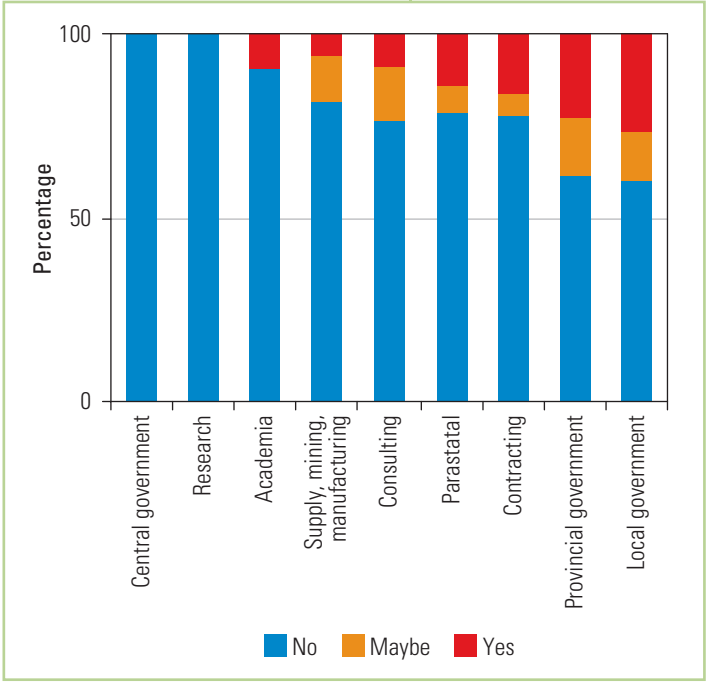
From the current profile, it appears that 47% of all practising engineers are 45 years and older. Allowing for premature deaths, early retirement and some leaving the industry or emigrating, the 45+ group should account for only about 25% to 35% of the workforce.

In the USA the proportion of all workers aged 45 and older will increase from 33% of the labour force in 1998 to 40% in 2008.[22] South African engineers are already way beyond the percentage that is causing grave concern in the USA!

The peaks in this group in 2004 were aged 52 to 54 and 57. As such, anticipated retirements will be high from mid-2009 onwards when the latter group reaches 63, that is, the first of the baby boomers – born in 1946. This is a worldwide phenomenon and is cause for concern in all professions internationally. (See Figure 7.41.)

The next large wave of retirements can be expected from 2012 onwards. The peaks in 2012

Figure 7.42 Percentage respondents likely to retire in next five years by sector



and 2014 relate to the effect that the change in duration of military service had on tertiary intakes in the early seventies.

These retirements will further deplete capacity and present a major problem. Of particular concern (see Figure 7.42) are the large percentage in local government who were considering early retirement (see Section 7.15).

A frustrated Mr Branscombe asked:

> *'… Why is a civil engineer considered too old at 65 when a politician can become president of a country at 75!'*[23]

A significant group said they could not afford to retire because of low retirement benefits, or could not see themselves stopping work from an intellectual and achievement point of view.

Given the desperate need to train young people, this large group needs to be retained for a period with a new mandate – as 'knowledge coaches'.

7.15 Early retirement

In the mid-nineties, long-serving staff at all levels of government were offered attractive packages to take early retirement. The theory was that this would create positions for black professionals. However, the overall profile of the civil engineering professional team was not understood at the time and there were insufficient numbers of senior black professionals to fill these posts. The effects of this are covered in Chapters 3 and 9. (Figure 7.42 shows that retirements in central government are not imminent, since most senior staff took packages six to eight years ago.)

Another alarming phenomenon is now taking place. Terms of appointment are being updated in much of the public sector. Changes in retirement and medical aid benefits will affect many people adversely. In local government staff have again been given the option of taking early retirement to retain all their accrued benefits. New conditions of employment could significantly reduce the overall pension benefits for those who are close to retirement. They are therefore planning to leave now. Much younger professionals are looking at employment in other sectors, as the relative attractiveness of working in local government has been reduced. Figure 7.41 shows that a significant portion from local and provincial government are considering retirement.

7.16 HIV/Aids

There were few reports of HIV/Aids being a problem among professionals. One death was mentioned in consulting and a few were reported in local government. The groups that were most affected were semi-skilled and unskilled labour in both contracting and local government. The LGSETA reported that death accounted for 25% of all lost to local government.

7.17 Equity targets

The affirmative action policy (above) has not only resulted in loss of capacity in those posts where early retirement packages were offered, but most government departments have been over-zealous in pursuing their equity profiles and have set appointment criteria so that only black applicants may fill vacant posts, without considering the availability of suitable staff. As a result many posts remain vacant, while suitable white candidates have emigrated because there is no opportunity for employment in their field of expertise. In addition, unqualified staff have been appointed in numerous instances.

Since the late nineties employment agencies have not retained CVs from white men over the age of 45 – but these are experienced people in the prime of their careers who still have a lot to offer the infrastructure development process. Those senior white professionals who still hold posts are termed 'hostages' because there are no other posts to which they are eligible to move, so they will remain in their current positions until retirement. In many instances their levels of frustration have become hindrances to their departments. Employment Equity Act 55 of 1998, clause 14(4) stated that:

> *'… nothing in this section requires a designated employer to take any decision concerning an employment policy in practice that would establish an absolute barrier to the prospective or continued employment or advancement of people who are not from designated groups …'*

Career path development for all in the industry is important to gain most from every civil engineering professional.

7.18 Institutional support

There are several statutory bodies each with different mandates which in one way or another support, control skills development and provide professionals with the tools of the trade. Some of these include:

- **ECSA** – the Engineering Council of South Africa which registers professional engineers, technologists and technicians and defines the way graduates should be trained to attain registration
- **CBE** – the Council for the Built Environment which is the overarching body for most of the professional councils and seeks to ensure that standards are upheld in the interests of health and public safety
- **The SETAs** – Sectoral Education and Training Authorities who are mandated to develop skills
- **CIDB** – the Construction Industry Development Board which seeks to develop a healthy construction industry. The board addresses the development of companies, staff, procurement processes, access to finance and many other issues
- **NHBRC** – the National Home Builders Registration Council registers homebuilders and also has an interest in developing capacity within companies they register
- **SANS** – the South African National Standards which develops and sets standards to keep apace with technology and international best practice

South Africa lagged behind the world during the isolation years. Much effort has been expended to put modern governance structures in place and develop best practice guidelines and approaches. Unfortunately mandates overlap to some extent in some of the above structures which results in duplicated effort, often not aligned, or important issues not being attended to at all.

The SETAs are an important vehicle for addressing the skills gaps identified and must be harnessed for the development of civil engineering professionals.

7.18.1 SETA support of skills development

The first survey carried out in March 2004 to gather data for the Sector Skills Plan (SSP) probed industry's knowledge and usage of the SETA (Sector Education and Authority) system. It was shocking to find that less than 5% of the respondents who responded individually –

including many company owners – had any notion of the SETA that their company belonged to. Only 15% of small consulting practices submitted workplace skills plans (WSPs).

Those who submitted WSPs and used the SETA system were large consulting and contracting companies who contribute to bursaries schemes and carry out a great deal of training. They actively participated and made claims to their SETAs. The balance did not participate in the system at all. But this does not mean that training does not take place in civil engineering.

(a) Short courses

Many short courses are being attended regularly, but claims for repayment of the skills levy are not being submitted for several reasons:

- Few small companies have the knowledge or capacity to fill in the forms.
- Few short courses are accredited.
- The content of courses often relates to new or updated technology or legislation that affects the industry. As technology develops or legislation is updated or issued rapidly, the process of documenting, having accredited and finding suitable training providers to deliver the courses is such a lengthy process that courses would be out of date before being delivered, if the whole process were to be followed.
- Although many generic topics are now listed on the CETA WSP training lists, companies do not realise that they can send staff on courses that are not accredited.
- In many other SETAs there is no funding for non-accredited courses. This is a problem for all engineering and built environment professionals who wish to keep up to date through CPD (continuing professional development).
- The claiming process is tedious.

Access to funding for CPD needs further consideration by most SETAs.

(b) Experiential and workplace training

Industry is deficient in its efforts to offer experiential and workplace training because of the high cost of training inexperienced staff. It is imperative that candidate learnerships, coupled with mentorship and coaching, should be developed and supported by the SETAs to ensure that this problem is addressed.

(c) Bursaries

The poor literacy level in South Africa has resulted in many SETAs not achieving their skills development targets as they have to attend to basic adult education before skills development can take place. As a result, a lot of effort has been expended on the lower National Qualifications Framework (NQF) levels, which should have been addressed by the school system.

Few SETAs have placed much emphasis on the development of professionals from NQF 6 and upwards. To their credit, the construction SETA (CETA) has invested heavily in bursaries for built environment professionals. As a result, increasing numbers are entering tertiary institutions in all disciplines. All companies belonging to CETA should investigate the rand for rand bursary scheme whereby CETA matches company investment in tertiary education to encourage companies to take on more students. (See www.ceta.org.za.)

7.19 The nett result

The nett result of all the above processes is that the number of professionals is reducing. This impacts on all levels, as can be seen from the set of diagrams below. The model

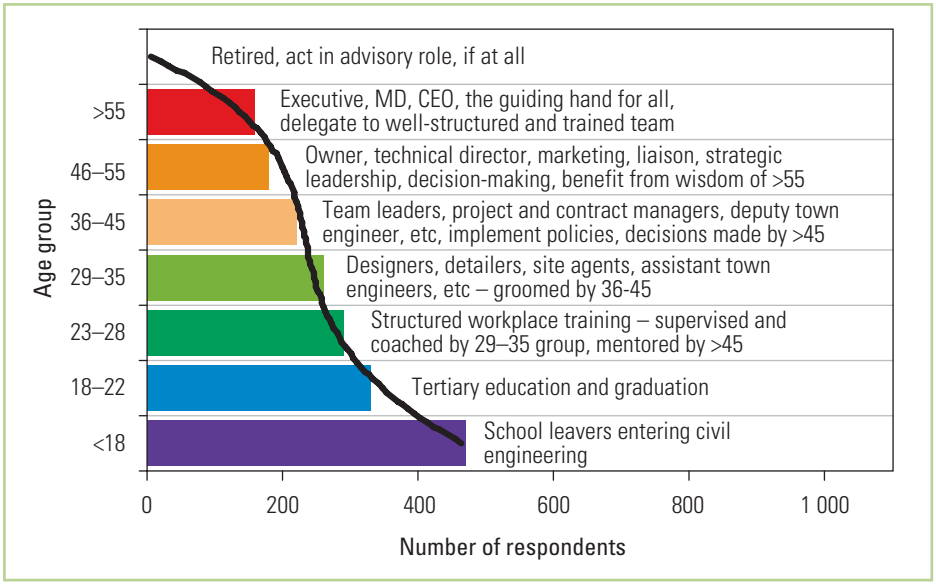


Figure 7.43 Ideal model for skills development and knowledge transfer

considers the training and utilisation of university graduates, but also applies to technologists and technicians, though in a different quantum.

Figure 7.43 represents the normal profile, where a large base of productive people with a significant number of experienced staff at all levels are available to supervise, control quality and grow the capacity of the base.

The parameters listed in this chapter have totally disrupted this profile.

Studying demographic profiles is a powerful means of interpreting social, economic and manpower needs. Each type of profile indicates the weakness or strengths of a nation and informs change. The profile below is typical of the Western world, where birth rates

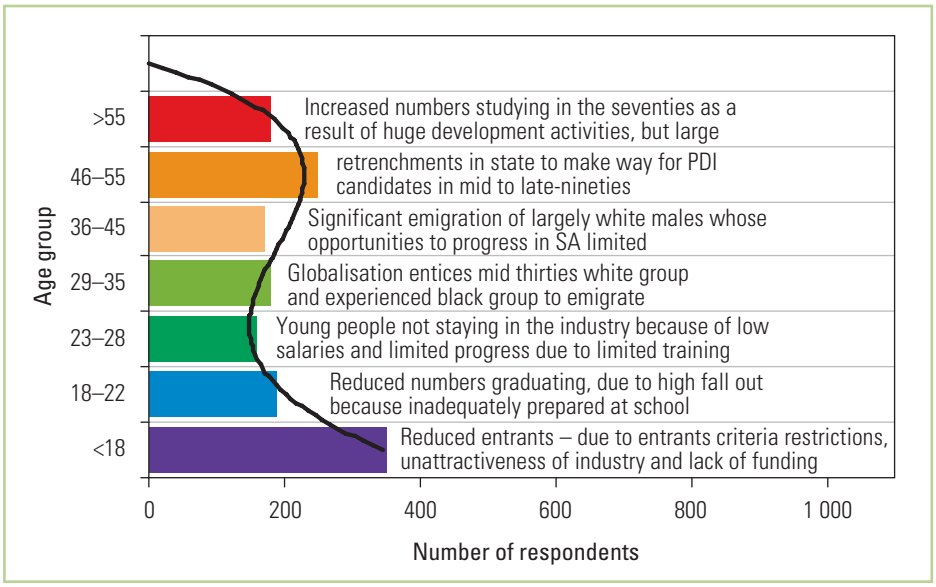


Figure 7.44 Problems relating to skills development and knowledge transfer

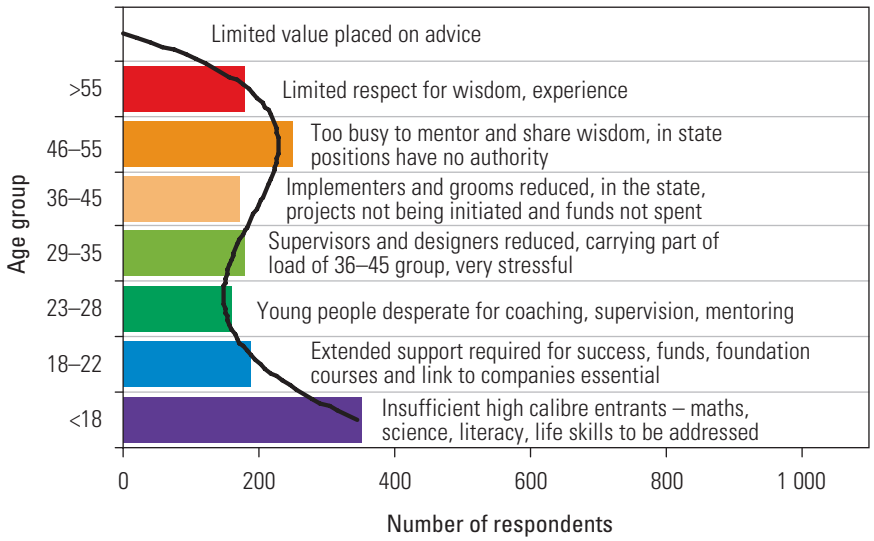


Figure 7.45 The impact on skills capacity, development and knowledge transfer

have been drastically reduced. These countries have a problem with developing sufficient professionals to maintain their infrastructure, and many have turned to South Africa as a new source of professionals, impacting on our capacity and ability to deliver.

South Africa did not have this problem in the past but with mass exodus of the middle group, finds itself in a similar position.

The above profile is problematic in terms of the continuing development of civil engineering capacity, for a number of reasons (see Figure 7.45).

The list of problems seems overwhelming. Those who are unhappy tend to blame the 'New South Africa'. However, many of the problems are found worldwide. In the final report on the causes of the Challenger accident[24] a paragraph read as follows:

> *'… the multiplicity of changes and uncertainty – transition to a single contractor, downsizing, reinventing NASA, increased workload, loss of significant personnel capabilities and low-morale have bred an environment which is ripe for human error. Distraction is commonplace and workers have begun to turn their career thoughts outside of the Shuttle/Space Station programs. The environment suggests that inadvertent errors are likely to increase and these errors will eventually have safety implications …'*

It all sounds so familiar – the challenge is to reverse the South African situation.

CONCLUSIONS

Civil engineering professionals are key to the development and growth of South Africa, yet they have become an exploited group who command little respect or recognition for their skills, dedication, the risks they take and the role they play. They are rarely invited to participate in strategic teams involved in major planning exercises, yet other sectors and countries actively poach them as they are known to add value. Consequently the numbers have been reducing for many years.

Young people are not progressing to become well-trained registered professionals as fast as they did in the seventies and eighties as a result of the absence of formal training.

The effect of competitive bidding and cost cutting, by client bodies has forced down fees for professional services, which in turn has kept salaries down. Further, reduced income means reduced expenditure in all aspects of business. This has impacted on training and investment in staff, which has then impacted on the ability to retain staff. Capacity is further threatened as the waves of retirements begin in 2009 and the public sector continues to offer early retirement packages to experienced senior staff.

Transformation requires specific attention as few management structures have experience in handling the diverse workforce entering the industry today.

To rebuild a healthy industry requires more capacity; improved training; better salaries and investment in personnel; and better client, consulting, contracting and interpersonal relationships.

Building blocks

To ensure a productive workforce the following are essential:

- Value all staff
- Competitive salaries
- Adequate workforce and acceptable workload
- Continuing career path development for all races and gender
- Projects to sustain employment of the human capital so developed

RECOMMENDATIONS

Reconstruction required

To retain the staff currently in the system and entice people back, the following must be attended to, to ensure that no further skills are lost:

- **Review conditions of appointment**
  Client bodies need to:
  - Consider value per rand, rather than the lowest price, when making appointments, and pay for quality work
  - Temporarily relax employment equity criteria for scarce skills
- **Review conditions of employment**
  Employers need to:
  - Review and improve remuneration
  - Restructure civil engineering positions in the public sector to take advantage of the skills set available
  - Create an enabling environment for the development of all staff
  - Create a more inviting environment for young graduates and females
  - Identify those with high potential and accelerate their development
  - Attract and train more staff from student to senior level in order to ultimately reduce the workload per person to acceptable levels
  - Recognise the personal needs and responsibilities of employees
  - Temporarily relax employment equity criteria for scarce skills
- **Retain senior professionals and re-appoint retired professionals**
  Senior professionals should be retained and retired professionals appointed with the specific mandate to:

- Supervise and train young graduates
- Initiate and manage projects

- **CPD**

  Actively allow and facilitate continuing professional development
- **Create centres of excellence**

  A rationalisation of fields of expertise is needed in tertiary institutions to ensure that quality education is available in each discipline of civil engineering. Further, business, management and project management courses specific to civil engineering need to be promoted.

Suggested Construction Charter activities

The Construction Charter scorecard covers broad based black economic empowerment (BBBEE) in a holistic way. By attending to each of the points above, employers would have addressed:

- Employment equity by developing black professionals
- Skills development by providing training

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PART IV
DRIVERS AND INHIBITORS

Contents

CHAPTER 8

The private sector

INTRODUCTION

Investment and development in the private sector saw a decline from the mid-eighties. The prospects are now looking promising, but require the sustainability of several favourable factors.

THE STATUS QUO

The private sector in the construction industry is made up of many players (see Chapter 2), including residential, non-residential, civil and steelwork/manufacturing contractors, consultants and suppliers.

Fifty seven per cent of the development in the construction industry can be attributed to expenditure by the private sector. A growth in GDP is key to its wellbeing.

Table 8.1 shows the importance of private sector development, with the public sector contributing only 43% to construction spending.

THE CHALLENGES

8.1 The drivers

For consistent development, and hence for spending to take place, a number of factors must be in place. These include:

- Growth
- Availability of finance
- Policy conducive to sound development
- Favourable interest, exchange rates and low inflation
- Institutional capacity

The South African economy has gone from strength to strength in the opening years of the twenty-first century, and is enjoying a period of low interest rates, low inflation, higher disposable income and a stronger currency. At present most of these factors are drivers, but some may become inhibitors.

Table 8.1 Spending in the construction sector[1]

Type of asset	Value (2003) R bn	Central government	Public corporations	Private sector
Residential	R 16,7	11,7%	0,0%	88,0%
Non-residential	R 16,2	25,0%	8,1%	69,0%
Construction works	R 24,5	45,0%	26,5%	28,6%
Total	**R 57,4**	**29,4%**	**13,6%**	**57,0%**

'… We recognise` that the pace of economic growth has to be accelerated …'

– Trevor Manuel

Trevor Manuel
(Minister of Finance)

8.1.1 Growth

South Africa's growth rate continues to improve and the various confidence indices have not been at this level for many years. An upbeat Treasury Director Lesetja Kganyago stated at the beginning of 2005,[2]

'… to make an impact on unemployment you need growth to be around 5 per cent or higher … if things continue … we should be able to realise a growth rate of 5 per cent or more …'

8.1.2 Availability of finance

That finance is available can be seen by the plans for, and the delivery of, many major projects. This is true of both the private sector and the public sector. However, government spending and delivery have not taken place at the expected rate owing to severe capacity restraints (discussed in Chapter 9). The private sector is experiencing unprecedented development and future plans are as follows:

(a) Mining and petrochemical

Investments in excess of R140 billion are planned over the next five to seven years. These include:

- Expansions in the platinum sector, provided the exchange rates are favourable
- De Beers C Cut, Voorspoed and other expansion projects
- Sasol expansion projects
- Mittal Steel SA's expansion into Africa
- Development of several new coal mines
- The Richards Bay Coal Terminal Expansion
- Mineral sands projects
- Offshore oil and gas projects

(b) Industrial and manufacturing

Increased development requires increased material, equipment and vehicle supplies. Many suppliers and manufacturers have announced intentions to expand their plants. These include:

- Glass manufacturers
- Cement manufacturers
- Formwork manufacturers
- Motor manufacturers and outlets
- Various plants centred on Coega
- SABMiller
- Aluminium smelter developments

(c) Retail

Retail developments associated with the 2010 Soccer World Cup are planned. Property developers are also talking of spending R20 billion and more on business, retail and residential developments around the nodes associated with the Gautrain project. In addition, the Soccer World Cup and Gautrain will require the development of economic infrastructure, such as adequate access.

Because of improved economic conditions in South Africa and BEE policies, a significant portion of the population enjoy greater disposable income. Increased purchasing power has seen unprecedented sales of fast-moving consumer goods (FMCG) in the scramble to 'buy

lifestyle'. This is driving the development of shopping centres, allied industrial and office park developments and warehousing to feed the demand, says the Old Mutual Property Profile. The South African retail sector is experiencing huge growth, resulting in a massive surge in demand for attractive property.[3]

(d) Recreation

Sports stadia and hotel upgrades associated with the 2010 Soccer World Cup are planned. Communication networks will be upgraded, requiring a great deal of structural development.

As South Africa's tourism industry continues to grow, more and more luxury hotels, tourist attractions (such as the Cradle of Humankind), game parks and entertainment centres are being planned and developed.

South Africans are increasingly investing in time-share and week-end accommodation in large secure holiday 'villages', which will further contribute to private sector development. The development of golfing estates is also fuelling the activity.

(e) Residential

The current focus on the redevelopment of CBDs is leading to the expansion of luxury residential accommodation. In some instances new developments are taking place, such as the Waterfront in Cape Town. In others, older office accommodation is being converted into luxury accommodation – as in Rosebank and downtown Johannesburg and Durban.

The urban-renewal tax incentive scheme based on the Revenue Laws Amendment Act of 2003 will eventually stimulate development within the central business districts (CBDs) of 16 large South African cities.

South Africa's weather, stability and competitive property pricing encourage foreign investors to develop luxury holiday and retirement homes.

Security concerns and the pace of business, which allows little time for traditional home care and maintenance, have given rise to the development of many secure luxury residential villages nationwide, in which all aspects of maintenance, services and security are taken care of by a body corporate or managing agents.

Acceleration in basic housing delivery commenced with the advent of the RDP. On the low cost end, housing development to meet the MDG is being stepped up. However, there is now a demand for more sophisticated housing. Better housing subsidies, effective from 1 April 2005, will see increased development in medium-cost housing stock, as households are encouraged to supplement their housing subsidies and build houses that are significantly larger than RDP homes.

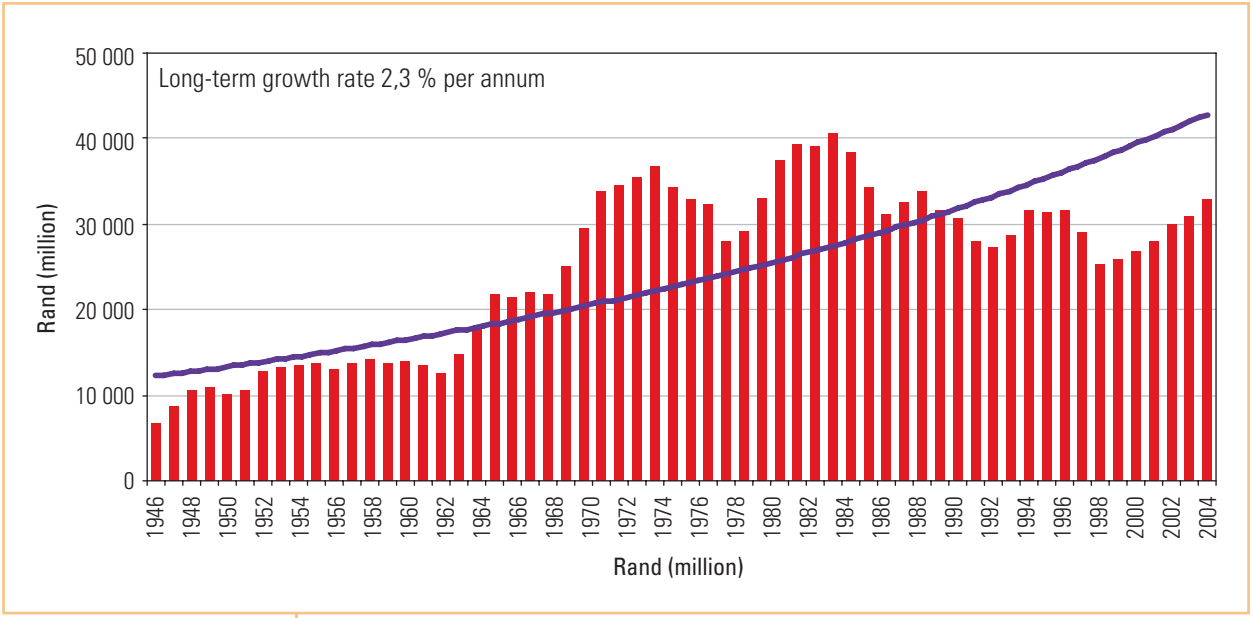
As such, prospects for residential and non-residential developments look promising and will continue to grow by at least the long-term percentage shown in Figure 8.1, if not faster. Independent equity advisor Mark Ingham estimates a 3% growth in residential development in the next few years.

(f) Health and education

Significant development activities are also taking place in private healthcare and education.

(g) The export market

During the depressed period South African companies sought opportunities beyond its borders and established themselves in Africa, the Middle East and Southeast Asia where major



SARB, MFA database

Figure 8.1 Total investment in buildings (rand million at constant 2000 prices)

development or aide funds were available. Companies report that as much as 50 per cent of their turnover is being earned outside South Africa. 'The State of the Civil Industry'[4] report for the second quarter of 2005 showed that just over 20% of the turnover for civil engineering contractors across the board was earned outside the country. The development of roads and bridges in the SADC region is the most significant type of export work being carried out.

8.1.3 Policy

An entire suite of new policies has been developed to address many areas that were previously overlooked or inadequately covered.

Corporate governance issues are still of concern in terms of attracting foreign investment, particularly capital for privatisation. The composition of boards and accountability are key, and again a great deal of work has been done on policies. David Hutton Wilson commented,

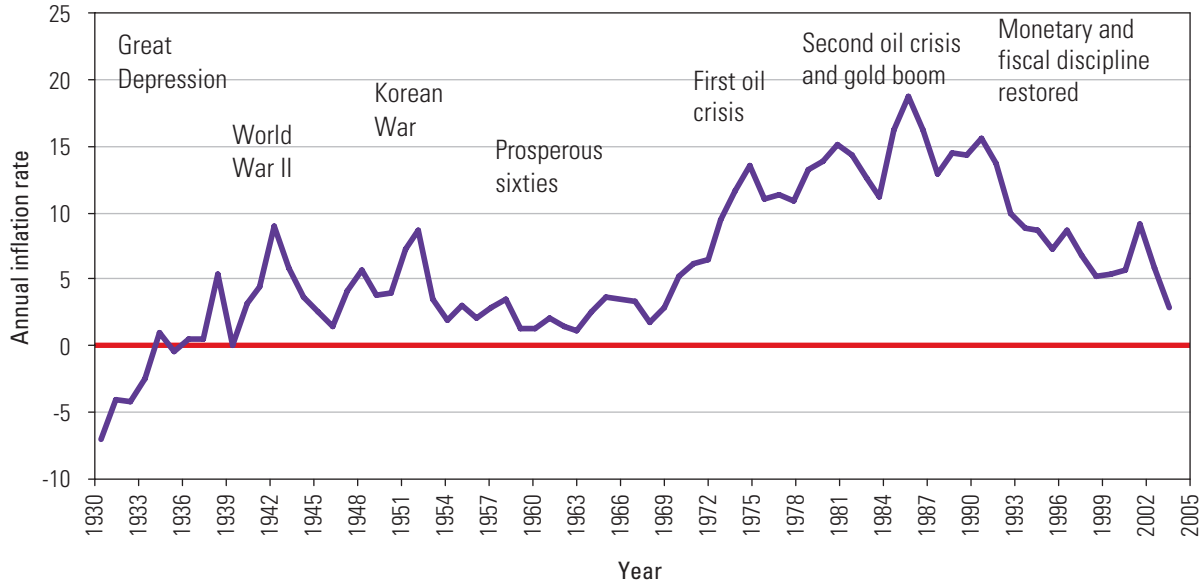
> *'… For South Africa to alleviate its key problems of housing, health, education and unemployment, it needs to increase its growth rate to at least six per cent per annum. To do this the country needs mega investment from overseas, measured in billions of US dollars … this requires sound corporate governance, good disclosure and a record of high level accounting standards …'*[5]

8.2 The Inhibitors

Four key areas could inhibit activity in the private sector:

8.2.1 The exchange rate

Several mining developments were planned for 2004 but were later shelved because of the dramatic strengthening of the rand in 2004 and its continued strength in 2005. Because income has been severely affected, many developments are no longer viable. Should the exchange rate weaken, many projects could be reconsidered. However, should the exchange rate continue to strengthen, more planned projects could be shelved.



Stats SA, MFA database

Figure 8.2 Growth of the building industry

8.2.2 Interest rates

Residential development is at an all time high as a result of favourable interest rates. If these increase significantly, development is likely to slow down.

8.2.3 Delays in the development of economic infrastructure

Many government projects have been delayed owing to lack of capacity and long delays in the decision-making process (see Chapter 9). It is critical that the development of Gautrain and the infrastructure for the 2010 Soccer World Cup should proceed according to plan, and that no further delays are experienced so that confidence and interest in the construction industry are maintained.

8.2.4 Capacity

Capacity is recognised as a major problem. Companies complain about the lack of 'competent persons'. For example, residential and non-residential building contractors have a shortage of structural and geotechnical engineers. Small and emerging contractors in particular do not have an adequate supply of artisans. This impacts on their ability to deliver houses of increased size and specifications according to the new subsidies, and requires urgent attention.

Public sector capacity is also deficient (see Chapter 9), which is impacting on the approval of projects to be handled by the private sector.

CONCLUSIONS

All the factors point to activity that should enable South Africa to achieve the 6% growth target. However, no matter what sector or activity is being examined, the underlying challenge is capacity, particularly institutional capacity. The recommendations made in the previous chapters must be implemented and in the short term those with expertise should be reappointed to key posts to initiate and manage projects.

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CHAPTER 9

The public sector

INTRODUCTION

South Africa boasts a model constitution and world-class legislation and has taken the leading role in developing a master plan to combat poverty on the African continent. In doing so, ambitious targets based on the Millennium Development Goals (MDGs) have been set to alleviate, if not eradicate poverty by 2014. These involve providing housing for every South African by that year, including basic services, transport and access to markets.

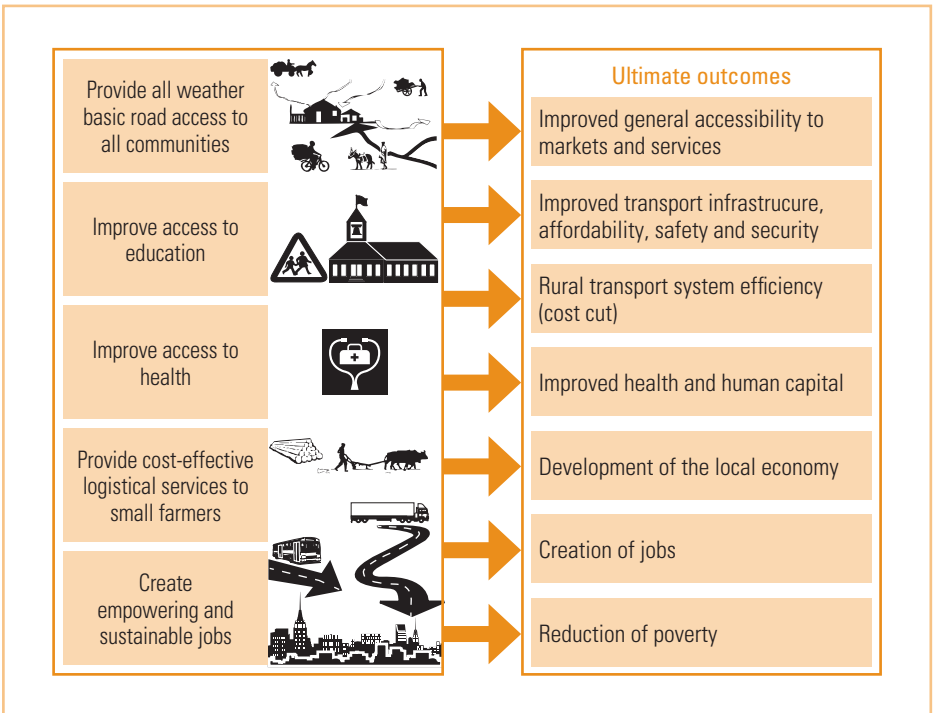
In addition, major economic development is planned to support a growing economy. These plans bode well for the construction sector. However, massive restructuring within state organs, lack of capacity and resulting bottlenecks threaten these developments.

THE STATUS QUO

Before looking at the drivers and inhibitors, previous and current structures and responsibilities need to be considered.

The way it was

Nineteenth-century engineers were responsible for transforming the economy of the world. They were:



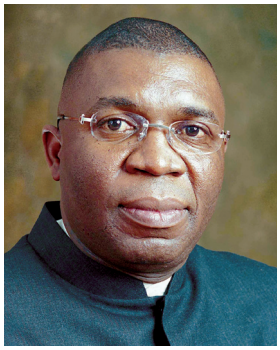
Department of Transport

Figure 9.1 Access improves quality of life

'… backlogs (in local government) have not been caused by lack of money ... some have severe capacity restraints and without reinforcement will not be able to address these backlogs … '

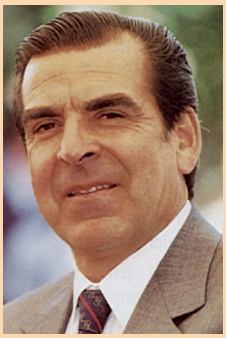
– Sydney Mufamadi

Sydney Mufamadi
(Minister, Provincial and Local Government)



Civil engineer for president!

Eduardo Frei Ruiz-Tagle joined the Christian Democratic party of Chile as a civil engineering student in 1958. He was actively involved in politics and his abhorrence of the military government led him to be a founder of the Free Elections Committee. He became the president of Chile in 1994, at the end of military rule and led the country into a prosperous free market economy, boasting growth in real GDP of 7 per cent to 1997. Inflation saw a downward trend, hitting a 60-year low in 1998. President Frei placed improved education, infrastructure and developing export markets at the top of his economic agenda. Chile has become one of the strongest economies and most stable societies in the developing world.



- **Entrepreneurs and innovators:** When they recognised the need for a particular product or project they carried out development without delay.
- **Conscious of social needs:** Their developments addressed the needs of society.
- **Financiers who took risks:** No one gave them a brief – they identified the need, developed the solution, sold the concept and then built the solution.
- **Influential with politicians:** They worked with decision makers and in many instances became politicians to influence decisions.

In the past, the public sector was a major employer of engineers. Indeed, it was the major training ground for engineers. The old South African Railways and Harbours (SAR&H) and the Department of Water Affairs and Forestry (DWAF) trained a large percentage of the senior engineers who are still active.

Until recently engineers played a major role in strategic thinking and decision making in infrastructure. In local government the three most senior staff members in a typical council were the town clerk, the treasurer and the city engineer.

Civil engineering education is diverse, covering many subjects, such as mathematics, applied mathematics, physics and computer science, and fields such as structural engineering, water, sanitation and transportation, plus environmental project management. The graduate is therefore comprehensively educated and able to think strategically.

With these abilities, visionary engineers developed a first world component of South Africa's infrastructure that still serves the country. Solly Morris, the city engineer, had the foresight to build the motorway system around Cape Town in the early sixties.

State and provincial departments employed many engineers who understood their roles and had the responsibility to deliver. The public were seldom aware of damaged or malfunctioning infrastructure such as washed-away roads, because the engineering team would be deployed immediately to establish the damage and attend to the repairs. This is in contrast with the months of delay in repairing roads after the floods in 2000.

The way it is today

Civil engineers are essentially technocrats, focused on delivering technical products, and not given to competing for position, power or influence. As a result, in their desire to accommodate, they have been moved from centre stage by others who are vying for senior positions. The result is that the civil engineer's strategic and visionary ability in many instances is not recognised or used by those in power.

Strategic planning is lacking in infrastructure delivery. Where proposals are made, those in senior positions are frequently not sufficiently skilled to make decisions about the viability of projects. As a result, many key projects are simply not happening, and this is impacting severely on the country's economy.

The lack of strategic direction, decision making and development in transport infrastructure has led to traffic being at a standstill for many hours of the day, costing the country billions of rand per annum.[1,2] In the eighties, the Department of Transport employed 152 engineers, a number that had dropped to two by the late nineties!

The lack of decision making where ports are concerned impacts on the country's export capacity. South Africa is losing deals to countries that have better infrastructure, though possibly not superior products.[3] Given that the country earns almost half its gross domestic product (GDP) through imports and exports, this is disquieting. The inadequacy of the rail network is also hindering products from reaching ports. The coal industry is very vocal about this problem. This reduces the country's wealth and compromises its ability to provide more jobs, one of the government's most critical objectives.

Even the Gautrain project, seen as the saviour of the construction industry, the solution to many traffic problems in Gauteng, and a key deliverable for the 2010 Soccer World Cup appears to have slipped behind schedule.

The CIDB reports that many projects in the pipeline are not reaching closure owing to lack of capacity in the PPP Unit of Treasury.[4]

South Africa is not alone in grappling with deficiencies in capacity, governance and service delivery.

Kaplan, in postulating that the world is moving from order toward anarchy, comments:[6]

Table 9.1 Types of infrastructure and their impact on the economy

Type of infrastructure	Development	Impact on Society/ Economy
Social	Housing	Welfare
	Schools	Education
	Hospitals	Health
	Service centres	Productivity
Social and economic	Water and sanitation	Health
	Telecommunications	Welfare
	Electricity	Economic production
Economic	Roads and bridges	Access to employment
	Railways	Integration
	Harbours	Transport/trade
	Airports	Transport/trade
	Agriculture	Sustainable jobs
	Manufacturing	Productivity
	Mining	Economic production
		Taxes to afford social infrastructure

SAFCEC

'… Urban societies are more challenging to govern than rural societies. In rural societies people can grow their own food, so they are less susceptible to price increases for basic commodities. Rural people don't require the complex infrastructure … that urban societies have. Urbanisation widens the scope of error for leaders in the developing world while simultaneously narrowing the scope for success. It is harder to satisfy an urban population than a rural population, especially when that population is growing in such leaps and bounds that governing institutions simply cannot keep apace …'

THE CHALLENGES

9.1 The drivers

Ambitious plans include:

- Nepad, MDG, Municipal Infrastructure Grant (MIG), Expanded Public Works Programme (EPWP) and the development of social infrastructure
- Coega and other industrial development zones (IDZs)
- The Gautrain backbone and later a complete high-speed rail network
- Gauteng's infrastructure development plans
- Sports stadia upgrades and development in preparation for the 2010 Soccer World Cup
- Development and widening of ports
- Development and upgrading of airports including expansion to service the A380 range of aircraft
- Development of the rail network and Transnet's upgrade plans as a whole
- Development of the road network
- Blue IQ projects
- Eskom expansion and upgrading
- Development of the pebble bed modular reactor
- Several public-private partnership (PPP) projects
- Major water projects including pipelines, 21 dams over the next 20 years and other Department of Water Affairs and Forestry (DWAF) projects
- New buildings for government departments

Many of these are enormous projects, unparalleled in the past. Independent equity advisor Mark Ingham estimates that they represent a planned investment of R200 billion over the next five years.

However, many factors could inhibit this magnitude of development.

9.2 The inhibitors

There has been major restructuring at all levels of government with a resulting loss of capacity and institutional knowledge (see Chapter 3).

Sustainability is a major problem. According to DPLG, municipal services are sustainable if:[5]

- The infrastructure is operational and is used efficiently and effectively
- The benefits of the services continue to be realised over a long period with no decrease in level of service
- The infrastructure is maintained
- All operational, maintenance and replacement costs are covered
- Associated natural resources are not over-exploited
- The management of the services is institutionalised

- There is access to sufficient support
- There are no negative effects to the environment
- There are no unplanned external interventions

In face-to-face interviews in the engineering departments of all three tiers of government respondents stressed the need for a major review of the structure, staffing and responsibility for delivery activities in these departments.

The major factors that have impacted on the delivery of sustainable infrastructure are:

- Non-technical leaders making decisions relating to engineering departments, for which they are not qualified, and/or have no experience
- The plethora of new legislation to be considered is adversely affecting the delivery process
- Budget constraints
- The application of affirmative action criteria to filling posts, whether the incumbents are suitably qualified or experienced for the post or not
- Staff shortages and the challenge of retaining qualified and experienced engineering staff
- Procurement
- Lack of project management capacity to roll out MIG

In the next section each of these major factors is considered in more detail:

9.2.1 Leadership and management of engineering departments

(a) Local municipalities

It appears that the top structures have been vastly expanded, although nationally the total number employed in local government has changed very little over the past ten years. This means that other staff groupings, including technical staff, have been reduced, but the demand for infrastructure delivery has greatly increased.

Few, if any, municipalities have increased technical staff since the new demarcations of 2000, yet all are now required to deliver, operate and maintain services covering larger areas, with population, length of roads and water supply and sanitation systems having increased two- to tenfold.

When LGWSETA researchers interviewed municipal managers, 74% complained of shortages of engineers and 43% of shortages of technicians.[7]

However, in many instances the senior staff (typically the town engineer and assistant town engineer) have been moved from leadership positions to manage the roads and water networks. Political appointees have taken over the roles of technical and assistant technical managers, based on the belief that anyone with management qualifications or experience can manage anything. This is proving to be a major problem, as civil engineering infrastructure is complex and requires a thorough understanding of not only financial and social issues, but technical issues before decisions can be taken.

This restructuring has had a detrimental effect on delivery. It is not a new phenomenon, however.

In 66 AD the Roman satirist Petronius Arbiter wrote:

> *'… We trained hard, but it seemed that every time we were beginning to form up into teams we would be reorganised … I was to learn later in life that we tend to meet any new challenge by reorganising … what a wonderful method it can be for creating the illusion of progress while producing confusion, inefficiency and demoralisation …'*

It is such a pity that history repeats itself!

The only officers that local authorities are required to have are a municipal manager, a chief accounting officer and a chief financial officer. Senior technical staff are not mandatory in organisations that provide and sell technical services! Since 60% of the municipal budget is spent on delivery, operation and maintenance of infrastructure, this does not make sense and must be changed! As a result less infrastructure is being developed in real terms, because most new managers are not experienced at conceiving projects, are not able to make decisions, and are often unwilling to take technical advice or to listen to the experienced technical professionals in their departments.

The following statements list the problems experienced as a result of vacancies or inappropriately qualified management:

- No land use planning
- No building control
- Lack of planning
- Lack of strategic direction
- Increased workload on others
- Inability to meet deadlines
- Inability to deliver infrastructure
- No maintenance, or only reactive maintenance when a crisis arises
- No in-house expertise for design or managing of consultants' work
- No in-house knowledge in terms of contracts and tender documentation
- No in-house expertise to assist with practical issues or emergencies … etc

Given that engineers and technologists have NQF 7 and higher qualifications, they represent some of the most highly qualified staff in local authorities and should be considered of great value in strategic positions and strategic thinking. In Australia the term 'municipal engineer' is no longer used.[8] Instead the most senior engineer has become the director of strategic planning. In this way appropriate infrastructure is decided on, and is properly motivated and approved.

(b) District municipalities

The problems are worse in district municipalities than in local municipalities, if that is possible!

Although district municipalities were set up to offer additional support to local councils, they have generally become hindrances rather than solutions. Since these are new structures, they have either not employed technical staff or have employed young inexperienced new recruits to local government, in contrast with the existing local municipalities that retain some capacity from the past.

A portion of local municipality income is assigned to district municipalities, but this rarely finds it way back to the projects so desperately needed by local councils. This is owing to lack of capacity, but sadly in many cases relates to power struggles between local and district municipalities. In many areas little progress can seen as a result of the establishment of this additional tier of local government.

(c) Other structures

The findings and frustrations are similar in most other structures in the public sector.

(d) The stereotype engineering professional

Non-technical staff complained in interviews about the authoritarian approach of civil professionals, and their inflexibility. Change management is extremely important in

environments that have undergone such dramatic restructuring. Few municipalities have addressed any such issues.

Professional input and team building would go a long way towards bridging the gap between professionals and managers and encouraging both parties to value the other.

The South African Institution of Civil Engineers (SAICE) 'Sustainable Infrastructure' programme[9] for councillors and officials has helped to bridge many such gaps. See below.

(e) Engineering management and succession planning

To address equity targets, management has become largely non-technical, which is causing major problems. Cyril Ramaphosa recently mentioned that if he could chose his career over again, he would study engineering, as:

'… engineers are trained to work systematically, solve problems and get things done …'

These are the people that are needed to accelerate delivery. Departments should strive to re-establish technical staff as their leaders. To achieve this and ensure acceptable equity ratios in future, comprehensive succession plans must be implemented in technical departments. When senior technical staff are a few years from retirement, younger technical staff should be employed to eventually take over. The handover should be a structured process designed to develop technical competence and comprehensive knowledge of the intricacies of service delivery, operation and maintenance.

At present little succession planning is evident, and the current trend of replacing senior, experienced staff with young staff with no internal training or without an overlap period is resulting in departments becoming ineffective very quickly. Policies are achieving transformation goals quantitatively, but they are not creating community and cohesive teams that can deliver and maintain infrastructure.

Similar problems are being experienced in many countries, including the USA, where[10]

'… forced 'retirement' … in some states as a result of term limits certainly infuses new blood into … bodies, but also wipes out the hard-earned knowledge … the result can be … gridlock…'

The public sector should review the education supply chain and set targets per age group rather than force transformation at all levels, whether skills and appropriately experienced

Sustainable infrastructure for South African towns and cities – a programme to empower local authority councillors to make informed decisions about the provision of infrastructure

The decision maker is at the forefront of the drive to improve the quality of life for all citizens. Many processes on which he or she will be called upon to make decisions are a mystery to the lay person. Provision of infrastructure is the domain of engineering professionals who are seldom politicians. They need direction from the representatives of the public, the decision makers, in order to perform.

The programme, developed by SAICE, enhances understanding about infrastructure-related issues. Components such as water supply, sanitation, roads, electricity, refuse management and maintenance, processes for infrastructure delivery such as tendering and budgeting, and the professionals involved in these projects are workshopped in an interactive, participative environment.

SAICE

staff are available or not. Graduation profiles in Chapter 5 should be used as a basis for setting realistic targets.

9.2.2 Legislation

The number of pieces of legislation impacting on local government and the water sectors alone is overwhelming – a subset of the more than 150 Acts that affect decisions include:

- **Specific municipal legislation**
  - Municipal Demarcation Act, 1998 (Act No 27 of 1998)
  - Municipal Structures Amendment Act, 2003 (Act No 1 of 2003)
  - Municipal Systems Amendment Act, 2003 (Act No 44 of 2003)
  - Municipal Finance Management Act, 2003 (Act No 56 of 2003)
  - Municipal Property Rates Act, 2004 (Act No 6 of 2004)
- **Water**
  - Water Services Act, 1997 (Act No 108 of 1997)
  - National Water Act, 1998 (Act No 36 of 1998) and Amendment 45 of 1999
- **Roads**
  - National Roads Act, 1971 (Act No 54 of 1971). Repealed by Act No 7 of 1998 which commenced on 1 April 1998
- **Housing**
  - Housing Act, 1997 (Act No 107 of 1997)
  - Housing Development Schemes for Retired Persons Act, 1988 (Act No 65 of 1988) as amended by Act No 20 of 1998
  - National Building Regulations and Building Standards Act, 1977 (Act No 103 of 1977)
- **Deeds and land**
  - Deeds Registries Act, 1937 (Act No 47 of 1937)
  - Land Affairs Act, 1987 (Act No 101 of 1987)
  - Physical Planning Act, 1991 (Act No 125 of 1991)
  - Land Administration Act, 1995 (Act No 2 of 1995)
  - Development Facilitation Act, 1995 (Act No 67 of 1995)
  - Communal Property Associations Act, 1996 (Act No 28 of 1996)
  - Extension of Security of Tenure Act, 1997 (Act No 62 of 1997)
  - Communal Land Rights Act, 2004 (Act No 11 of 2004)
- **Health and safety**
  - Occupational Health and Safety Act, 1993 (Act No 85 of 1993)
- **Environmental**
  - Environment Conservation Act, 1989 (Act No 73 of 1989)
  - National Environmental Management Act, 1998 (Act No 107 of 1998) as amended by Act No 8 of 2004
  - National Heritage Resources Act, 1999 (Act No 25 of 1999)
  - Occupational Health and Safety Act, 1993 (Act No 85 of 1993)
- **Constitution, labour and BBBEE**
  - Constitution of the Republic of South Africa, 1996 (Act No 108 of 1996)
  - Labour Relations Act, 1995 (Act No 66 of 1995)
  - Basic Conditions of Employment Act, 1997 (Act No 75 of 1997) as amended by Act No 52 of 2003
  - Employment Equity Act, 1998 (Act No 55 of 1998)

- Broad Based Black Economic Empowerment Act, 2003 (Act No 53 of 2003)

- **Finance and procurement**
  - State Tender Board Act, 1968 (Act No 86 of 1968)
  - Intergovernmental Fiscal Relations Act, 1997 (Act No 97 of 1997)
  - Public Finance Management Act, 1999 (Act No 1 of 1999)
  - Division of Revenue Act (DORA, Act No 30 of 1999)
  - Preferential Procurement Policy Framework Act, 2000 (Act No 5 of 2000)
- **Skills development**
  - South African Qualifications Authority Act, 1995 (Act No 58 of 1995)
  - Skills Development Act, 1998 (Act No. 97 of 1998) as amended by Act No 31 of 2003
  - Skills Development Levies Act, 1999 (Act No 9 of 1999)
  - Adult Basic Education and Training Bill (Government Gazette No 21461 7 August 2002)
- **Professional councils**
  - Construction Industry Development Board Act, 2000 (Act No 38 of 2000)
  - Council for the Built Environment Act, 2000 (Act No 43 of 2000)
  - Built Environment Councils Acts, 2000 (Acts No 44–49 of 2000)

The number and complexity of these Acts has severely hampered delivery in the local government sector. According to the Demarcation Board's assessment of municipal capacity for 2003, local authorities tend to be better at performing their income-generating functions than their service delivery and developmental functions. This problem requires urgent attention.

Where there is technical capacity, staff complain that they never reach the production phase because of the time spent on paperwork, compliance and approval of projects. They have become pen pushers.

Local government is responsible for delivering basic services to communities, investing in and maintaining infrastructure and promoting economic growth and poverty alleviation. Output relating to most of this responsibility rests with the civil engineering profession, a group that has been[11]

> *'… moved to the boiler room and is not in a position to give any advice on the direction the ship should take or to plan new trips!'*

9.2.3 Budget constraints

Budgets are spent on three main categories: infrastructure, staff and community services. The first two will be considered in detail in relation to civil engineering professionals and relevant infrastructure delivery, management, operation and maintenance.

(a) Infrastructure

Funding for infrastructure comes from a number of sources:

(i) New infrastructure

- **Grants** from funds such as the CMIP, and now MIG, for the supply of basic services
- **Loans from financial organisations**. The two main players are the Development Bank of South Africa (DBSA), and the Infrastructure Finance Corporation (INCA), although there are many more.

However, the declining financial situation of municipalities is making it increasingly difficult to access this type of funding (See Figure 9.2). Most of these funds go to metros that are still on a sound financial footing.

- **Funds collected from ratepayers**. These funds are often barely sufficient to remunerate staff and pay operating expenses. Many municipalities operate at a loss.

Without capacity to develop plans and apply for funding, these funds are not being allocated, even to municipalities that would qualify for funding!

(ii) Maintenance

In general, expenditure on maintenance is not considered important, which means that the existing infrastructure is deteriorating.

This is a universal problem. In the USA, the Infrastructure Reportcard[12] laments the cost of restoring infrastructure to acceptable conditions, owing to inadequate or non-existent regular or preventative maintenance over an extended period. When forced to cut its maintenance budget, New York City estimated that an increase in their capital budget of $400 million per annum would result when the unmaintained infrastructure became unserviceable.[13]

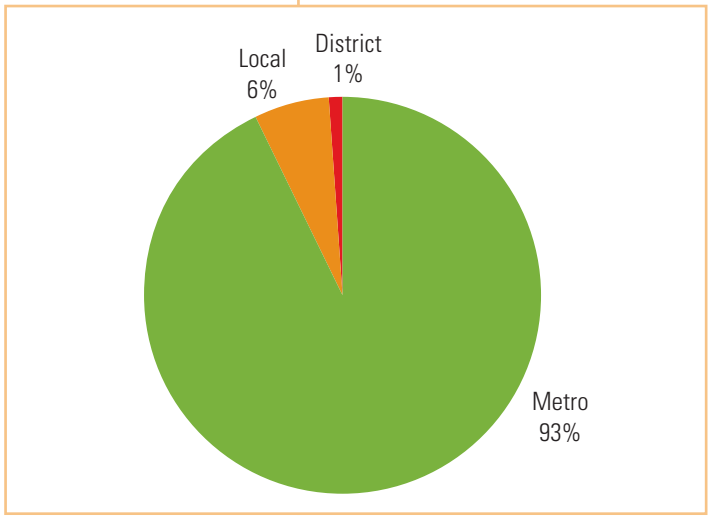
South Africa cannot afford this happen. Unaccounted-for water is cause for concern in municipalities from the smallest to the largest. For example, eThekwini[14] reported 30% losses or more, largely owing to deteriorating infrastructure.

> *'… Many of South Africa's major cities and towns are more than a century old, with water services infrastructure having deteriorated beyond its economic life …'*[15]

At least 2% of all older pipes should be replaced each year to maintain existing water networks at their full capacity. That is, all pipes should be replaced every 50 years.

The cost of replacing a section of road is ten times more expensive than maintaining it. In 1988 road budgets were slashed by over 50%. In 2000, a study done for the AA found that in the past ten years roads in good condition had dropped from 75% to 30%, and roads in poor condition had increased from 5% to 33%.[16] Figures from the South African Roads Agency Ltd (SANRAL) show that in 2005 over 50% of the non-tolled national road network is in poor or very poor condition.[17]

Figure 9.2 Municipal borrowings by category, pilot survey



National Treasury survey

The Department of Transport in preparing its 'Road infrastructure strategic framework'[18] stated

> *'… policies seek to bridge the economic divide through the integration of first and second economies ie emphasising the need to maintain good quality strategic economic road infrastructure while elevating the profile of social infrastructure …'*

Development and maintenance go hand in hand. This is not understood or is overlooked by non-technical decision makers and little is spent on maintenance. Furthermore, from a political point of view, maintenance is not so visible as new projects, and does not buy votes, hence is seldom top priority in terms of expenditure.

Table 9.2 Causes of deteriorating infrastructure

Causes of deteriorating Infrastructure	%
Budget constraints, lack of funds and unwillingness to do maintenance	25
Lack of skilled and experienced technical staff	20
Technical staff no longer have authority to initiate activities. Political interference or national government priorities divert funds for capital expenditure at the expense of maintenance and operations	18
Inexperienced senior management cannot or will not make decisions. Lack of awareness of importance of infrastructure maintenance and possible consequences of neglect. Lack of business understanding and ability to manage	15
Lack of equipment and difficulty in accessing rural areas	12
Protracted motivation, approval and procurement procedures	5
Vandalism and misuse of infrastructure by end users	5

South Africa's well-developed and maintained transportation system, both road and rail, has been key to its economic development for generations. However, the lack of expenditure on the rail system has impacted severely on the rail network's ability as a freight carrier and has put so much additional pressure on the road network that it is rapidly deteriorating and failing in many places. A report by the World Bank puts this into perspective. Owing to lack of maintenance, 45% of roads built in Africa with international funding no longer exist.

In the SANRAL report (above) the Minister of Finance, Minister Trevor Manuel, had the last word:

> *'… this is an emphasis that cannot continue for too long, because the curve that describes the decay of inadequately maintained economic assets becomes dangerously steep if relative neglect persists beyond a few years …'*

A relook at funding of maintenance is desperately needed.

(iii) Operations

Operations have now become a problem in local government. As with contractors, the number of artisans rising in the ranks has dropped, and there is a dire shortage of adequately trained staff who are capable of operating essential plants such as water purification and sewage treatment works. Without senior civil engineering professionals in councils to manage these aspects, there is no one to ensure that operators are adequately trained or to monitor the correct operation of these essential services.

Some of the roles and responsibilities of the professional engineer in terms of the Health and Safety Act and Regulations include:

> *'… Engineers have a legal and moral responsibility and should advise clients accordingly. They must among other things:*

- Carry out sufficient inspections at appropriate times to ensure compliance with the design
- Keep a record of those inspections …'

Table 9.3 Principle causes of operational problems

Reasons for failing operations	%
Shortage of skilled and experienced operational and technical staff	33
Ageing / unmaintained infrastructure /poor preventative maintenance programmes	26
Budget constraints	18
Lack of commitment / understanding by officials	18
Vandalism and end-user abuse of infrastructure	5

There is now confusion as to who is responsible for operations, particularly in councils where there are no engineers, technologists or technicians.

Systems were in place for chemicals and other materials to always be available through municipal stores. With budget constraints, increased bureaucracy and lack of capacity, provision for ongoing operations is overlooked and many water purification and sewerage works no longer comply with the health criteria set by DWAF.

(b) Staff

In the past, staff expenditure was limited to 29% of budget. This constraint was to ensure that the bulk of funds collected from ratepayers was spent on delivering services. Since 1999 staff expenditure has spiralled, with expenditure of 59% recorded in an extreme case!

Technical and delivery staff numbers have not been increased, but top structures and their remuneration packages have grown substantially. The year 2005 sees municipalities again offering packages to senior experienced engineering staff to balance the books. This is destroying their capacity to deliver. Similar offers are not being made to the top structures which are reported to be earning significantly higher salaries than senior technical personnel. These impact on service delivery.

While the rest of the world is recognising the inefficiencies and costs of huge hierarchies and has spent considerable efforts in the past ten years on downsizing, South Africa's local authorities have grown large hierarchies of non-technical staff at senior levels.

In a recent address, Minister Trevor Manuel[19] commented

'… We cannot afford to reinforce the huge divides that apartheid introduced. When people without adequate experience are placed in positions of power and influence simply because they possess the right qualification and are of the right race and gender, then the result is a massive financial risk for the companies concerned and, in some cases, for the economy as a whole.

He went on to say:

'...this problem has arisen in the public sector ... inexperienced people who do not possess the competencies required for the job are given a job with a huge salary…'

This has happened in local government, with three main consequences:

- A disproportionate amount of the budget is spent on staff, which leaves less for infrastructure delivery, operation and maintenance

- Inexperienced staff are not able to make sound decisions about the provision, maintenance and operation of infrastructure
- There is no one to train the young technical staff. Excellent experienced technicians are working in the sector who are able to take on senior roles, because of the comprehensive training they received in the larger towns under the watchful eye of the experienced city engineers of the past. By removing all their senior staff, no one is training the teachers of the future.

Bishop Desmond Tutu recently implored South Africans to realise that it is time to use 'power for correction'. People who understand how to address infrastructure delivery and poverty alleviation should be in authoritative positions.

9.2.4 Affirmative action

The philosophy behind creating an enabling environment is sound. However, the legacy of apartheid precluded many from access to any form of engineering education. There are fewer than ten senior (50+) black engineers in local authorities.

From the early nineties, the black student population began to grow, but progress was limited by the number who had received adequate schooling. The handful of students who graduated in the mid-nineties are now in their early thirties. It will thus be another 10 to 20 years before senior positions in engineering will represent the demographics of the country.

When affirmative action was introduced, all three tiers of government and parastatals offered early retirement packages across the board to senior staff, assuming that there would be a ready supply of black staff to fill the vacancies. In terms of scarce skills, such as civil engineering, this was not so.

As a result, many departments lost a large proportion of their technical capacity when their work load was about to increase, because of the new municipal demarcations introduced in 2000.

Not only have these retirements caused a major loss in terms of delivery capacity, but the knowledge that was lost has impacted on the progress of the young engineering staff who would have benefited from their supervision, coaching and mentorship.

This problem was identified in the UK in the mid-nineties when Kevin Thompson[20] cautioned that:

> *'… By getting rid of older people an organisation's KNOWLEDGE is being lost, not just its people …'*

Despite being critically short of staff, most departments in all tiers of government and parastatals rigidly apply employment equity policies. As a result,

- Inappropriately qualified or unqualified staff are employed.
- Posts remain vacant, despite the availability of suitably qualified and experienced applicants of all ages!

Making choices purely on equity or representivity without considering competence is proving counterproductive to the delivery process.

Currently there are relatively few qualified senior black civil engineers, and still fewer are registered with the Engineering Council of South Africa (ECSA). As a result, those who are qualified and have professional status are paid a premium and snatched up by companies that are frantic to meet their employment equity targets.

Owing to the shortage of technical black staff, even young black staff are in great demand. Debbie Goodman, MD of Jack Hammer Executive Headhunters, observed:[21]

'… the demand for these gems exceeds the supply – particularly when the clock is ticking and charter (or equity) deadlines must be met …'

This leads to job-hopping and payment of unreasonably high and ever-increasing packages that are not commensurate with the level of experience. Job-hoppers rarely build up experience in any position. A large proportion of young graduates will therefore not be adequately experienced to take up senior professional posts, but will nevertheless be appointed.

The Minister of Finance, Minister Trevor Manuel, has something to say about this.

'… The wanton drive to get rich quickly must come to an end if we are to have sustainable growth … people who job-hop do not build up a body of expertise or experience …'

A real contribution to transformation would be for all tiers of government to appoint the right person for the job, regardless of race, gender or disability, and to again place the responsibility on senior staff to supervise, coach and mentor the young so that they can benefit from the knowledge accumulated from years of experience. Says Mamphela Ramphele, the well-known activist and World Bank managing director,

'… strict professional competence criteria need to be applied … to ensure efficiency and effectiveness …'[22]

By growing organically, the young generation will be able to take their rightful places in time and address the current demographic imbalances without disrupting service delivery.

9.2.5 Staff retention

There has been substantial loss of civil engineering staff over the past ten years. Other than early retirements as described above, losses at all levels have continued unabated. The problem and methods of addressing them are discussed below.

(a) Reasons for leaving

Reasons for resignations of civil engineering staff are given in Table 9.4.

The Local Government Water Sector Education and Training Authority (LGWSETA) capacity research project yielded similar input across the board, with the four biggest frustrations being:

- Poor remuneration
- Lack of development and career path opportunities
- Lack of recognition of staff achievements
- The inadequate way people are managed, definition of roles, etc

(i) Salaries

Clearly attention needs to be focused on salaries in relation to these scarce skills. Richard Kruger, director of infrastructure implementation at DPLG, stated:[23]

'… government must retain the engineers it still has and use them optimally … municipal engineers should be paid according to their skills level and the service they render rather than the size of the municipality they work for …'

Table 9.4 Reasons for resignations of civil engineering professionals

Reason for resignation	%
Salaries too low/poaching	50
Frustration with bureaucracy, lack of authority and quality of staff appointed	28
Lack of investment, value or training for technical staff, both young and older	19
Emigration	3

The issue of retirement benefits (outlined in Chapter 7 – 'Supply – professionals') must also be considered.

It has been suggested that salaries required by experienced senior staff are beyond the means of the public sector and less expensive staff should be employed from the international labour market. This is extremely short-sighted as there are many hidden costs and compatibility problems with immigrants. They include:

- Recognition of prior learning, as many foreign qualifications are not recognised in South Africa and are not aligned with the country's needs
- The cost of relocation and additional demand for forex
- The unproductive time spent settling into the new country and work environment
- The learning curve to master South African design codes, standards, legislation, labour practices, and perhaps even language
- The inappropriate solutions that may be implemented as a result of not understanding local cultures and requirements

The expertise developed in this country should be harnessed.

Recent reports have highlighted that staff in top structures earn way in excess of President Mbeki. National salary scales should be developed that align all levels of responsibility, expertise and experience in order to better utilise the salary budgets.

(ii) Grading

Since technical skills are of critical importance, the re-grading of staff nationally is becoming a problem for senior technicians. Grading systems do not place technical competence, responsibility or complexity of task in an appropriate position on the higher end of their scales. It appears that many experienced technicians have been dropped a level or two; hence they are leaving for greener pastures. The resultant frustration levels were found to be high, regardless of age, race or gender.

If senior technical staff were correctly graded, there would be no complaint about the salaries they command as they would align with others on the same level. As outlined in Chapter 3, standard organograms should be developed for each sphere in the public sector.

(b) Coaching and retaining young people

The keys to staff retention include:

- Variety of work
- Communication with staff
- Flexibility
- Responsibility
- Recognition

'… the greater the employee's job knowledge … the greater the quality of service …'

- Strong relationships

(See Chapter 6, 'Supply – graduates'.)

Properly managed learnerships that allow young graduates to move from one phase of a project to the next would offer the variety required by young people. If senior managers do not have the time to supervise or manage career development for young graduates, then external mentors or experienced consulting staff need to be assigned to this duty (including retired people).

By ensuring that all young people progress through learnerships, not only will they benefit from the variety of work, but they will enjoy ongoing communication with senior staff – the so-called high touch that is desperately needed in today's 'high-tech' society.

The LGWESTA Sector Skills Plan 2005–2009 identifies one of the weaknesses in staff training and retention as,

> *'… the system of internship within local government is not at all developed … there is a lack of learning facilitation, coaching, mentoring and workplace assessment skills amongst line managers and supervisors …'*

Local government workers did not benefit from internship training in the past, as it was not recognised as a learning achievement, nor were they provided with career progression and remuneration benefits.

The candidate learnerships currently being developed will lead to professional registration with ECSA as Pr Eng, Pr Tech Eng and Pr Techni.

Although attaining this level of registration indicates significant development of competence after graduation, fewer than 29% of local authorities recognised any of these qualifications for promotion or increased remuneration.

Employees who were interviewed stressed their frustration with the lack of career path planning and dearth of opportunities to increase remuneration as a result of training, in addition to the absence of formal recognition of skills acquired through training.

Not only is attending to employee training and other aspects essential in terms of staff retention, but staff knowledge is the key to improved service delivery and management. According to the American Public Works Association,[24]

> *'… the greater the employee's job knowledge … the greater the quality of service …'*

(c) Identification of work

Current developments concerning the identification of work should result in staff being adequately recognised, remunerated and retained. Definitions of reserved work and responsibilities are being developed by ECSA in terms of the Engineering Profession Act, (Act No 46 of 2000). In essence, engineering works relating to municipal infrastructure which will require a technical person in terms of safety and the public interest include transportation systems, traffic engineering, civil works including township services, water treatment and supply, sewerage works, soil conservation works, irrigation works, stormwater and drainage works and solid waste disposal. When the work is considered complex, a registered engineer will be mandatory. Where work is less complex and can be broadly defined, an engineering technologist may be used. If the work is well defined a registered engineering technician may be appointed.

(d) South African Local Government Association (SALGA) and LGWSETA views

The 2005/2009 LGWSETA SSP submission states,

'... In sum, it appears that the local government and water sectors, like most other organisations competing for scarce skills today, need to pay particular attention to their people management policies, procedures and practices if they are to compete for and retain the right skills ...'

SALGA has proposed wide-ranging changes to local government human resource and LR policies and practices, including:

- **The establishment of uniform conditions of service**, particularly in the areas of remuneration, pensions and medical aid
- **The introduction of a new remuneration policy with strong performance linkages:** The policy will initially focus on municipal managers and their direct reports as well as those on fixed-term contracts. The policy explicitly addresses attraction and retention of scarce skills and provides for a scarce skills premium to be paid
- **The introduction of a new performance management policy and procedures:** This proposed policy allows institutional performance management via integrated development plans (IDPs) to be linked to individual performance management

Retention issues apply to a greater or lesser degree to all organs of state, including provincial, central government and parastatals.

9.2.6 Procurement

Each organisation has chosen to interpret the procurement guidelines differently, but all apply maximum points to black ownership and the lowest price. Although it is permissible to reject tenderers who do not have the appropriate experience, or who cannot offer the service required, such discretion has not been applied by many tender committees.

Although the Municipal Finance Management Act requires every municipality to have a supply chain management policy and councillors may not serve on the tender committee, technical staff are rarely involved in these committees or consulted on technical issues in the awarding of tenders.

At times technical staff find it necessary to cancel projects in the interests of public health and safety and the responsible application of funds, rather than use an inadequate tenderer selected by the tender committee. Past experience tells them that the project will be a failure or may present a risk or danger if carried out by inexperienced contractors. This input was offered by all groups who were interviewed, regardless of race or gender

This misjudgement impacts not only on delivery, but also on the sustainability of those companies that could have executed the project, but who were rejected in favour of incompetent companies.

The judgement of technical staff should be valued in awarding tenders relating to infrastructure.

9.2.7 Capacity for and understanding of the Municipal Infrastructure Grant (MIG)

The MIG concept is commendable, as it is a mechanism of providing funding directly to technical teams in order to carry out development of basic services. The project management unit (PMU) manager reports directly to the municipal manager, by-passing many tiers of management. However, the shortage of experienced technical staff was not recognised when developing this model. As a result,

- There is insufficient capacity or experience to draw up budgets for development and submit them for allocation of funds

- There is insufficient capacity or experience to adjudicate or process applications

Hence a limited number of business plans have been received and approved, and only a portion of funds earmarked for 2004/2005 have been spent. Dr Tjaart van der Walt, president of IMESA (Institution of Municipal Engineering of South Africa) observed,

> *'… Most municipalities appear to be in need of applicable project management skills to unlock government funding and fast track service delivery projects …'*[25]

Twenty three local municipality PMUs estimated that they required 100 more engineers, technologists, technicians and project managers internally and a further 103 externally. Eleven district municipality PMUs required an additional 43 technical staff internally and 33 externally to plan, initiate, manage and monitor MIG projects.

It is clear that there is a shortage of civil engineering capacity in both the private and public sector. These additional numbers must be enticed from other sources, including those who have left the industry, those who have left the country, the pool of retired staff and young people who must be trained to play their part in PMUs. Further, other disciplines such as construction managers and construction project managers could supplement the project management capacity that has traditionally been composed of civil engineering professionals

9.2.8 The balancing act

Addressing the capacity dimension in local government, the authors of *Cities transformed*,[26] who take a worldview of local government, summarise the problem:

> *'… during the 1980s rapid urban growth throughout the developing world began to seriously outstrip the capacity of most cities to provide adequate services for their citizens … maintenance was poor, public subsidies were high, it was difficult to avoid corrupt practices entirely and the pace of construction was inadequate … '*

In discussing the urbanisation phenomenon it asks whether there is a 'best' model of urban governance:

> *'… the term urban governance implies a greater diversity in the organisation of services, a greater variety of actors and stakeholders … greater involvement of NGOs and community groups … greater transparency and accountability in both the planning and implementation of local policy…'*

and adds:

> *'… technical support needed by developing municipalities … in their constrained economic circumstances have been the object of significant program assistance …'*

Critics of the government and local government system need to take heed. South Africa is not alone in grappling with urbanisation and service delivery. The problem is enormous. Migration from rural communities has taken place over many decades, with insufficient attention being paid to development, making the challenge even greater today.

However, although transparency is important, technical capacity and leadership are needed to deliver the necessary infrastructure. A balance has to be struck between political

agendas and the technical needs of municipalities. In the effort to accommodate the aspirations of all stakeholders, technical leadership and prowess have been discounted to such an extent that delivery has been severely hampered. Technical assistance is needed in many municipalities and must urgently be provided.

9.3 Public private partnerships, franchises, agencies or more autonomy

Capacity constraints and lack of delivery indicate that different structures and different approaches are required to address the needs of local government. In particular the need to ring-fence funds for development, operations and maintenance has led to many approaches being tried or suggested over the past few years.

9.3.1 Public private partnerships

There is a view that the woes of local authorities will be addressed by PPP solutions. A few such initiatives have been successful, particularly in operations and maintenance of water infrastructure. However, there is resistance to privatisation to single large, mostly international companies. In addition, moving to this mode of service delivery on a large scale will encounter the same capacity constraints unless these contracts include meaningful capacity development.

9.3.2 Agencies

Income streams from the delivery of services are essential to a local authority. By privatising the main services, the cash cows are lost. To achieve dedicated service delivery units, the agency route seems to be most favourable, as it separates the strategic from the non-strategic, and policy from operations. Departments and individuals can then take responsibility for their own tasks and can be held accountable. The central administration body would ensure that good quality, affordable services are delivered. In making its decision to follow the agency route, the iGoli 2002 strategic plan[27] to transform Johannesburg stated that,

> *'… from an organisational perspective, iGoli seeks to put in place 'sensible' structure that will deliver services at greater levels of efficiency …'*

9.3.3 Franchising

The idea of franchising operations and maintenance to SMMEs that are developed and supported by large players in the market acting as the franchisors such as water boards and major contractors has been suggested. Possible details have yet to be worked out.

9.3.4 More autonomy

The pendulum seems to have swung too far away from giving technical staff authority to deliver technical solutions. The MIG model, in which infrastructure funds are ring-fenced and the PMU manager reports directly to the municipal manager, should ensure speedy allocation and use of funds. This can only happen when there is sufficient technical capacity to drive the projects.

In the USA after the state downsizing exercises of the 1980s and 1990s, it was necessary to contract out a lot of work. Agency staff found that their roles had changed in that they

> *'… focused less on engineering work and more on contract administration and management of others who were doing the engineering work …'*[28]

However, they still needed a background in engineering to assess the solutions.

Should the MIG approach achieve what it set out to do, the model should be extended to all infrastructure delivery and not be limited to basic services, in order to give technical capacity the autonomy to deliver, operate and maintain the necessary services.

9.4 Views of the Department of Provincial and Local Government (DPLG)

In summary, the DPLG National Capacity Building Framework captured most of the points raised very concisely in describing capacity constraints within local government. See Tables 9.5 and 9.6.

Sadly, although this demonstrates an understanding of the problems, few interventions have been put in place to retain the dwindling pool of civil engineering professionals and attract and train new blood.

CONCLUSIONS

It generally takes a widely acknowledged crisis before partners cooperate in order to resolve the problem … civil engineering capacity constraints in all levels of government are there now – and it is time to act!

Bottlenecks are severe. If these could be overcome, the flow of work could dramatically increase. This will require more technical staff not only in local authorities, but in the consulting, contracting and supply sectors. By improving the growth, poverty alleviation and job creation would take place organically without the need to create additional interventions such as the EPWP and the charters.

Table 9.5 DPLG National Capacity Framework – institutional capacity constraints

Institutional capacity constraints
Insufficient staff contingency and the seemingly non-availability of appropriate candidates because of inability to attract these individuals into the local government arena as well as the lack of such trained or graduated individuals
Mismatch between the staff contingency (organogram) and the functions to be performed
Insufficient strategic leadership to drive large-scale change management and developmental processes
Insufficient political leadership capable of guiding the change process.
Limited understanding of the developmental organisational purpose and vision.
An organisational culture that does not uphold the principles of service delivery.
Bureaucratic and hierarchical structures and systems that limit functional relations and programme and project based activities as created and demanded within their IDPs.
Dissipated organisational memory owing to continuous transformation and lack of knowledge management
Low degree of internal confidence and sense of progress
Lack of: ■ internal operational infrastructure and technology ■ infrastructure for external service delivery to communities ■ office infrastructure and equipment needed for minimum operational proficiency ■ appropriate consolidation of systems and structures to stabilise finances and begin to ensure service delivery and development. (National Capacity Building Framework, version 1.7)

Table 9.6 DPLG National Capacity Framework – individual capacity constraints

Individual capacity constraints
Lack of competency, which leads to the inability to simply do tasks
Poorly defined job descriptions
Recruitment and selection of staff not in line with job descriptions
Inadequate requisite technical skills in critical functional areas.
Inadequate knowledge and information base within municipalities.
Poor understanding of local government legal framework
Insufficient expertise to interpret and translate legislation and policies into action
Lack of in-house technical abilities to develop systems, support internal processes, perform all the municipal functions and to accommodate new functions
Lack of service-oriented attitude and behaviour

New mechanisms ought to be considered whereby delivery can be accelerated and technical staff have the authority to supply, maintain and operate infrastructure. By removing delivery from the protracted processes and controls now inherent to government, decisions will be made quickly, staff will be dedicated to their function, and will devote their time to delivery, operations, maintenance, training and knowledge transfer.

To build long-term capacity, remuneration and benefits should be reviewed to retain existing staff, attract young staff and harness retired staff to initiate projects and train young staff.

Building blocks

- **Capacity:** For the country to deliver on a scale and at the rate needed to prevent inadequate infrastructure from blocking economic growth, all tiers of government will have to increase their technical capacity.
- **Authority:** The efficiency of infrastructure delivery structures will have to be drastically improved. For delivery to be driven at the required rate, those with the expertise need to be given authority.

RECOMMENDATIONS

Reconstruction required

- **At least 500 civil engineering professionals are needed in local government:** Considering the number of vacancies, a major campaign needs to be mounted to identify those who have left the industry, be they young or retired staff, in order to drastically increase capacity at the appropriate levels. To absorb the number of students who cannot obtain experiential training and graduates who cannot find work, teams should be constituted to carry out the work per municipality or department as follows:
  - A senior professional to initiate projects, supervise and coach junior staff according to a structured training programme
  - Two graduates requiring candidate training, who will carry out the work under supervision

- Two students requiring experiential training who will assist and learn from the graduates and coach

- **Succession planning:** Succession plans need to be set up to ensure that new leaders are well trained and are ready to take over from those who will be retiring in the next few years.
- **Different structures to deliver services:** To release civil and other engineering professionals from administrative posts and structures, separate infrastructure delivery units should be set up with their own budgets, purchasing power and authority to recruit suitable staff. This should speed up the delivery process and ensure that efficient operations and systematic maintenance systems are implemented.
- **Authority:** Senior engineering professionals should be involved at a strategic level. A mandatory technical leader per local authority should be created.
- **Learnerships:** All national diploma students should be signed up in learnership programmes to ensure that they are adequately funded during their studies and have automatic access to experiential training. When the Stage II learnerships are registered, all graduates should be included in the learnership system.
- **Salaries:** Remuneration must be reviewed urgently and scarce skills and regional allowances should be considered. Such reviews should not be restricted to civil engineering staff, but carried out across all structures. Market-related salaries should be considered for all posts to ensure optimum use of funds and the best quality of staff for serving the public.
- **Identification of work appropriate to engineering professionals:** Recognition of the appropriate skills for the task is essential for sound delivery, operation and maintenance. All departments should review the qualifications and experience demanded in the previous structures for effective service delivery and management.
- **Utilise the whole skills base:** The professional skills base is currently too small to apply equity criteria for staff selection at all ages. It will be necessary to negotiate with government to reconsider employment policies and equity targets relating to scarce skills.

  For the short term at least it will be necessary to set targets relating to graduation statistics and redeploy senior experienced professionals to:
  - Initiate, adjudicate and manage projects at all levels of government
  - Serve as knowledge coaches in all levels of government, with specific guidelines on their role, and the outcomes required, including the registration of all young graduates with ECSA
- **PPPs, franchising, agencies:** Where capacity constraints cannot be overcome, alternative models should be considered to ensure sound delivery, maintenance and operation of services.

Suggested Construction Charter activities

- **Councillor empowerment programme:** The SAICE empowerment programme has been developed to enlighten councillors on the technical complexities involved in delivering, maintaining and operating infrastructure. Companies should be encouraged to provide staff to assist with delivering these courses, or give donations towards delivering these courses at all local authorities.
- **Secondment of capacity:** Private sector companies could consider seconding staff to government departments for short periods to initiate and manage projects as well as train young staff.
- **Training of young people in departments:** Where municipal or government depart-

ments are unable to train young people in various aspects of the project cycle, contractors or consultants could offer training in their organisations for an appropriate period. The cost of the hours donated for each of these could be used as the value of the investment.

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PART V
CONCLUSIONS

Contents

CHAPTER 10

Numbers and needs

INTRODUCTION

It is now necessary to consider the number required in the industry. An analysis of each sector indicates that the problem is very complex, that there is a definite shortage, and that the load being carried by many people in the industry is unsustainable. Furthermore, there is a great deal of pressure for the industry to transform as fast as possible.

Although manpower planning is frowned upon, because it may develop too many for a particular industry, South Africa is now so short of experienced civil professionals that mechanisms must be set in place to start addressing the shortages. Without a quality supply, South Africa cannot hope to 'create the world' that it has in mind.

From the Office of the Chief Economist in the Department of Trade and Industry[1] we are told,

> *'… the problem arising from deficits in high skills will only be resolved over the long term. In the absence of short term solutions, strategies need to be devised to urgently address … the deficit so that growth, development … can be achieved …'*

To ensure that there is an adequate supply of professionals to address the country's needs, it is necessary to look at:

- the current numbers in the field to determine the scope and volume of tertiary education required
- other mechanisms for immediately increasing the pool of appropriately qualified and experienced staff

THE STATUS QUO

10.1 Demand

Given that R200 billion or more is to be spent on infrastructure in the next five to seven years, the view is that the civil engineering industry is entering a long-term growth phase. Growth will continue beyond 2010 because the expansion of infrastructure, upgrading of basic services and maintenance of the greatly extended network will be required.

This growth was predicted as far back as 1998 in a study commissioned by Pretoria Portland Cement to predict the long-term demand for cement. (See Figure 10.1.)

The actual performance shows that the predicted turnaround has begun. The challenge is to ensure that there is sufficient capacity to cope with the dramatically increased work-load, since achieving these optimistic predictions is not possible with the current number of professionals in the industry.

10.1.1 Vacancies

Chapters 2 and 3 outlined the demand for civil engineering staff in the private and public sectors.

'Scientists discover the world that exists; engineers create the world that never was …'

– Theodore Von Karman, Aerospace Engineer

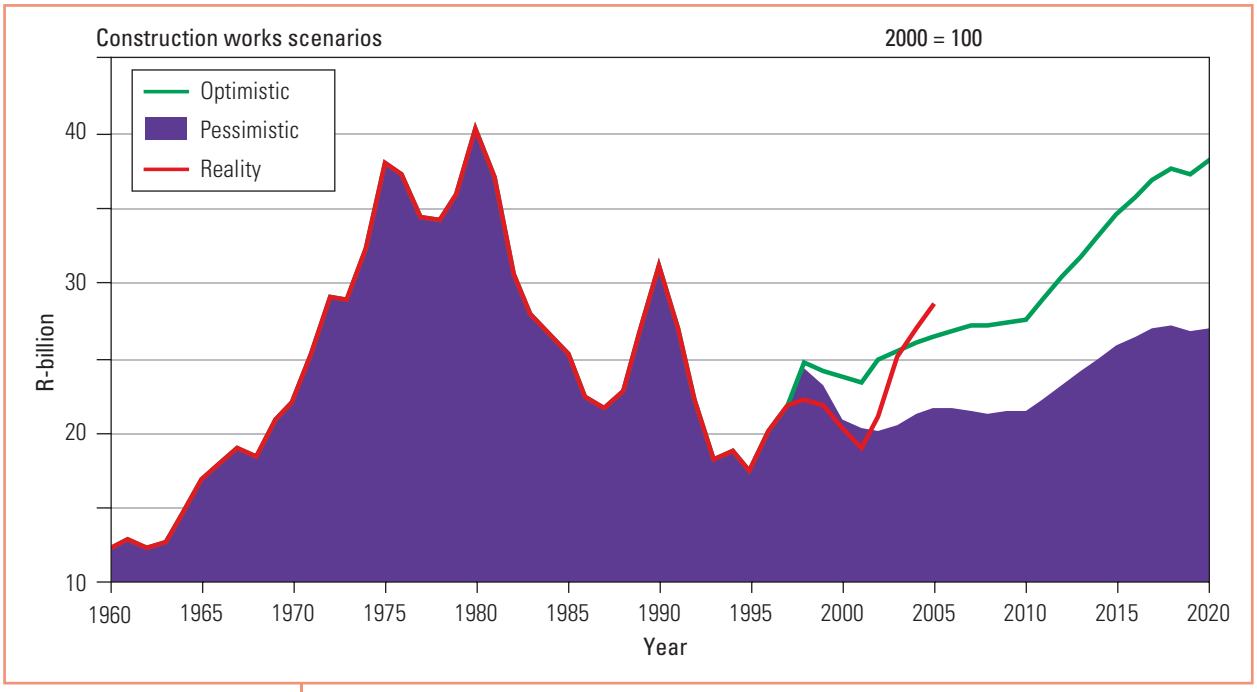


Figure 10.1 Spending in civil engineering construction, actual and projected, 1960–2020

Vacancy levels already present a huge problem in terms of current workload. In local government alone vacancies amount to at least 1 000. Vacancies in parastatals, provinces and central government represent a further 500 or more.

Academia, although facing severe financial constraints, also complains of not being able to attract staff. Consulting, contracting and the supply chain also expressed frustration at not being able to source suitably qualified staff. Vacancies in the private sector therefore represent a further 300 to 500.

There are therefore 1 500 to 2 000 civil engineering vacancies in South Africa today, many of which require highly experienced staff.

10.1.2 Increased workload

The increased workload predicated presents an enormous challenge in terms of being able to supply sufficient skills.

In considering the viability of the huge investments required to develop and upgrade the transport network, the Department of Transport estimates than an additional 945 to 1 890 staff will be required by consulting practices in the private sector within the next few years. This translates roughly to a 7,5% to 15% increase, that is, 450 to 900 more engineers, technologists and technicians. They also suggest that an additional 310 to 3 060 highly skilled staff will be required by contracting companies in the private sector. When one considers the mix of professionals in the built environment this could mean 100 to 1 000 more civil engineers, technologists and technicians, a 5%–50% increase in the number currently employed in civil engineering contracting. They also suggest that 70 to 710 highly skilled staff will be required in provinces and central government to support the increased expenditure.

The Department of Water Affairs and Forestry (DWAF) has ambitious Millennium Development Goals (MDG) to address. Similar numbers of staff could therefore be needed for water and sanitation projects.

The Gautrain project is expected to require 700 to 1 200 civil engineering professionals during its design and construction.

All these projections indicate that a further 1 500 to 4 000 civil engineering professionals could be needed to handle growth and development projects if they were all to take place at the same time.

When one considers vacancies and increased workload, South Africa appears to need an additional 3 000 to 6 000 civil engineers, technologists and technicians.

10.2 Supply

Chapters 5, 6 and 7 outlined the supply chain. This included students who occupy experiential training posts, graduates and experienced professionals operating at all levels. These staff are to be found in many sectors as shown in Figure 10.2.

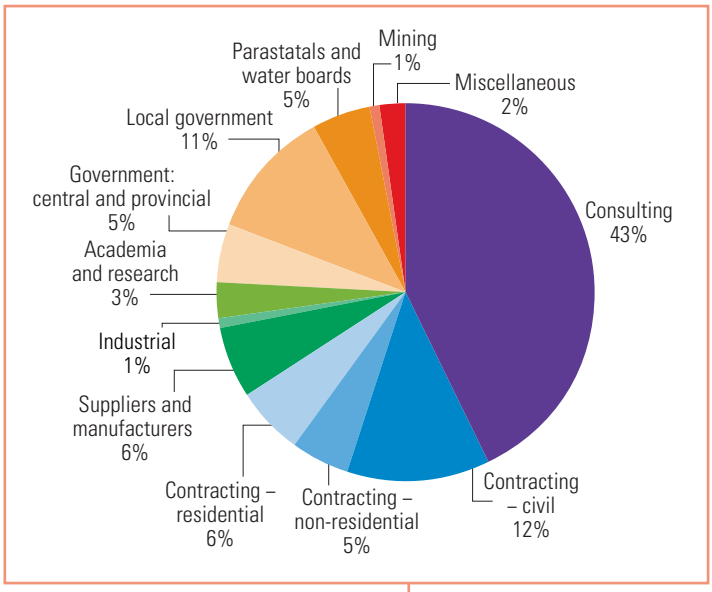


Figure 10.2 Distribution of civil professionals per sector

10.2.1 The number in the industry

Table 10.1 shows the breakdown of all civil professionals in South Africa. An allowance of 10% has been made to account for companies that are not associated with any of the stakeholder bodies, as well as small or specialist sectors that may not have been included in the survey. The columns represent all engineers, technologists and technicians, whether they are registered with ECSA or not. Table 10.2 shows the breakdown of those who are registered or not registered.

The ratio of engineer to technician/technologist is 1:1,3.

Table 10.1 Industry utilisation of civil engineering professionals

Sector	Engineer	Technologist	Technician	Total
Consulting	2 977	865	2 024	**5 866**
Contracting – civil, non-res and res	1 012	101	2 030	**3 143**
Suppliers and manufacturers	309	84	408	**801**
Mining and industrial	198	22	13	**232**
Academia and research	343	73	53	**469**
Government – central and provincial	222	47	438	**708**
Local government	376	368	780	**1 524**
Parastatals and water boards	297	119	316	**732**
Miscellaneous	189	33	12	**233**
Add 10% for sectors not covered, and companies not registered with stakeholders	592	171	607	**1 371**
Total	**6 515**	**1 883**	**6 681**	**15 079**

Table 10.2 Registered versus non-registered civil engineering professionals practising in South Africa, established from field research

	Registered Pr Eng, Pr Tech Eng or Pr Techni	Not registered or registered as a candidate	Total
Engineer	3 915	2 600	**6 515**
Technologist	966	917	**1 883**
Technician	516	6 165	**6 681**
Total	**5 396**	**9 679**	**15 079**

The human resources (HR) survey was designed to establish the mix of professionally registered and unregistered or candidate professionals. Although most companies in the private sector keep reasonably accurate records on registration status, the distinction was not always understood. HR departments in the public sector were seldom able to provide registration information. It was necessary to contact the engineering departments in many organisations to extract this breakdown.

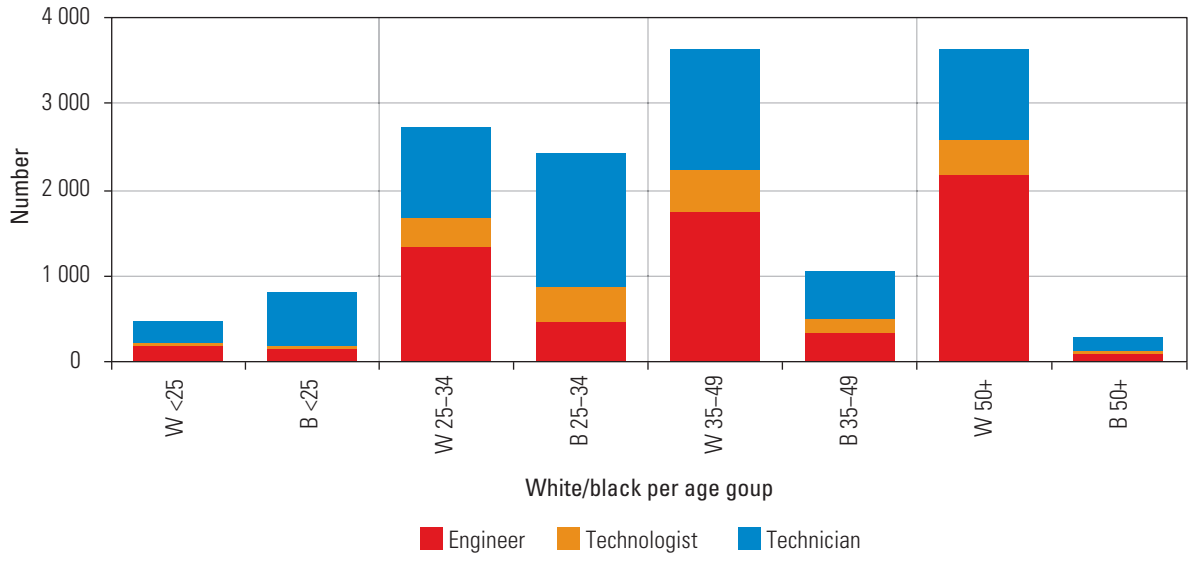
It is believed that the various surveys were sufficiently comprehensive for the above totals to be considered an accurate assessment of the total number of engineers, technologists and technicians employed in civil engineering in South Africa.

Figures 10.3 and 10.4 give an indication of the age spread and transformation in the industry.

(a) Cross-checking against ECSA registrations

As a cross-check, ECSA data was studied. Since it is not currently necessary for all practising engineers to register, direct comparisons with ECSA figures can only be made for registered staff. Those who are not registered are generally staff who are not responsible for signing off projects; many are employed in state departments, where promotions are not linked

Figure 10.3 The transforming profile of civil engineering professionals employed in South Africa, by age and qualification, 2004



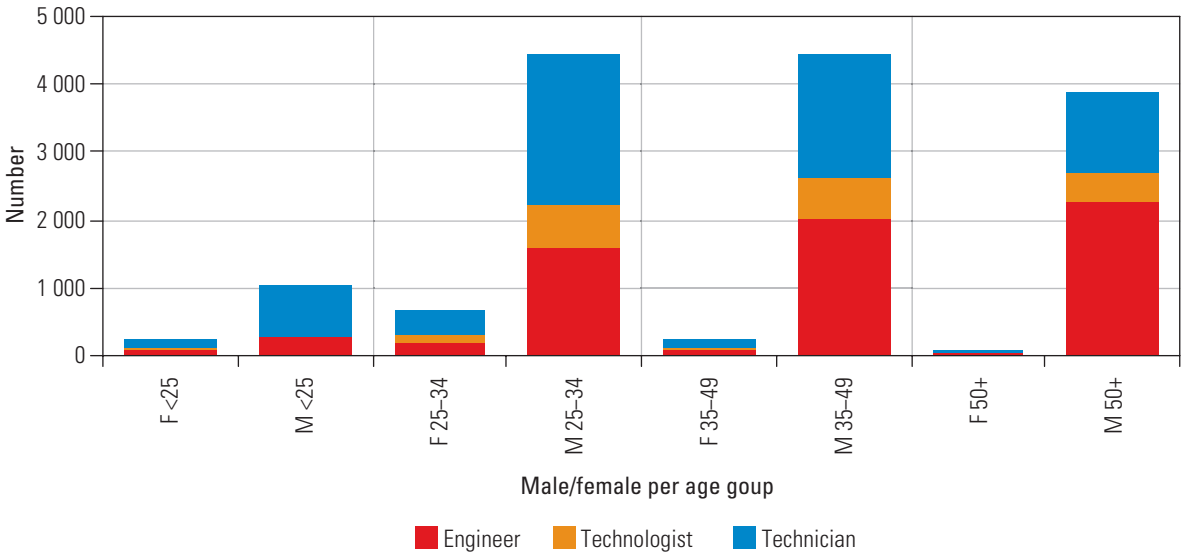


Figure 10.4 The gender profile of civil engineering professionals employed in South Africa, by age and qualification, 2004.

to registration; and many are juniors, prior to or during their candidate phase. The ECSA statistics relating to civil engineering are summarised in Table 10.3.

ECSA registration has no age restriction, and the register contains many professional engineers who have long since retired. Twenty five per cent of all civil engineers in the ECSA database are over 63 years of age. Furthermore, approximately 500 are living overseas. This sets the nett number of civil Pr Eng below age 63 in South Africa at around 4 275, which is slightly higher than the findings from the field research. The difference can be attributed to organisations that could not furnish registration status, those who retired earlier than 63, and those who have left the industry, but retain their registration in case they should wish to return. (The difference represents a pool of engineers who should be enticed back into the industry.)

There is not a great deal of pressure on technicians to register, hence there is little correlation. In addition employers are not sure about this category of registration, as it has only recently been introduced. It is also suspected that some Pr Tech Eng were submitted as Pr Techni as there is confusion over the two designations.

Table 10.3 ECSA registration status of civil professionals, May 2005

Registration	Male	Female	White	Black	Total
Pr Eng	6 246	120	6 134	232	**6 366**
Candidate Pr Eng	664	127	574	217	**791**
Pr Tech Eng	1 153	18	1 023	148	**1171**
Candidate Pr Tech Eng	317	30	168	179	**347**
Pr Techni	343	4	316	31	**347**
Candidate Pr Techni	293	56	84	265	**349**

ECSA

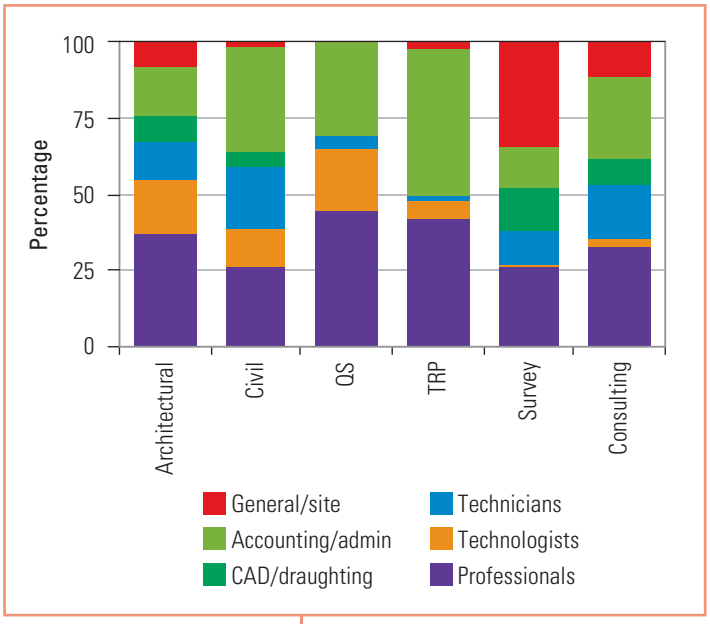


Figure 10.5 Utilisation of professionals in the built environment

For technologists to break through the glass ceiling, a Pr Tech Eng is essential. Here 10% of technologists registered with ECSA are older than 63, and around 60 live overseas, so again there is excellent correlation (within 3%) between ECSA figures and field research.

(b) Professional ratios

In other professions in the built environment, the ratio between university and technikon graduates (the ratio of purple to the total of the orange and blue in Figure 10.5) is roughly 1:1, although in quantity surveying, town planning and surveying, the number of university-trained professionals is higher than technikon trained.

The ratios found in practice reflect the ratios in tertiary institutions in all but civil engineering and building science. Civil diplomates exceed the number absorbed in industry. Most companies will attest that they are inundated with letters from technikon students pleading for experiential training and employment after graduating. The appropriate number to be trained requires attention.

10.2.2 The student population

In a balanced system, those exiting should be replaced with those entering. However, losses owing to emigration, people leaving the industry, early retirement and ultimately retirement have exceeded the numbers graduating for several years. To handle the increased workload, the workforce must be increased through more graduations. To determine whether this is possible, long-term enrolment and graduations need to be considered.

The year 2004 saw a dramatic increase in the number of students enrolling at all universities and to a lesser extent at technikons. Hence from 2008 a slightly increased inflow could arise as a result of increased graduations. However, from 2009 onwards the outgoing tide of retirements will impact negatively on the workforce.

The number of graduates entering the industry (Table 10.4) is lower than the total graduations as many students are foreign and return home; many young graduates go overseas for a few years; and others go into other fields immediately. Unfortunately, the HR survey did not ask about immigration. The immigration figures shown below are therefore an estimate developed from Statistics SA figures, de Beers research[2] and a study of the difference between the number of black engineers in the industry and the number of black engineers who have graduated from South African universities.

The technician figures are assumed to reduce towards the end of the period, as a result of the Department of Education's capping policies, which are currently under review.

10.2.3 The nett effect

The nett effect has been negative for the past few years. With increased national diploma graduations, there will be a nett gain of 627 civil engineering professionals entering the market-place from 2005 to 2009, but with the onset of mass retirements from the end of 2009, the nett gains will be only 20 or 30 a year for five to ten years.

Table 10.4 Losses and gains in the industry if no interventions are put in place

	2005	2006	2007	2008	2009	2010
Gains						
BSc/BEng	135	165	175	195	205	205
National diploma	435	485	520	500	500	500
Immigration	40	40	50	50	45	40
Total	**610**	**690**	**745**	**745**	**750**	**745**
Losses						
Leave the industry including premature deaths	121	124	124	126	127	127
Emigrate	220	230	210	210	210	210
Early retirement	106	46	60	64	56	71
Retirement	145	209	106	181	238	255
Total	**592**	**609**	**500**	**581**	**631**	**663**
NETT	**18**	**81**	**245**	**164**	**119**	**82**

A simple model has been created to visualise the dynamics of demand and supply. In Figure 10.6, the bucket symbolises the 'bucket load' of work to be done, and the water level represents the professionals available to do the work.

At present, according to all the analyses, the bucket is not full, because there are many vacancies. The workload is expected to increase; hence the size of the bucket will increase.

Figure 10.6 The emptying civil professional capacity bucket

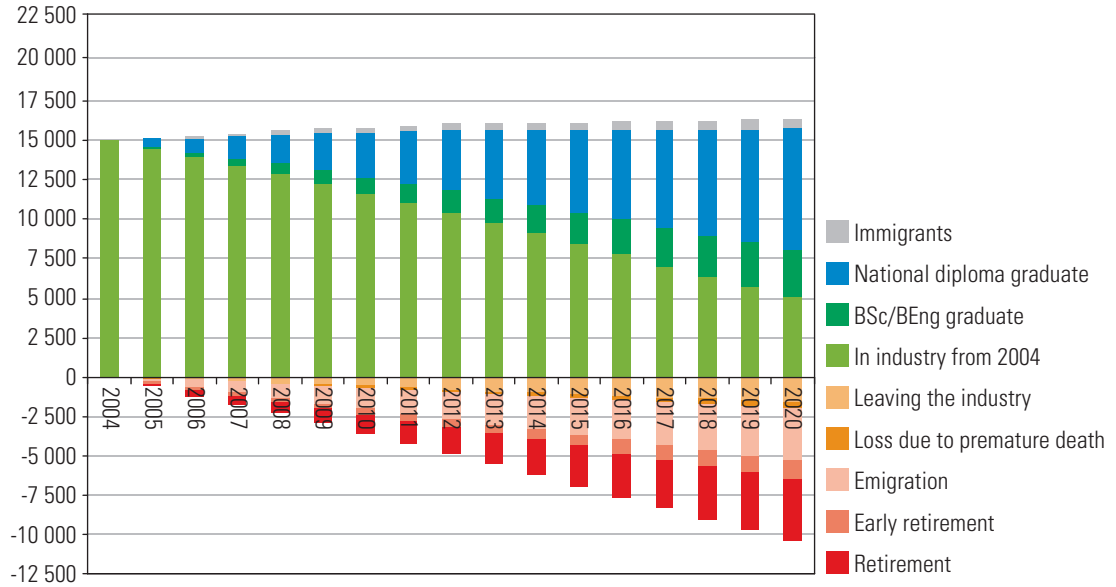


Figure 10.7 Civil engineering capacity – the 'do nothing' approach

To keep the water (or staff) at least at its current level in relation to the work, a significant inflow is required.

Looking at the inflow and outflow, assuming that no interventions are put into place, there will be negligible nett inflow of staff when the workload is increasing at a formidable rate!

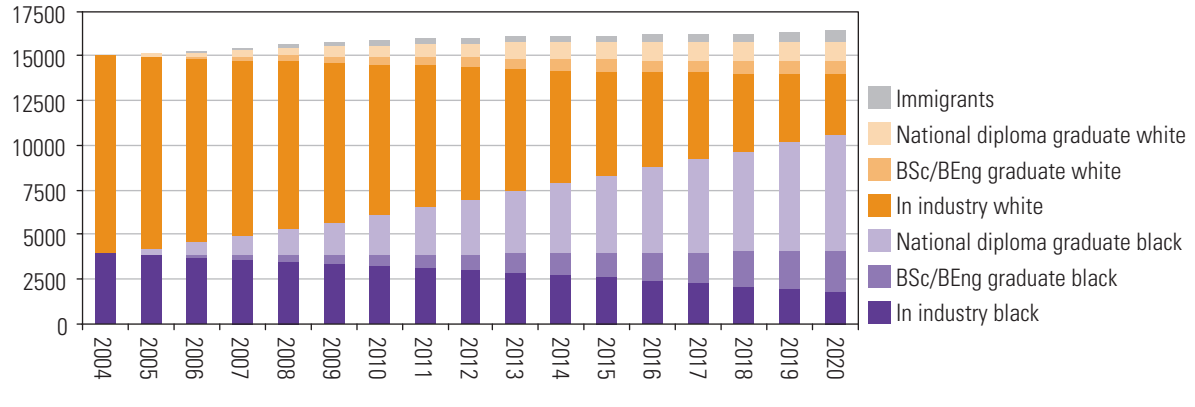
Figure 10.7 shows the 'do nothing' scenarios over a longer period. It can be seen that at the current rate of gains and losses, the workforce will increase by only 8% over the next 15 years.

10.2.4 Transformation

The profile of the younger group shows that recent efforts in terms of career guidance and the increased number of bursaries specifically for PDIs have had a significant effect on transformation (see Figures 108 and 10.9).

Figure 10.8 Transformation in civil engineering

It is assumed that graduates from technikons will represent racial demographics of South Africa by 2011 and universities by 2013. This will only be possible if the number of African



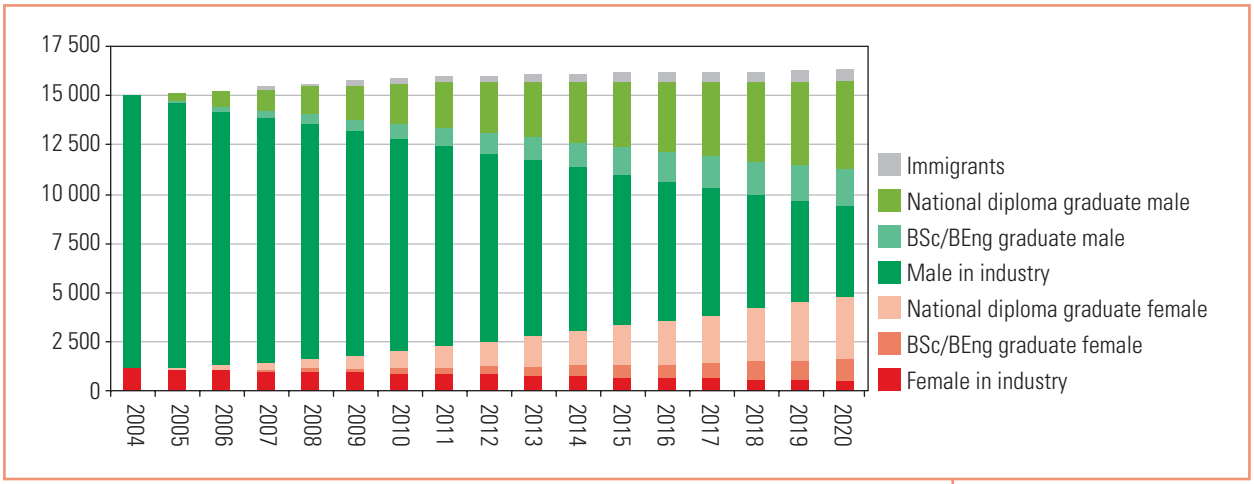


Figure 10.9 Gender in civil engineering

matriculants in particular with higher grade A, B or C symbols in maths increases significantly over the next three years.

Gender transformation is likely to take longer because the ramp up from limited participation to full participation is not taking place at the same pace as racial transformation. On average the female student population has been increasing by 1,5% per annum over the last ten years. Unless major campaigns are directed specifically at women, it is unlikely that graduations will reach 50% female before 2015 for technikons and 2018 for universities.

In canvassing for more entrants into the profession, it must be remembered that women constitute a virtually untapped pool of resources to be developed.

THE CHALLENGE – HOW MANY NEEDED?

The number of graduates is inadequate to address the country's growth. It is now time to determine the numbers required through tertiary institutions.

10.3 International benchmarks

Civil engineering is only one of the engineering disciplines that are registered by ECSA. The total number of engineers and candidates is given in Table 10.5.

When international ratios of engineers to population are quoted, they are usually based on figures from the registering bodies of each country. Many registering bodies similar to ECSA quote only the number of professional engineers registered in their country.

Other countries quote all engineers, whether professionally registered or not. It was not always clear whether the figures received were for all engineers or only registered engineers, although it was interesting to discover how many countries in South America, sub-Saharan Africa and Southeast Asia do have registering bodies and follow processes similar to ECSA.

The numbers were gleaned from a combination of an extensive desktop survey[3,4,5,6] and contacting various institutions and registering bodies where possible. Much of the published data has come from widely scattered sources with varying degrees of reliability and detail, and dates of datasets varied to some extent. This may have led to minor inconsistencies in Table 10.6, hence the figures serve only as an indication of the engineer to population status.

South Africa is perceived to be technologically stronger than many countries. It is disquieting that the ratio of population to engineer in South Africa is not significantly better than Zimbabwe, Namibia and Tanzania and other less developed countries.

Table 10.5 Pr Eng in ECSA – all disciplines

Discipline	Pr Eng	Candidate engineers	Total
Agricultural	217	34	251
Chemical	783	304	1 087
Civil	6 364	785	7 149
Electrical	2 769	718	3 487
Mechanical	2 941	796	3 737
Mining	424	101	525
Metallurgical	285	62	347
Materials	2	6	8
Industrial	154	71	225
Marine	10	0	10
Aeronautical	38	9	47
Electronic	471	376	847
Electro-mechanical	320	27	347
Total	**14 778**	**3 289**	**18 067**

ECSA

Recognition of a dual economy and the need to bring the entire population into the economy requires that the country develops infrastructure to support this transition. To achieve this, the ratio should be closer to developing countries.

When stratifying the success of education according to ethnic group (in Chapter 4), a disparity was evident. Similarly, when one compares the number of white engineers with the white population only, the ratio matches that of industrialised countries. (See Table 10.6.)

Many years ago, when studying commercial activities in South Africa, Dr Hall, a scenario planner, concluded that the numbers employed to serve the white population matched those of the Western World, hence the impressive first world infrastructure serving mainly the white communities concentrated in the main cities.

He concluded that if the country was to tackle service delivery in all forms, including legal, financial, and infrastructure, the number of professional staff would have to increase dramatically to address the needs of the whole population.

Unfortunately, instead of increasing the number of professionals, South Africa is steadily reducing them to achieve the required ratios for equity targets. This reduction is taking place at the expense of service delivery and poverty eradication.

Continued development and maintenance of economic and social infrastructure for the whole population must take place, so the civil engineering pool must be vastly augmented (see Table 10.7).

The 50 068:1 ratio of black population to black engineers is considerably higher than in most countries. To bring this figure down to 6 000:1 (the best figure reported elsewhere in Africa) will require 7 084 more engineers to enter the system. This will improve the national ratio to about 2 322:1, which is slightly better than Korea.

If this is attempted over a ten-year period, an additional 710 engineers must graduate per annum. The current number graduating is in the order of 1 400, which means that a 50% increase in graduations is required, without taking other adjustments into account, such as emigration, the large number of retirements due to take place over the next few years, and

Table 10.6 International engineer and doctor to population statistics

Country	Population	No of registered engineers	Population per engineer	Population per doctor
Norway	4 600 246	37 685	122	308
China *	1 300 000 000	10 000 000	130	593
Finland	5 357 934	39 537	136	304
India *	1 020 000 000	6 500 000	157	2 320
Greece	15 000 000	87 337	172	199
Denmark	5 520 295	30 926	179	273
Canada	30 337 000	169 512	179	475
Sweden	9 254 613	44 352	209	291
Germany	82 443 000	380 000	217	291
Brazil	184 203 744	811 483	227	379
Iceland	270 603	1 019	266	283
France	60 656 178	220 000	276	297
Ireland	3 917 203	14 000	280	362
Japan	121 000 000	400 000	303	476
UK	58 821 000	189 406	311	492
USA	296 771 226	762 000	389	361
Argentina	36 260 130	80 000	453	354
Australia	20 372 452	44 767	455	414
Hong Kong	5 000 000	10 798	463	617
Malaysia	25 500 000	47 000	543	1 436
Chile	14 973 843	22 000	681	2 025
Poland *	40 265 683	53 796	748	408
Singapore	4 240 000	3 161	1 341	318
Korea	45 985 289	21 534	2 135	585
Hungary	10 661 747	4 815	2 214	437
Romania	23 434 194	8 056	2 909	523
South Africa	**46 888 200**	**14 806**	**3 166**	**1 493**
Sri Lanka	18 732 255	3 348	5 595	-
Tanzania	36 766 356	6 200	5 930	-
Namibia	2 030 692	320	6 346	4 545
Zimbabwe	12 746 990	2 000	6 373	7 092
Swaziland	979 000	80	12 238	9 100
Zambia	11 261 795	881	12 783	11 100
Ghana	21 029 853	1 644	12 792	2 500

* May represent all engineers and not just registered engineers

Table 10.7 South African engineers to population ratios

	Engineers	Population	Ratio
White Pr Eng	13 957	4 379 800	314
Black Pr Eng	849	42 508 400	50 068
National	14 806	46 888 200	3 166

the increasing workload. In terms of graduation figures for civil engineers, this would mean increasing the number of graduates from 180 to 270. Unfortunately, attempts to increase the number entering universities now will augment the number of registered engineers in only seven to ten years time.

South Africa must retain all professionals and urgently implement interventions to grow the pool of black professionals. Capacity to deliver depends not only on numbers but also on ability and experience. This can only be provided by senior engineers making critical technical decisions and carrying out production work or training younger engineers to their level, or both.

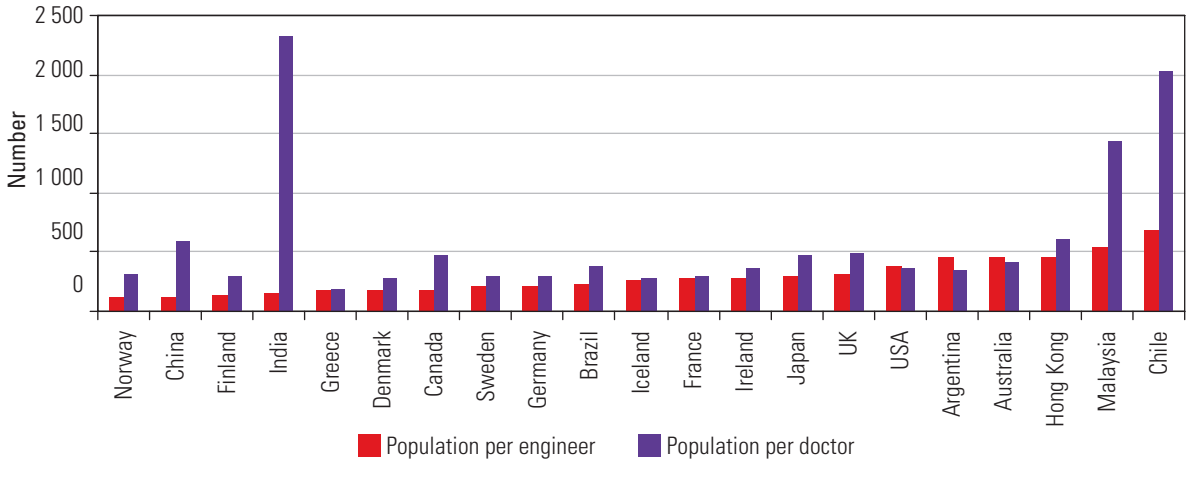
Table 10.5 offers a perspective on the benefit of engineers on health in the developed world by comparison with developing and underdeveloped countries. In the developed world, in all countries except Australia and the USA, and also in developing countries where one engineer services 750 people or less, there are more engineers than doctors (see Figure 10.10). In developing countries, other than Zimbabwe, there are more doctors than engineers (see Figure 10.11).

Professor Harry Seftel, retired professor of medicine and chief physician at Hillbrow Hospital, once wrote

> *'… during the first half of the 20th century, the life span doubled in the Western World. The doubling had little to do with the efforts of the medical profession. The striking increase was mostly due to engineers whose technology produced a vast improvement in environmental and social hygiene. This included the provision of clean air and water, sanitation and water-borne sewerage, housing, electricity, roads and transport …'*

South Africa needs more civil engineering professionals – but how many?

Figure 10.10 Engineer and doctor to population in developed and developing countries



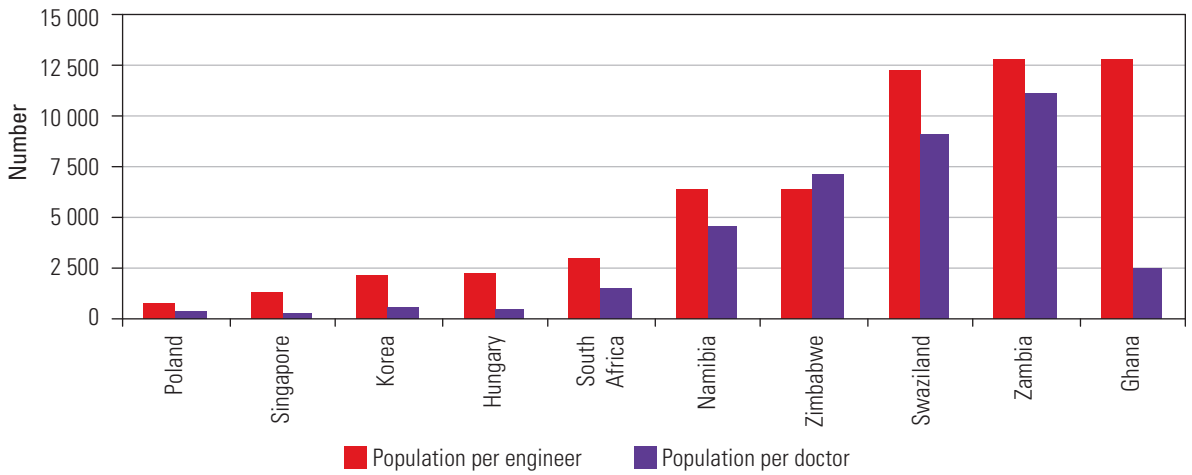


Figure 10.11 Engineer and doctor to population in some developing and under-developed countries

10.4 South Africa's needs

10.4.1 The numbers to be educated and trained

Deciding on the numbers to be trained is a huge challenge. The calculations that are presented below are intended to stimulate debate and to elicit input to fine-tune the model for planning future education and training.

Using the professional figures above, the annual graduations required to maintain the current status quo are determined by dividing the typical career span in civil engineering by 40.

Thereafter, figures are inflated to make up for increased vacancies that will occur from 2009 onwards as a result of retirement; losses owing to emigration and people leaving the industry; and allowing for training students from neighbouring states and further afield.

To graduate 285 civil engineers per annum is a challenge. In addition, 374 national diploma graduates would be required per annum to provide 291 technicians and 83 who will later become technologists.

South Africa lags behind in terms of the number of engineers. To address this, the above base figure should be increased by the 50% determined above. This would mean that 427 engineers and 561 technicians should graduate annually.

Table 10.8 The numbers to be trained per annum

Adjustments	Engineer	Technologist	Technician	Total
Number in industry December 2004	6 515	1 883	6 681	**15 079**
Need to be trained pa based on a 40-year career	163	47	167	**377**
Adjustment for huge number retiring in next 8 years	43	13	44	**100**
People leaving industry / emigrating	69	20	70	**159**
Foreign students add 6%	10	3	10	**23**
Total to train pa to maintain status quo	**285**	**83**	**291**	**659**

Increasing university numbers to 427 per annum appears to be a tall order.
In 1988, when Hugo et al[7] attempted manpower planning for the industry, they stated

> *'… it is generally agreed that a total of between 300 and 350 professional civil engineers are annually required until the turn of the century … this will require 5 properly staffed departments across the country … these levels … cannot be achieved without decisive government intervention …'*

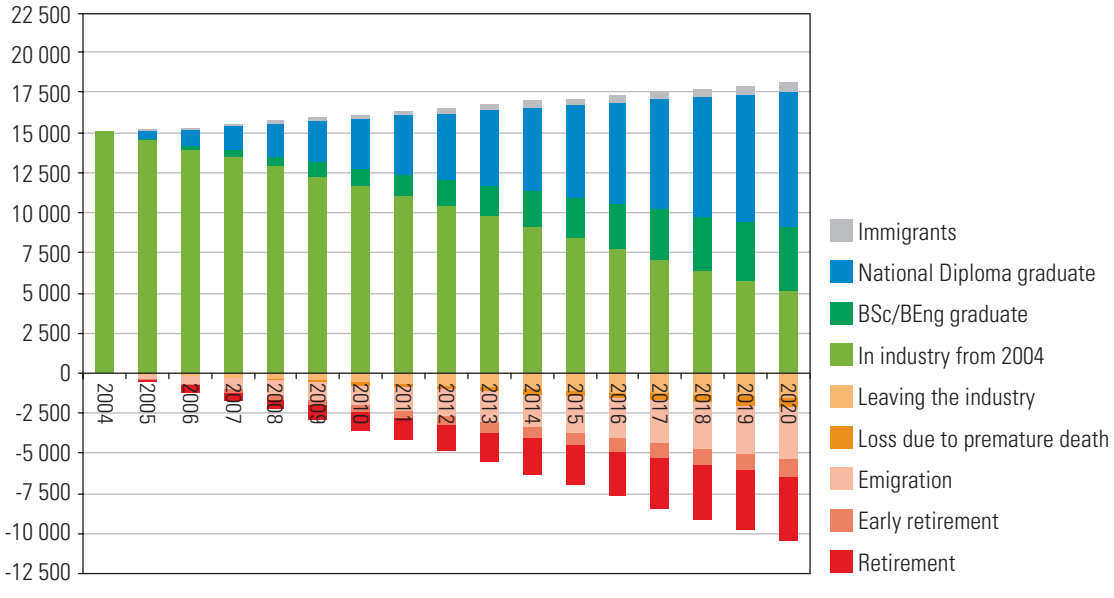
This intervention did not take place, and the numbers graduating dwindled to fewer than 150 in 2003, resulting in the current skills crisis facing the civil engineering industry in South Africa. Had the recommendations been implemented, South African would now be richer by 2 000 civil engineers and would not be facing a crisis of this magnitude.

The 1988 report should be revisited as a matter of urgency in terms of resourcing institutions. The need to employ at least 25 academic staff per department to ensure an adequate spread of expertise in all teaching subjects was particularly interesting. The number is now substantially lower in many departments and some subjects can no longer be adequately covered at all institutions, hence the shortages described in Section 7.8.

The findings in the above report are still applicable, and will form part of the recommendations.

It has been suggested that up to 15% of the engineers in the industry could be replaced by technologists. A number of initiatives have been set up to identify high-calibre technicians for studies towards a BTech and further coaching. This could reduce the number of civil engineering graduates that are required to 363. This is still a tall order, because it requires doubling the current graduations of engineers. Further, the increase should be focussed on African graduates to address the demographic imbalance. Similar increases are possibly also required in the other engineering departments. The number of African matriculants with A, B or C in higher grade maths would thus need to increase by 2 000 to 2 500 to allow for these additional engineering graduations.

Figure 10.12 The effect of increased graduations on civil engineering capacity



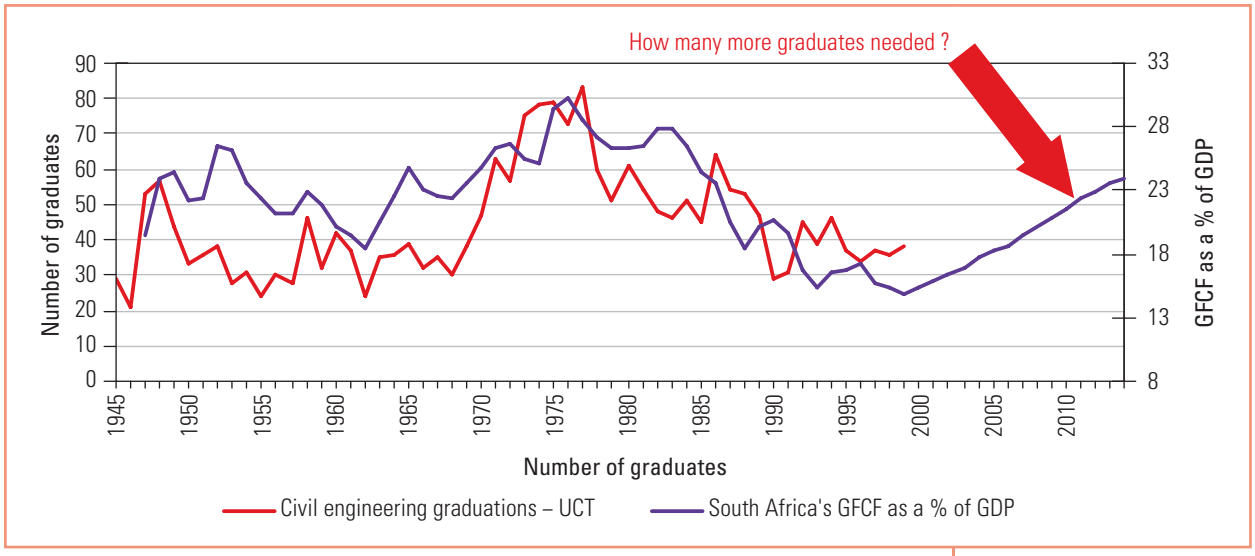


Figure 10.13 The fifty-year construction cycle[9]

The total number of technicians required would be 625. The current numbers are fairly close to this figure, requiring only a 25% increase in output. Many technicians do not graduate because they cannot find experiential training opportunities. Shortly before going to print, one technikon reported that only two out of 23 S3 students had been able to complete their experiential training. At this particular institution students cannot proceed to S4 until their experiential training has been completed. It would not be difficult to increase the number of diplomates, provided that the technicians can be placed in industry and are of the calibre that industry is prepared to invest in. The biggest challenge for technikons will be to produce quality graduates, with appropriate qualifications that industry will use. The challenge for industry will be to find sufficient 'knowledge coaches' to train and develop these young people.

Figure 10.12 shows what will happen if these recommendations are implemented. The total number in the industry will have increased by 20% (3 057) in 2020, assuming that the above numbers of graduates per annum are achieved by 2013. (It has been assumed that 12% will not come into the industry after graduation.)

There is always concern that increasing graduations in boom times may prove foolish, as the next 'bust' period will not sustain the numbers. But civil engineers have moved into many other walks of life and have been successful. No education and training is ever wasted.

However, one can see from the long-term view presented by Murray and Roberts in their recent Stakeholders Report[8] that the previous boom cycle lasted 35 to 40 years. Given the huge development challenges in South Africa and the rest of Africa, increasing the number of graduates at this stage is essential and is not over ambitious. Graduations have always followed construction activity. It is interesting to note that UCT graduations as far back as the forties were no exception (see Figure 10.13).

(a) Engineer to technician ratios

The number of engineers in the industry has been dropping. In the 'do nothing' scenario, engineers would have dropped from 44% of the team in 2004 to 30% in 2020. Technologists would have increased from 12 to 15%. The view is the overall drop of technologist plus engineer is too drastic.

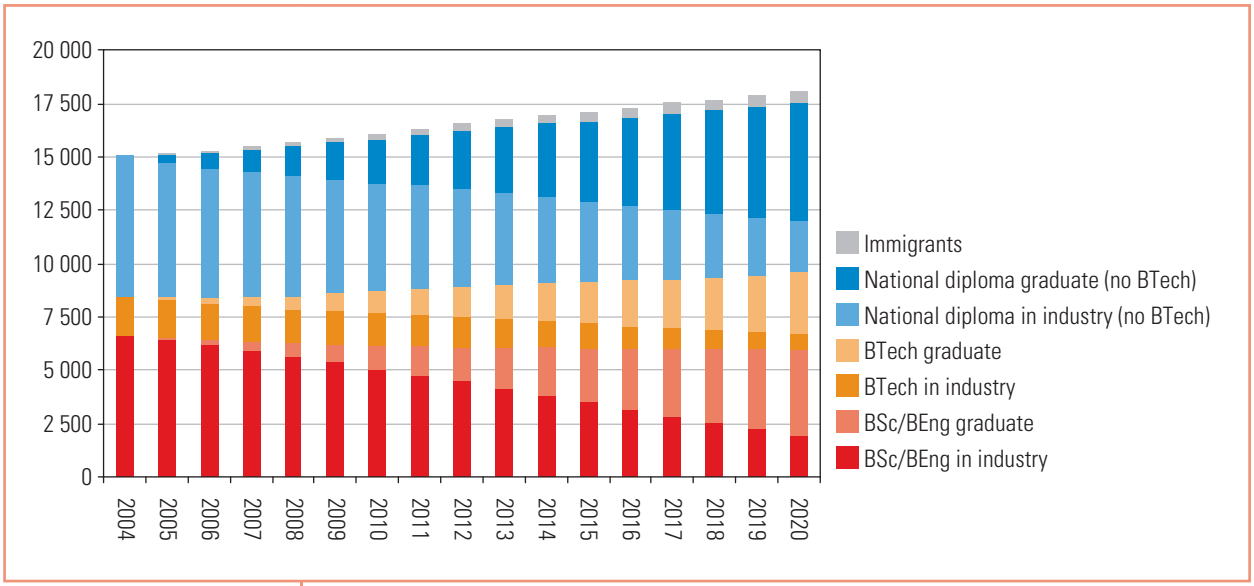


Figure 10.14 The changing ratios of engineers, technologists and technicians

If graduations are increased as outlined above, engineers will have dropped to 34% in 2020. Although industry feels at present that it can only afford to replace 15% of the engineers with technologists, the drop from 44 to 34 represents a 23% decrease. Thus an increase in technologists is needed. By ensuring that one third of all national diploma graduates return to do a BTech, technologists will have increased to 20% of the team by 2020. Engineers and technologists together would then represent 54% of the team, only 2% less than at present. There may be a case for further adjusting this mix, or introducing other built environment professionals to supplement the current configuration of the civil engineering team. Investigations in this regard will continue after publication of this book.

10.4.2 The numbers to be attracted and retained

Although graduations will improve capacity by 2020, the increased numbers as mooted above will not address the emptying capacity bucket in the short term. Increased graduations offer only an additional 636 graduates entering the industry by 2009, but (as has been seen in earlier chapters) large numbers leave the industry from age 35 and up.

It is essential to stem the tides of emigration, loss of professionals from the industry, and retirement. Those who have left the industry should be enticed to return. Further, educating increased numbers will require more capacity in the industry for workplace training. Contracts that are soon to terminate should be renewed with a direct mandate to train and initiate and manage projects. Figure 10.15 shows the difference that such slowing the losses will make in the short term.

(a) Extending the retirement age

Because they recognise the age wave, many industrialised countries are considering extending retirement age. Germany is proposing a six-year extension and a retirement age of 72 has been suggested in the UK! While this may seem excessive, South Africa should consider a five-year extension for the next five years. Hence instead of talking about early retirement, a new offer of a 'late retirement' package should be developed. The model in Figure 10.15 assumes that half of those reaching retirement age will be convinced to stay on for a further five years. The model

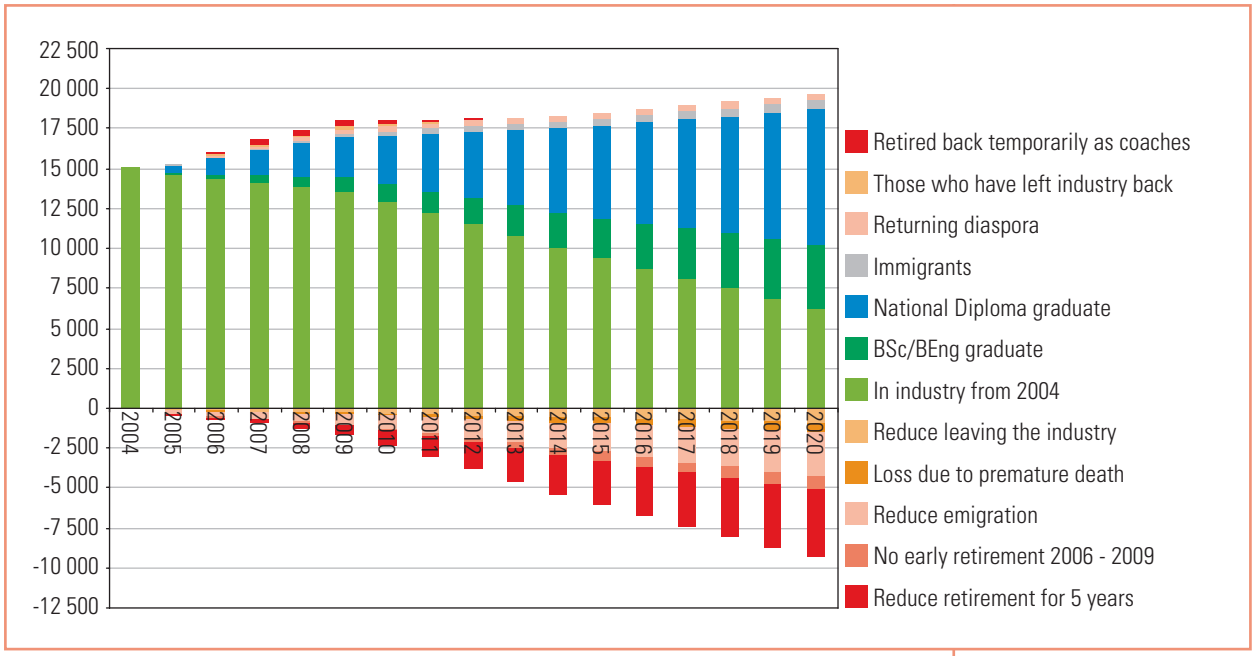


Figure 10.15 Increased short-term capacity by slowing down losses

also assumes that early retirements would be stopped completely for five years, thus reducing the losses. This will assist with bridging the gap while young people are being developed.

(b) Reducing losses through emigration and leaving the industry

In terms of emigration and others leaving the industry, it is assumed that losses will have halved for the next five years because of immediate actions such as addressing salaries and career growth opportunities. In addition, the figures allow for the return of some 250 South Africans living abroad based on similar measures.

(c) Retired capacity in increasing diplomate throughput

The final additions to the short-term capacity in Figure 10.15 relate to the need to redeploy 450 retired professionals for a five-year period to supervise and coach the several thousand young graduates who have not had adequate training and are unable to pick up the current load. Redeploying these knowledge coaches will allow companies to take on more students who require experiential training. In so doing, more technikon students would finally manage to graduate, hence the additional numbers coming into the industry in Figure 10.16.

Job creation is an imperative. In civil engineering the jobs are there, but young people are not receiving adequate support to fill the posts and succeed. Help in the form of knowledge coaches (or 'retreads', as they are affectionately known) is desperately needed.

All these interventions are essential because students who enter tertiary institutions from 2006 and later will only come to the market when the 2010 Soccer World Cup. Gautrain and other large projects will already have been commissioned. However, there will still be many challenges in terms of delivering the Millennium Development Goals (MDG); extending Gautrain and maintaining the greatly increased infrastructure. Those who should have retired, but were encouraged to stay on until the end of 2009, will also need replacing when they finally 'hang up their boots' and there will be a drop off in the returning diaspora by that stage. There will more than enough work for new recruits.

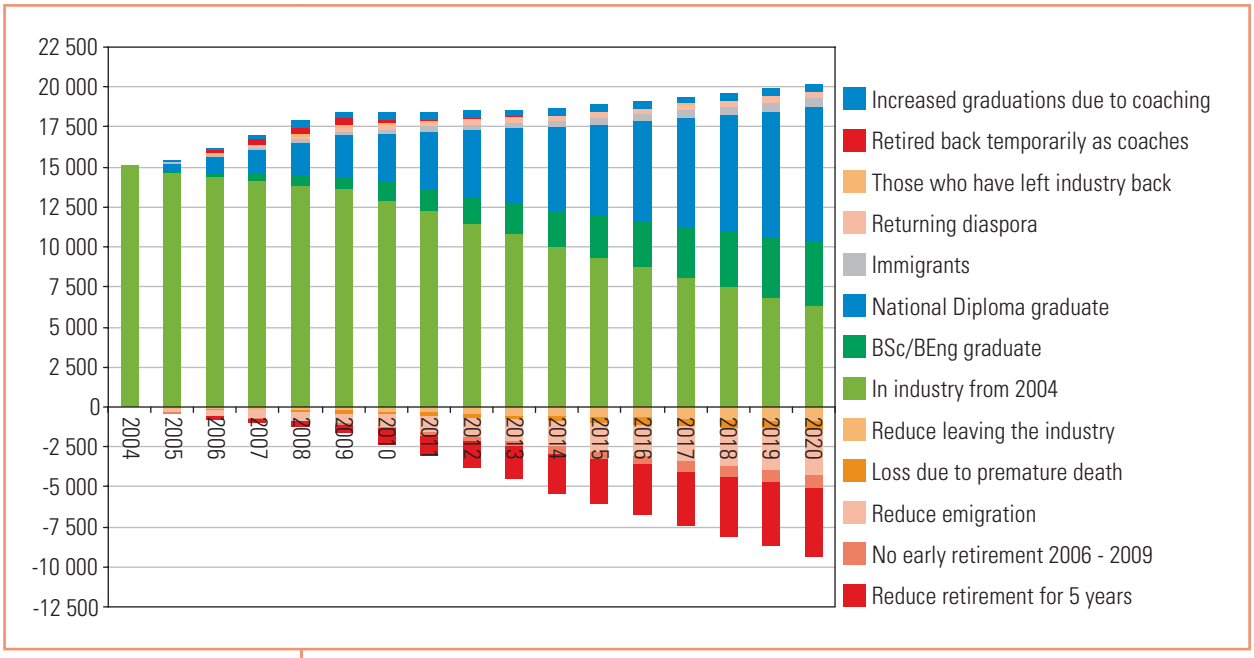


Figure 10.16 Increased short-term capacity by slowing down losses and increasing national diploma graduation opportunities

An additional factor to bear in mind is the statutory identification of work for civil engineering professionals that is required by the Engineering Professions Act 46 of 2000. When effected, this should afford security for engineering posts. Professional incumbents will be retained and reserved posts that are now filled by non-engineering staff will gradually be vacated to comply with the requirements of the Act. This will require more civil professionals in the system.

If industry and government are serious about sustaining and growing civil capacity, and aggressively implement these suggestions, capacity could be dramatically improved.

But these interventions may not totally address the short-term needs. Two more options for additional capacity will now be considered.

10.4.3 Augmentation by international project teams

Increasingly, major projects are being won by international, multi-disciplinary companies or consortia. As a result of the skills shortages that have already been recognised in South Africa, many designs are being handled by offshore design teams on a project-by-project basis. Using state-of-the-art ICT, it is possible for designers to be located anywhere in the world. Specialist skills have become an international asset. Furthermore, internationally experienced project management and construction project management capacity are being supplied by lead contractors. In describing the capacity required for Mittal SA's new coke plant, GM Andries Joubert said,[9]

'… certain labour will be imported from China, as South Africa does not have the skills base …'

This trend is not limited to Mittal SA's developments. The estimated numbers of overseas professionals that will be involved in South African projects over the next five years are shown in Figure 10.17. This approach provides short-term capacity, which may be required shortly.

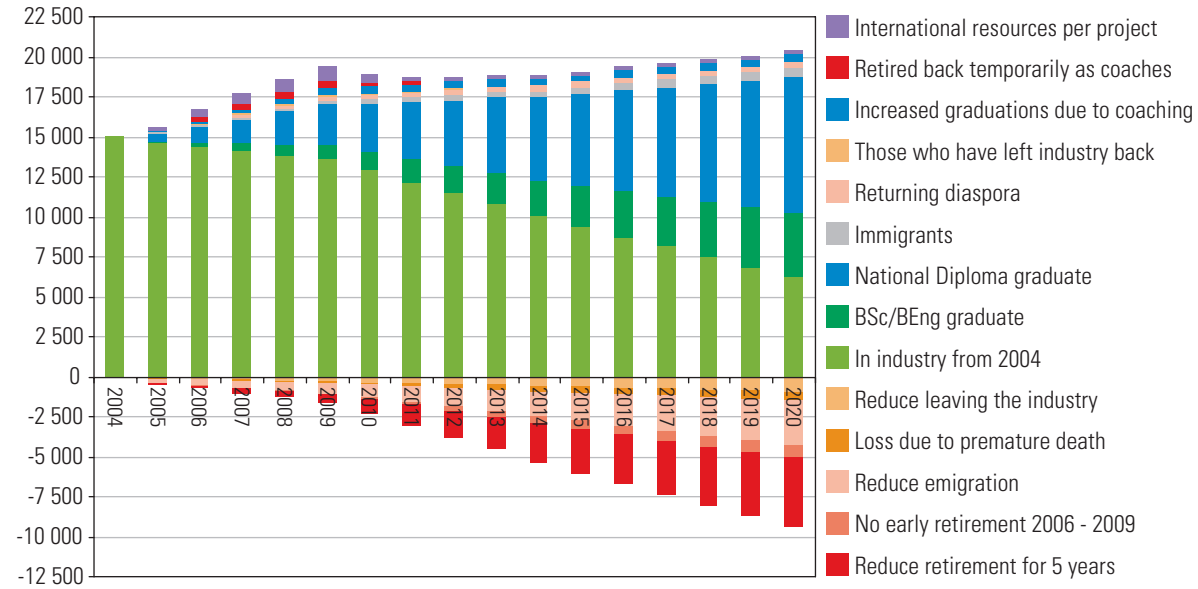


Figure 10.17 Increased short-term capacity by using international resources in project consortia

10.4.4 The role immigrants can play

The only other way to improve capacity, particularly in the short term, is to encourage immigration. This was necessary in the booming seventies and early eighties, and may be necessary again. Immigrant or migrant workers in professional positions can bring positive aspects to the country in terms of new or innovative thinking and skills. This is not a quick fix, however, as it takes time to adapt and understand local conditions before immigrants are able to deliver efficiently. The following issues need to be considered:

- Different education standards – requiring verification by SAQA and ECSA before work permits can be issued
- Language barriers
- Cultural differences
- Relocation costs and logistics including accommodation, schools, employment for partners and breaking family ties
- Understanding the local environment in terms of materials, codes of practice, standards, legislation, social customs and taboos, administrative structures and procedures, procurement and governance, source of funding, corporate culture, labour and labour practices, suppliers, etc
- Increased foreign curreny expenditure
- Reduced investor confidence in the country

The animosity from the local population in competing for positions is another factor that must be considered. There is also a long-term problem with employing immigrants in that there will be fewer posts for local graduates when they have completed their studies. Job creation is of prime importance, so the first priority must be to train and develop South Africa's own young graduates.

Positions in the public sector also present a challenge. Foreign nationals must not only master all the technical and contractual issues outlined above, but also assimilate the national vision, developmental goals and culture of the organisations. Furthermore cultural

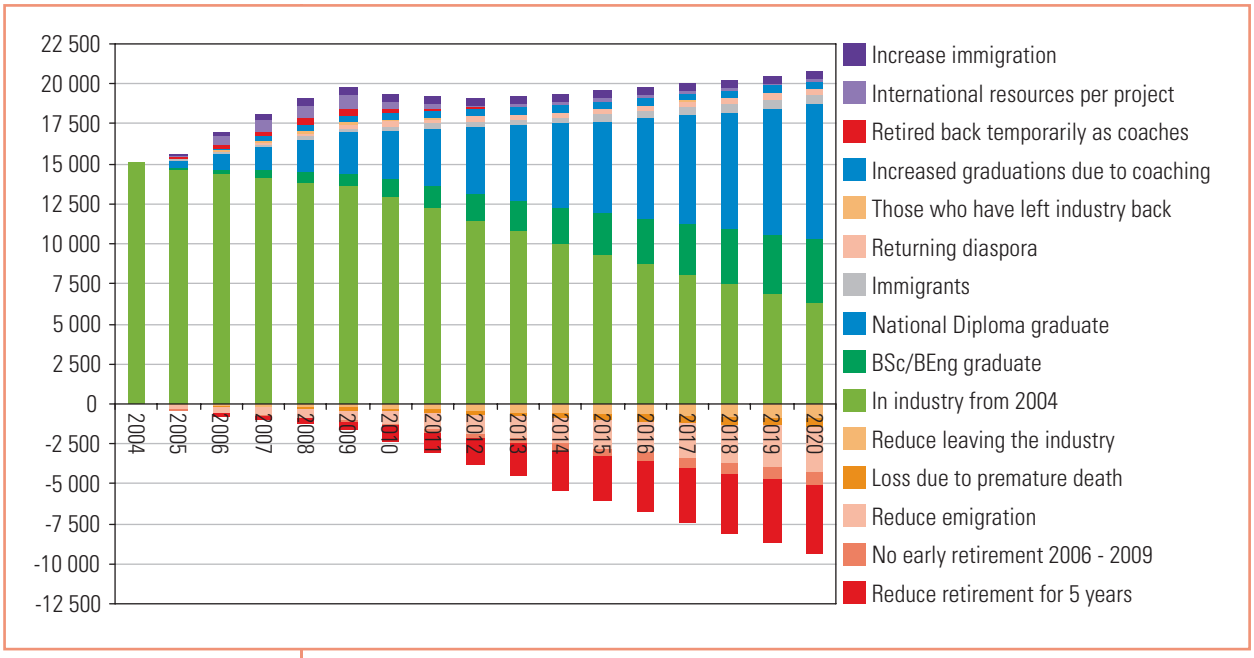


Figure 10.18 Increased short-term capacity by immigration

requirements and solutions for the communities being served are very different from most other countries. Only a few foreign nationals work in local, provincial government or in water boards.

'High tech' fields lend themselves better to immigration. Currently most foreign nationals are to be found in specialist consulting, contracting and the industrial sector.

Where posts simply cannot be filled by South Africans, even with creative pairing of experienced and recent graduates, then immigration will certainly add capacity, as can be seen in Figure 10.18. However, the challenge is to determine the specialities and numbers needed and ensure that those selected will add value in as short a time as possible.

Brian Bruce, CEO of Murray and Roberts, when discussing the challenge of the impending growth stated,[10]

> *'… what we have to find is an ability to achieve our growth through what South Africa can do, whilst tapping into what Asia is doing …'*

South Africa must develop its people.

10.4.5 Immediate needs and future research

The initial research which informed this document was aimed at addressing the difficulty technikon students experience in finding employment. Many more problems have emerged during the research process. Clearly there is a major shortage of experienced staff able to deliver infrastructure. The short term actions suggested will deliver 4 776 additional staff into the industry by 2009. This number will reduce as the short-term measures come to an end.

This increase will offer civil engineering capacity for project initiation and design, and crucially it will offer management capacity for the creation of at least 100 000 jobs

This type of intervention is vital. However, in the longer term, research needs to be carried out to determine and develop new ways of approaching delivery. This may include a

more efficient mix of built environment professionals and processes to address the country's development, operations and maintenance needs. Further research will be initiated to ensure that tertiary education and industry training is appropriately directed to address future challenges.

CONCLUSIONS

If interventions are put in place immediately, the looming civil engineering skills crisis can be reversed to some extent, but there is no more time for debate. This document gives an accurate analysis of numbers, age, qualification and transformation profiles that can be used as the basis to develop all the interventions required.

In the interests of achieving South Africa's development goals, all are urged to act now!

Building blocks

- An adequate pool of well-trained civil engineering professionals to develop and maintain the infrastructure required to ensure prosperity for all.

RECOMMENDATIONS

Reconstruction required

- **Increase the number of civil engineering university graduates to 350 to 400:** Awareness, selection, nurturing and all the recommendations from previous chapters must be considered to ensure that university entrants are successful.
- **Increase the number of civil engineering BTech graduates:** Identify all technicians with potential to continue with BTech specialisation.
- **Increase the number of students graduating with a national diploma to 600 to 650:** Address the throughput at technikons to ensure that more students graduate. In particular resolve the problems associated with experiential training.
- **Reintroduce structured workplace training:** To ensure that all who have been educated develop their full potential. Learnerships urgently need to be developed.
- **Improve salaries and conditions of service:** To retain all staff.
- **Retain senior staff beyond retirement age:** Retiring staff, and those whose contracts are expiring should be retained with a new mandate to train, initiate and manage projects.
- **Put policies in place to utilise the whole skills base:** The need for transformation is clearly understood and supported, but policies should be amended to allow all with skill to be employed.
- **Encourage South African professionals abroad to return:** Mount recruitment campaigns to encourage all South African professionals who are living abroad to return.
- **Reduce emigration:** Employment policies, salaries and to a lesser extent crime and perceived education problems have contributed to emigration of the mid-career group. If significant changes take place, emigration is likely to slow down, particularly considering the first two parameters.
- **Reduce the number leaving the industry:** Much of the above applies to those leaving the industry. The salary issue applies to all age groups.

NOTES

1 Department for International Development (DFID), *DTI Study on the Development of High Level Skills in Engineering, Information Technology and Management*, DFID, 2001, pp 1–2, 18, A–1.

2 The Adcorp Strategic Centre (ASIC), *Market intelligence report, South Africa* De Beers Group, 2003, pp 6–18.
3 P Esterhuysen, *Africa A-Z continental and country profiles*, Pretoria, Africa Institute of South Africa, 1998.
4 Institute for Management and Development (IMD), *Competitiveness yearbook,* 2004.
5 J Hamilton, *The engineering profession*, Engineering Council, London, n d.
6 M Hosking, There is not current shortage of engineers, article issued by Engineering Placements, July 2005.
7 F Hugo, A Kemp and A Rohde, Report on an international investigation of university education in civil engineering, for Bruinette Kruger Stoffberg, Keeve Steyn Inc, Scott & De Waal, Inc, Strydom Newmark Anthony Inc, Van Niekerk Kleyn Edwards Inc and Van Wyk & Louw Inc, 1989.
8 Murray and Roberts, Report to stakeholders, 30 June 2005.
9 L Hill, Construction starts on Mittal SA's new coke plant, *Engineering News*, 18 July 2005.
10 B Bruce, SA construction boom could last decades, *Engineering News*, 2 September 2005.

CHAPTER 11

The way forward

Clearly the future for civil engineering development looks very rosy. The challenges are the skills gaps and scarce skills. The issues to be addressed are legion. South Africa's dual economy adds to the headache, giving rise to problems common to those experienced in the industrialised world and developing economies.

Globally the problems include:

- The 'latchkey children' – a generation that are not making as much progress as the previous generation because they are separated from their parents at a young age and are exposed to environments which are not conducive to learning or problem solving. (Either parents do not live together or parents work full time or both.)
- A reducing number of school leavers who are interested in scientific, engineering and technical (SET) careers
- Fewer school leavers who are adequately prepared for tertiary education in SET as a result of the change in the approach to education in many countries
- A reducing number of civil engineering graduates joining the workforce in the industrialised world
- The pull of globalisation and the resulting brain drain experienced by many developing and under-developed countries
- The loss of experienced civil engineering professionals to other careers largely due to the long hours and low salaries associated with civil engineering
- Lack of integration of minority groups, immigrants and gender into the engineering workforce
- The loss of a large percentage of ageing professionals due to retire in the next five to ten years (the baby boomers)
- Massive urbanisation, which has
  - Created unprecedented demand for new infrastructure
  - Put extreme strain on budgets, resulting in little or no maintenance being carried
  - Resulted in local government structures with an inadequate complement of technical staff to manage infrastructure development and maintenance

These present capacity challenges in terms of civil engineering worldwide. The problems are exacerbated in South Africa by the legacy of Bantu education, apartheid, the brain drain and the need for rapid transformation (the integration of majority groups and not only minority groups). The result is that:

- **South Africa** is short of experienced mid-career professionals who can take over the reins
- **South Africa** is training too few engineers. More entrants into the field are needed
- **South Africa** is matriculating too few learners with higher grade maths
- **South Africa** will have difficulty transforming the civil engineering profile in the near future unless the number of Africans with higher grade A, B or C symbols in maths and science is dramatically increased
- **South African** companies do not have spare capacity to coach young national diploma students so many never graduate
- **South Africa** is not devoting enough energy to training young graduates, so they do not achieve the level of competence required to register with ECSA, and hence pick up the load
- **South African** local authorities and other public sector structures are critically short of civil engineering staff
- **South African** companies in the private sector are experiencing difficulty in finding staff
- **South African** tertiary institutions are under-resourced
- **South Africa** will soon lose a large group of highly experienced civil professionals as they reach retirement age
- **South Africa** must urgently develop capacity to deliver
  - Its huge commitment for social infrastructure
  - Vastly extended economic infrastructure
  - An improvement in existing infrastructure, most of which is in desperate need of maintenance

To deliver the infrastructure required means that South Africa must harness ALL the capacity available to initiate, design, deliver, operate and maintain infrastructure and must train

young graduates to take their rightful place in the civil engineering team.

The options are clear. South Africa has a choice – to take the high road or the low road.

Taking the high road is within reach provided that decisive actions are taken immediately. What has been lacking until now has been a nationally driven process to measure, initiate interventions and integrate existing initiatives, in order to maximise the economic and social potential of such interventions and their contribution to building skills, creating jobs and infrastructure.

A logframe follows which contains the many aspects that require immediate attention. While a number of the interventions may not produce immediate results, appropriate solutions must be developed and put in place now for future results. Stakeholders, organisations or sectors need to unite and take responsibility for these interventions. An attempt has been made to suggest who should be involved in some instances, but in all cases input from the industry through SAICE membership and other stakeholders will be made available when working with government. For a more detailed implementation of each project, see the relevant chapter and the reconstruction recommendations.

It must also be said that the list is not all-inclusive, and represents only the urgent actions required. Many other initiatives currently under way also contribute towards capacity development.

The time has arrived to involve all South Africans regardless of age, gender or race in the development challenge. The only way to change the past and build a great future for all is to heed the words of President Thabo Mbeki, who in his book "Africa: The time has come"[1] said

> *'…the African renaissance can only succeed if its aims and objectives are defined by the Africans themselves, if its programmes are designed by ourselves and if we take responsibility for the success or failure of our policies…'*

It is time to use this material to develop integrated, national policies and solutions to build the capacity needed for growth and prosperity. It is time to make a difference. Let all involved

NOTES

1 T Mbeki, *Africa, the time has come*, Tafelberg, Cape Town, 1998.

LOGFRAME: Addressing imbalances in the civil engineering profession – Draft list of interventions for discussion, fine tuning and roll out

Organisation acronyms not used previously

BE	Built environment
VA	Voluntary associations
Industry	Private and public sector
ALL	Includes BE, industry, ECSA, tertiary, government and other stakeholders

Funding acronyms

CSI	Corporate social investment
SD	Skills development (investment required of industry by the Construction Charter)
To be raised	Means the lead organisation needs to raise funds for the initiative

Time frame for results

ST	Short term
MT	Medium term
LT	Long term

Addressing imbalances in the civil engineering profession – Draft list of interventions for discussion, fine tuning and roll out

To be addressed	Objective	Time frame for results	Suggested Activities	Suggested Organisation	Funding
Schools	**Increase the number of high-calibre matriculants competent in maths for entrance into tertiary institutions**				
Syllabus	Improve numeracy from Grade 1 through to Grade 12	LT	Combine forces with SAICA, CDE, tertiary engineering, actuarial and economics departments and others requiring competence in maths to work with government to address the weaknesses in maths and the language of instruction	ALL	
	Improve number of matriculants with HG maths	ST	Encourage government to reward improved HG throughput versus SG (or in future maths literacy)	ALL	
	Improve employability	ST	Encourage government to make English a compulsory language	ALL	
Teaching	Increase number of competent teachers	MT	Carry out research to identify successful teacher training programmes for industry to support	??	
			Support successful teacher training programmes	BE	CSI
			Encourage government to put effort into attracting and training more maths and science teachers	ALL	
			Encourage government to improve teachers' salaries where skills are scarce	ALL	
Schools	Improve the learning environment	ST	Convene a workshop with government to improve school infrastructure. Discuss:	ALL	
		MT	■ The development of appropriate, cost-effective designs including community involvement in construction	BE	CSI
		ST to MT	■ Upgrading of existing infrastructure	Contracting	CSI
		ST to MT	■ Upgrading of resources	BE	CSI
Nurturing	Increase the pool of competent black matriculants	ST to MT	Carry out research to identify successful selection and nurturing programmes	??	
			Support successful selection and nurturing programmes	BE	CSI
			Identify bright students who should be moved to schools better able to develop their potential	DOE	
Career guidance	Create awareness of opportunities in engineering and the built environment	ST and ongoing	Roll out nationwide presentations covering engineering and the built environment at all schools with sufficient potential learners	ECSA SAICE VA s	To be raised
			Requires teams to be sourced as follows:		
			■ Appointed staff located in each province	SAICE, SAICA	
			■ Young role model volunteers from industry such as the SAACE YPF	SAACE	CSI
			■ Companies and branch members of built environment institutions	ALL	CSI
			■ SAICE branches through bridge building and water competitions	SAICE	CSI

To be addressed	Objective	Time frame for results	Suggested Activities	Suggested Organisation	Funding
Career guidance	Create awareness of opportunities in engineering and the built environment		■ Tertiary institutions when scouting for talent	Tertiary	
			Requires full-time coordinators to:		
			■ Prepare posters and brochures		
			■ Liaise with DOE		
			■ Set up appointments with schools and prepare handouts for presenters		
			■ Keep website up to date to track progress with visits and promotions		
			■ Monitor registrations at tertiary institutions from the selected schools		
			■ Prepare material for websites and career reference guides		
		ST	DOE to consider adding career guidance material and relevant website addresses to maths and science textbooks	DOE	
		ST to MT	Develop methods for influencing parents eg national campaigns on TV, taxis, etc	DST, SAICE	To be raised
Testing	Identify students with potential from entire population	ST to MT	Carry out research to determine appropriate tests to advise interested students whether they have the aptitude to consider engineering	??	
		ST and ongoing	Offer guidance and counselling for those interested, to ensure that they are making the appropriate career choice	??	
Orientation to tertiary education	To develop the culture of learning and analytical reasoning and prepare students to make the	ST to MT	Research various programmes and reference material to assess their value	A SETA?	
		ST to MT	Encourage industry and funders to put potential students through such courses	Industry	SD
Tertiary	**To increase the throughput rate and number of high-calibre graduates entering industry**				
Correct numbers	Ensure appropriate number of students for industry requirements. Increase university graduates and quality of technikon graduates	ST	Negotiate with DOE to pay higher subsidy for 'scarce skills' students and reduce the number entering to only those with potential	SAICE and ALL to support	
Selection criteria	Ensure suitable students enter tertiary level to reduce number of dropouts	ST to MT	Research all selection criteria, and develop national standard	??	
Entrance testing	Ensure suitable students enter tertiary level to reduce number of dropouts	ST to MT	Research all entrance tests and develop national approach	??	
			Meet with HODs to agree harmonised solution	DOE, SAICE	
			Meet with deans and VCs to explain that making engineering courses open to all is counter-productive	DOE, SAICE	

To be addressed	Objective	Time frame for results	Suggested Activities	Suggested Organisation	Funding
Bursaries	Provide sufficient funding, timeously so that all with potential can be sustained through tertiary studies	ST to MT	Research industry needs and bursaries currently offered to determine increased level of investment required	A SETA?	
		ST	Investigate selection criteria and awarding of bursaries to ensure that the correct number of high-calibre students are supported for each discipline in the built environment	CETA?	
		ST and ongoing	Encourage increased investment in tertiary studies, including first-year 'risk' bursaries	ALL	SD
		ST to MT	Structure bursaries to cover students' needs and ensure that they are accommodated in an environment conducive to learning	ALL	SD
		ST to MT	Complete selection process early enough to advise students of their selection and make money available in January (students cannot afford to pay deposits themselves)	ALL	
			Create greater awareness in industry of NSFAS funds so that small companies can support students through their studies without carrying the full financial burden	SAICE, VAs	
Monitoring	To identify and address problems timeously	ST and ongoing	Ensure quality students nurtured throughout their studies - assess results monthly and not just at the end of the semester so that interventions can be made timeously where necessary	Tertiary	Funds to be raised for extra capacity
Make demmies/ tutors available	Ensure students have access to additional resources and support when necessary	ST and ongoing	Senior students to be encouraged to help younger students when struggling	Tertiary	Funds to be raised for extra capacity
		ST and ongoing	Lecturers should also be encouraged to offer extra lectures where students are struggling	Tertiary	
		ST and ongoing	Industry should be encouraged to adopt students, act as role models and assist when they are battling	Industry	CSI/SD
Dedicated residences or areas in residences	To house students in more friendly environment	MT	Identify students from previously disadvantaged backgrounds and house them on their own with senior students from similar backgrounds for support, and to group them in terms of extra tuition requirements and team building	Tertiary	
		MT	Assist students with driver's licences	SETAs	
		MT	Assist students with life skills including introduction to banking, ICT	SETAs Tertiary	To be raised
Foundation training	Harmonise offerings	ST	Host a workshop to review content and successes of all courses, to improve each offering and ensure best results	ALL	To be raised
		ST	Resolve who should fund these courses and how students can afford foundation training because they are not covered by bursaries or NSFAS	ALL	
		MT	Alternatively consider 'foundation colleges'	DOE	

To be addressed	Objective	Time frame for results	Suggested Activities	Suggested Organisation	Funding
Curricula review	To develop curricula more relevant to industry needs to improve employment opportunities	ST	Host recurriculation workshop with tertiary institutions, industry, ECSA, DOE, CHE and SETAs to review findings and better align education and workplace training.	ALL	To be raised
			■ Consider Centres of Excellence		
			■ Restructure first year to make first semester a little less intimidating!	DOE ECSA Tertiary	
			■ Review second-year maths and statistics with a view to moving part of the more complex work to postgraduate courses where required		
Lecturers	To improve quality and staff to student ratios	ST	Organise or fund the organisation of innovative courses to improve lecturing skills	ALL	To be raised
		ST	Encourage captains of industry and experts to participate in lecturing	BE	
		MT	Review and increase salaries where necessary	DOE, Tertiary	
		MT	Encourage industry to subvent salaries	ALL	CSI
		MT	Ensure all departments are adequately resourced	DOE, Tertiary	
		MT to LT	Consider dedicated engineering schools	DOE	
Learnerships	Link students with companies	ST	Encourage industry to take on more national diploma students from the beginning of their careers.	ALL	SD
Experiential training	Ensure students gain experience so that they can qualify	ST	Set up a website and placement service for those not yet linked up with learnerships	SAICE Umsobomvu	To be raised
			Set up website to help link students with vacation training opportunities	SAICE Umsobomvu	To be raised
Placement	Ensure that graduates are absorbed and trained	ST	Set up website and placement service for those who are unable to find employment	SAICE Umsobomvu	To be raised
Orientation to the workplace	Assess courses available to prepare students to make the most of their working career	ST	Research various programmes to assess their value and publish findings to industry	A SETA?	
			Encourage industry and funders to put graduates through such courses	Industry	SD
Encourage postgraduate studies	Allow staff to develop additional skills to assist with career path progression	MT	Encourage technicians to continue with BTech and engineers to do master's or doctorates. Encourage all to pursue business or project management studies	Industry	SD
Candidate phase	**Improved graduate training and skills transfer to develop competent practitioners to grow into senior positions**				
Promote ECSA registration	To ensure that industry is aware of the value of registration and invests in developing young graduates	MT	Promote ECSA registration and the facets of training to final-year classes and all employers in both the private and public sector	ALL	

To be addressed	Objective	Time frame for results	Suggested Activities	Suggested Organisation	Funding
Register Pr Eng, Pr Tech Eng and Pr Techni as qualifications with SAQA	To ensure appropriate workplace training takes place	ST	Complete the definition of the ECSA Stage II candidate qualifications and have registered with SAQA	ECSA	
Learnerships	Develop learnerships to ensure comprehensive workplace training for all	ST to MT	Register learnerships for all disciplines, develop curricula, training material and procedures	SETAs SAICE SAACE IMESA	To be raised
			Promote learnerships to all employers and explain the SETA claiming processes to incentivise them to coach young graduates	ALL	SD
Courses	Increase graduate attendance at training courses addressing practical topics	ST	Identify supplementary courses to support each of the learnerships and have material developed and courses accredited	ALL	To be raised
			Encourage industry to send learners on supplementary courses	ALL	SD
Mentors	Career path planning to ensure that graduates progress in their careers	ST and ongoing	Encourage industry to assign mentors to graduates to assist with career path planning	ALL	SD
Coaches	To ensure transfer of knowledge	ST	Develop team of supervisors/coaches who can be harnessed to assist companies with limited senior capacity	SAICE VAs	To be raised
			Encourage retired personnel to make themselves available as mentors, supervisors and coaches	SAICE VAs	
			Train and motivate coaches and monitor progress to ensure that the new systems are understood and implemented	SAICE VAs	To be raised
Life skills, driver's licenses	Equip graduates to cope with all the demands made on them	ST	Few black graduates have access to vehicles and are able to drive, which disadvantages them in the workplace. Help them get driver's licences and attend additional communication and presentation courses or training where necessary	SETAs Tertiary	To be raised
Publish standards	To develop a feel for the magnitude of possible solutions	MT	For checking purposes, re-introduce standards/libraries of all possible details and elements, such as were in place prior to the introduction of computers. These will serve as a cross-check on the appropriateness of computer solutions	SAICE and others	To be raised
Encyclopedia of civil engineering	Make practical check lists and a good practice guide available	MT	Involve senior, very experienced engineers to record all practical details, best practice, check lists, etc, in relation to all topics	SAICE and others	To be raised
Knowledge system	To make all technical material available to all	MT	Locate, collate and publish all papers, proceedings, research findings in a knowledge system	SAICE and others	To be raised
Multi-media	Develop knowledge system and encyclopedia in multi-media form	MT	Make above available in interactive, easily accessible, searchable form, for use by all	SAICE and others	To be raised

To be addressed	Objective	Time frame for results	Suggested Activities	Suggested Organisation	Funding
Salaries	Review salaries and conditions of employment	ST	Publish guidelines on starting salaries for young graduates to reduce the level of 'exploitation' reportedly taking place	ECSA SAICE SAACE Government	
Professionals	**Create an enabling environment to attract and retain skills and reduce the numbers leaving the industry or emigrating**				
Project pricing/ procurement	Address problems relating to bidding and procurement	ST to MT	In consulting, cutting fees results in low salaries and hence a less attractive environment	SAACE SABTACO	
			In contracting, low tender prices result in inferior jobs, or jobs not being completed and threaten existence of companies	SAFCEC and others	
			Encourage clients to consider value per rand rather than the lowest price	ALL	
Salaries	Review salaries and conditions of employment	ST	Review salaries and conditions of employment	ECSA SAICE SAACE Government	
Compulsory registration	To ensure that all practicing have developed sufficient competence	ST to MT	Give ECSA input as required to achieve this long-planned objective	ECSA	
Identification of work	To ensure that those with appropriate qualifications and experience take responsibility for engineering work	ST to MT	Give ECSA input and support to achieve this all important milestone	ECSA	
Membership of SAICE	To ensure that practitioners keep apace with technology, legislation and national needs	ST to MT	Mount a major campaign to encourage all to join SAICE. If possible link this with registration	SAICE	
CPD	Ensure that all professionals keep up to date with latest technology, legislation etc to deliver appropriate solutions	ST	Identify all gaps at present and develop and offer appropriate courses. List on SETAs WSPs. Have regular courses accredited	SAICE SAACE Others	To be raised
			Implement compulsory CPD	ALL	SD
Personal needs	Improve working environment for all	ST to MT	Sensitise companies to respect the personal needs and responsibilities of employees	ALL	
Integration	To develop an enabling environment in which all feel comfortable and part of the team	ST to MT	Diversity issues and change management urgently need addressing to ensure that all are equally developed and utilised.	ALL	

To be addressed	Objective	Time frame for results	Suggested Activities	Suggested Organisation	Funding
Use all capacity	Review employment policies to harness all staff	ST to MT	Employment equity policies need to be reviewed, particularly in departments which are critically short of civil engineering staff	Public sector	
Early retirement	Retain staff until retirement age and later	ST to MT	Stop the practice of offering packages to encourage early retirement	ALL	
Senior staff and retired staff	Retain senior and re-deploy retired staff to extend capacity over five-year 'boom' period	ST	Policies need to be developed to retain senior staff past retirement age to initiate and manage projects and train young graduates during the next busy five years in the construction industry	ALL	
Succession planning	To ensure that suitably qualified and experienced staff are available to take over when mass retirements begin towards the end of the decade	ST to MT	Succession plans including transferring of 'deep smarts' must be put in place. Potential candidates need to be afforded opportunities to continue with postgraduate studies, business training, and interacting regularly with senior experts	ALL	
South Africans overseas and those who have left the industry	Encourage the return of all who have left to increase the workforce for the huge developments expected over the next 5 to 10 years	ST	Major campaigns should be put in place to encourage those with local engineering experience to return to the industry	ALL	To be raised
State	**To increase the flow of work and ensure that all professionals being attracted and developed can be utilised**				
Delivery	Empower decision-makers on how to handle the delivery crisis	ST to MT	Deliver councillor programme 'Sustainable Infrastructure for South African Towns and Cities' nationwide	SAICE	To be raised
Capacity	Re-capacitate departments so that projects are initiated	ST	Develop teams of senior and junior staff to pick up the workload. The junior staff should carry out the work under the supervision of senior (if necessary redeployed retired) staff	DPLG DWAF DBSA Umsobomvu SALGA SAICE IMESA	To be raised
	Address attraction and retention issues		Work with departments to address problems which include:		
			■ Low salaries		
			■ Equity criteria precluding experienced personnel from being utilised		
			■ Inappropriate structures. Develop standard organograms with particular qualifications and experience for various technical posts		
			■ Unfreeze posts frozen because of budget constraints		
			■ Develop structures to deliver and maintain infrastructure		

To be addressed	Objective	Time frame for results	Suggested Activities	Suggested Organisation	Funding
Other staff	**Address shortages of other civil engineering staff**				
Draughting and detailing staff	Increase the pool of draughting and detailing staff to replace the ageing staff and address current gaps in industry	ST to MT	Develop learnerships and set-up more training centres for draughting, steel and concrete detailing	SAACE SAISC CETA SAICE	To be raised
Artisans	Increase the number of artisans in the industry, to replace ageing skills base and provide capacity for drawing and estimating offices	ST to MT	Develop colleges which have appropriate equipment to allow learners to gain practical experience at college. Develop national test equivalent to, or use the trade test, as a national standard to measure quality	CETA Contracting stakeholders	To be raised
Operators	Increase the number of water-care operators in local authorities	ST to MT	Develop and deliver training courses and skills programmes for water-care operations	LGSETA ESETA DWAF WISA SAICE	To be raised
Institutional	**To create an enabling environment for delivery of appropriate solutions**				
Codes and standards	Achieve world class standard/ best practice	MT to LT	Complete the updating of many codes of practice and standards to ensure best practice and sustainable solutions	ALL	To be raised
Councils, boards, training authorities	Harmonise objectives and processes developed by various councils, boards and training authorities to avoid overlap, conflict and loopholes	MT to LT	Convene industry think-tank to determine activities needed by each board, council or authority to address capacity development problems	ALL	To be raised