Facts and Figures on Skills in Manufacturing

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the dti
Department:
Trade and Industry
REPUBLIC OF SOUTH AFRICA

towards full-scale industrialisation
and inclusive growth

Compiled by Vass JR and Raidani P

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Introduction

This information brief provides an overview of engineering employment trends in South Africa for the period 2002 – 2014, focusing on engineers, technologists and technicians in the manufacturing sector. The trends are analysed per sub-sector and by demographic indicators such as levels of education, population groups, age groups and gender. This brief is a summary of longer technical reports on engineering professionals[1], which are available on request. The data source is the *Quarterly Labour Force Survey (Q3)* published by Statistics South Africa (StatsSA).

Manufacturing is the fourth-largest sector of the South African economy, and a key determinant of growth and competitiveness in the provision of a skilled technical workforce. Engineers, technicians and artisans constitute the core of the technical workforce, ensuring innovation and efficiency in the production process through the optimal use, design and maintenance of material, equipment, capital and personnel.

Highlights

- Artisans represent the largest proportion (72%) of the key technical occupations, decreasing by 0,7% per year.
- Engineers and technologists represent the smallest proportion (4%) but increased the fastest, by 3,4% per year.
- Technicians represent 24%, decreasing by 0,4% per year.
- The latest technologies are available in South Africa.

1 Longer technical reports on artisans and engineering Professionals may be made available on request from: skillsfortheeconomy@thedti.gov.za.

- Most engineers and technologists are in the basic metals sector. The petroleum; food, beverages and tobacco; and transport equipment sub-sectors are, respectively, the second, third and fourth top employers of engineers and technologists. The food, beverages and tobacco sub-sector is the top employer of technicians.
- The share of white technicians decreased from 47% to 28% over the period. Black Africans constitute 50% of all engineers and technologists.
- Women constitute about one-third of employed technicians but only 8% of engineers and technologists, increasing from 7% in 2002.
- Only 19% of engineering students at universities of technology graduated in 2014.
- Most artisans are underqualified (59%); 26% have Grade 12.
- Most engineers (72%) have postmatric qualifications; only 7% have below Grade 12 qualifications. Black engineers and technicians have the lowest share of registrations with the Engineering Council of South Africa (ECSA).

International Comparison of the Quality of Higher Education and the Availability of Scientists and Engineers

The World Economic Forum's *Global Competitiveness Report* provides an overview of the competitiveness performance of 144 economies, and is considered the most comprehensive assessment of its kind globally. It contains a detailed profile for each of the economies included in the study, as well as an extensive section of data tables with global rankings covering more than 100 indicators.

Table 1: Global ranking of indicators (focusing on BRICS countries)

	China	South Africa	Brazil	India	Russia
Women in the labour force	60	84	86	133	41
Availability of latest technology	97	39	77	110	108
Quality of the education system	52	140	126	45	84
Quality of mathematics and science education	56	144	131	67	59
Availability of scientists and engineers	43	102	114	45	70

Source: *Global Competitiveness Report 2014-15*

South Africa is ranked at 102 (less than 50% on average) out of 144 countries when looking at the availability of scientists and engineers in the country. This means South Africa does not have enough scientists and engineers, which could impact negatively on the country's levels of innovation and competitiveness. The quality of mathematics and science education in South Africa is ranked the lowest of all 144 countries. The quality of the higher education system in South Africa is poor (ranked 140 out of 144 countries), which is also the lowest of all countries within the Brazil-Russia-India-China-South Africa (BRICS) group of countries.

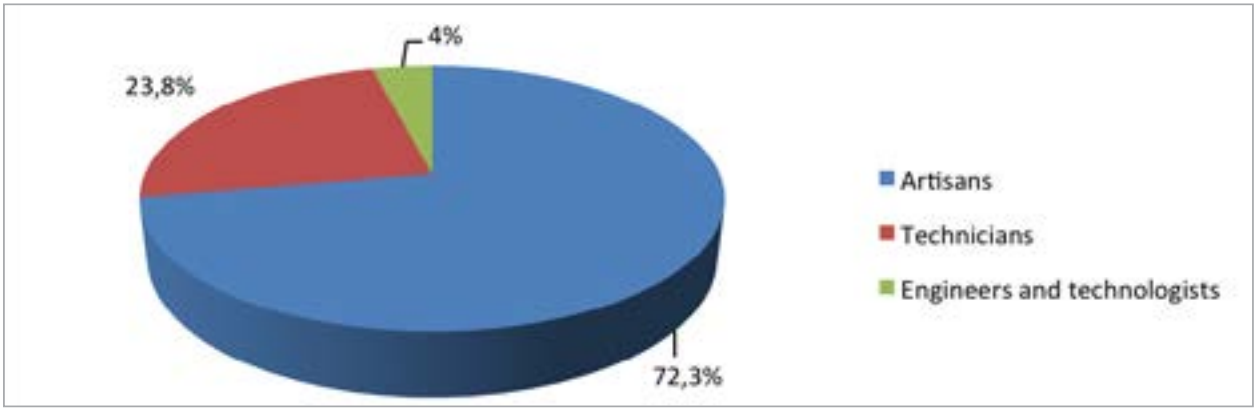
There is availability of the latest technology in South Africa (ranked 39 out of 144 countries), which is better than the other BRICS countries.

The provision of a skilled technical workforce is a key determinant of future growth in the manufacturing sector and overall competitiveness in the economy. Engineers, technologists and scientists have advanced technical skills in manufacturing. Table 1 suggests that the quality of the education system in South Africa is poor, particularly in mathematics and science, which may contribute to the lack of available scientists and engineers in South Africa. This may impact negatively on manufacturing growth and competitiveness in the economy as a whole, as engineers form a crucial part of the research and development dynamic of a country.

Employment of Engineering Professionals in Manufacturing

Figure 1 shows that artisans represent the majority (72,3%), followed by technicians (23,8%), while engineers and technologists constitute 4% of the technical workforce.

Figure 1: Distribution of engineering professionals and artisans in manufacturing (2014)



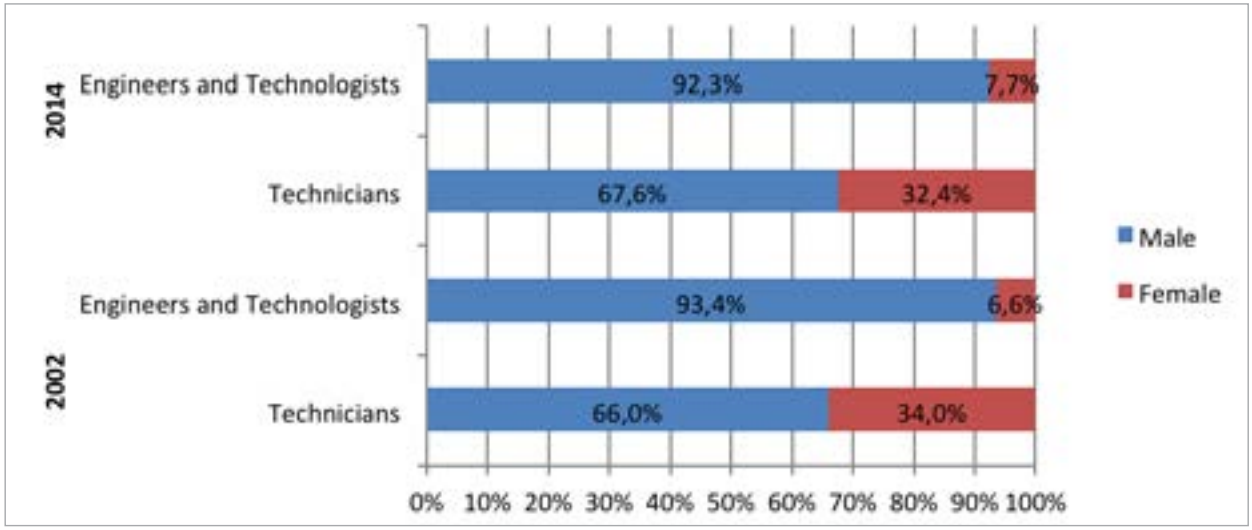
Source: StatsSA, *Quarterly Labour Force Survey (Q3)* and own calculations

Over the period, total manufacturing employment increased at about 0,5% per year, which is almost a quarter of the total employment growth in the economy (2,3%), **(see Annexure A)**. By comparison, the compound annual growth rate (CAGR) varied widely in technical occupations in manufacturing, ranging from 3,4% for engineers and technologists to -0,7% for artisans and 0,4% for technicians (2002 – 2014). Only engineering professionals increased at a rate higher than the general employment rate of 0,5% in manufacturing (**see Annexure A**).

Demographic Profile of Engineering Professionals

Employment in the engineering profession continues to be male-dominated. Figure 2 suggests that less than 10% of engineers and technologists are women, with their share increasing from 6,6% in 2002 to 7,7% in 2014. Just below one-third (32,4%) of all technicians are women. It is clear that there are systemic constraints in the employment of female engineers, as female engineering graduates increased by 13% at tertiary institutions over the period.

Figure 2: Employment of engineering professionals by gender (percentage), 2002 and 2014

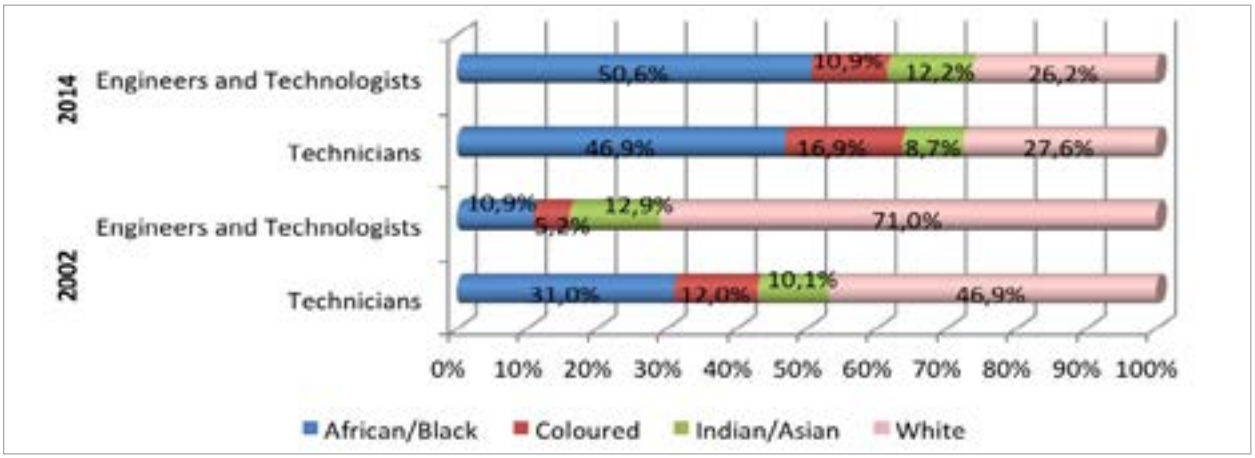


Source: StatsSA, *Quarterly Labour Force Survey (Q3)* and own calculations

Figure 3 shows that the continuing decrease in white engineers and the increase in black African engineers have continued apace. Du Toit and Roodt (2008) show there was a doubling in the number of black (African, coloured and Indian) engineers and technologists, from 15,5% (1996 – 1999) to 30,5% (2000 – 2005). Over the same period, black technicians increased from 28,6% to 41,4%. This trend continued for black engineers, technologists and technicians.

Figure 3 shows that in 2002, about 46,9% of employed technicians were white, decreasing to 27,6% in 2014. The share of Indian engineers and technologists decreased from 12,9% in 2002 to 12,2% in 2014. The percentage of coloured engineers and technologists doubled, from 5,2% in 2002 to 10,9% in 2014. The share of employed black African engineers and technologists increased from 10,9% in 2002 to 50,6% of the total number of engineers and technologists in 2014.

Figure 3: Engineering professionals by population group (percentage), 2002 and 2014

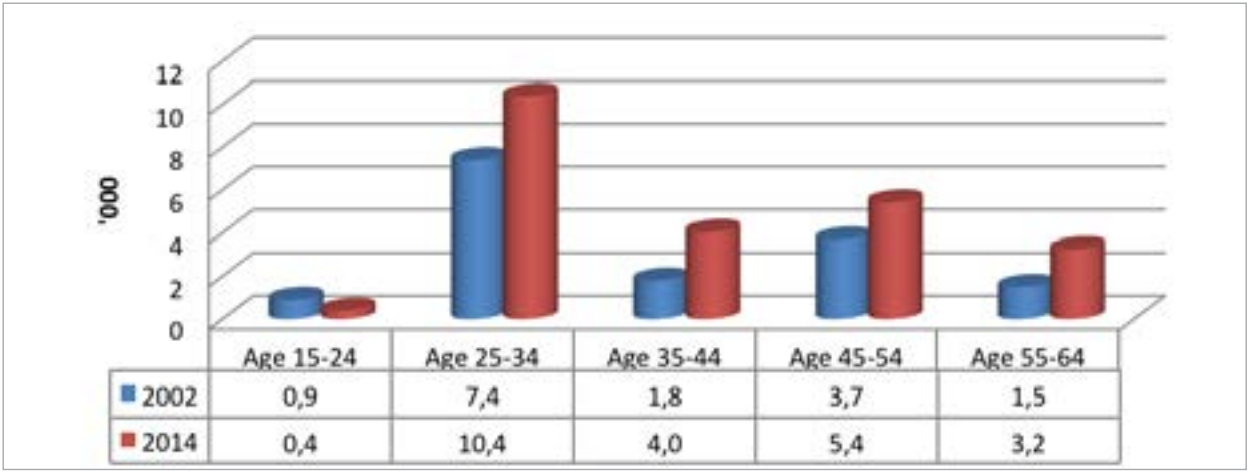


Source: StatsSA, *Quarterly Labour Force Survey (Q3) and* own calculations

The age profile presented in Figure 4 suggests that engineers and technologists are relatively young, with 44,2% in the age group 25 – 34. There is a suggestion of a decreasing engineering skills pipeline, as the number of newly qualified engineers and technologists (15 – 24 years) decreased significantly from 900 to 400. However, there might be a depth of experience, as suggested by the relatively high share of engineers and technologists older than 35 years. This could positively affect the transfer of skills from older to younger engineers, and the availability of experienced mentors in the manufacturing sector.

Taken together, these results suggest there is a lower attrition rate, or higher retention rate, of experienced engineers but a decreasing pipeline into the profession. This disjuncture between experience and youth may have negative effects in the long run on the growth and innovation capability requirements that are necessary to ensure greater competitiveness in the manufacturing sector, given the centrality of engineering professions in the production process.

Figure 4: Employment of engineers and technologists by age group (2002 and 2014)



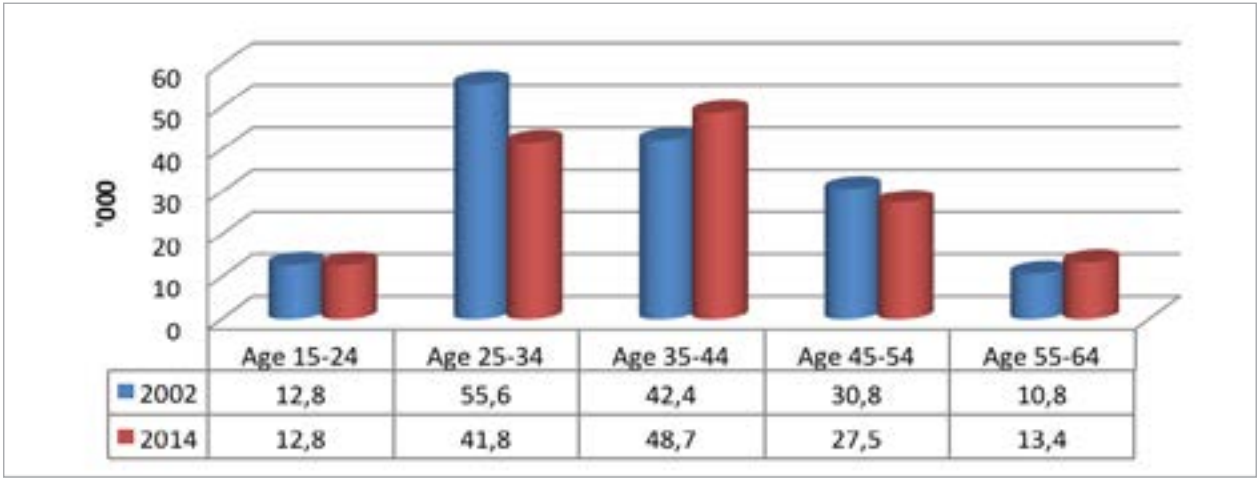
	Age 15-24	Age 25-34	Age 35-44	Age 45-54	Age 55-64
2002	0,9	7,4	1,8	3,7	1,5
2014	0,4	10,4	4,0	5,4	3,2

Source: StatsSA, *Quarterly Labour Force Survey* (Q3) and own calculations

There appears to be a more balanced mix of youth and experience among technicians, compared with the age profiles of engineers and technologists. Categories 25 – 34 years, 35 – 44 years and 45 – 64 years constitute about 29%, 33,8% and 28,4%, respectively, as shown in Figure 5. This implies that the possibilities for skills transfer to the younger generation are greatly increased.

However, the decrease in the number of technicians (-24,9%) who are in their prime productive years (25 – 34 years) is worrying. Combined with the static growth among entry-level technicians (15 – 24 years), these results do not bode well for the development of a skills pipeline into the occupation.

Figure 5: Number of technicians by age group (2002 and 2014)



	Age 15-24	Age 25-34	Age 35-44	Age 45-54	Age 55-64
2002	12,8	55,6	42,4	30,8	10,8
2014	12,8	41,8	48,7	27,5	13,4

Source: StatsSA, *Quarterly Labour Force Survey* (Q3) and own calculations

Employment of Engineers and Technicians by Sub-Sector

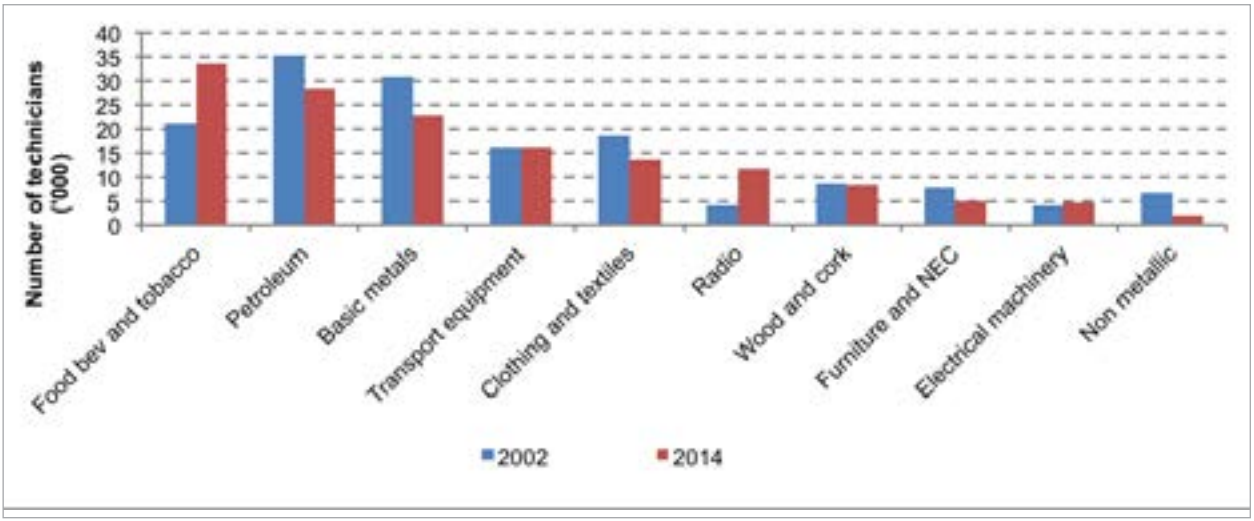
In 2002, most technicians were employed in the petroleum sector, albeit by a small margin (Figure 6). However, by 2014, there was a significant decrease in employment in the petroleum and basic metals sub-sectors, resulting in the food, beverages and tobacco sub-sector shifting to the top. The basic metals sub-sector has previously been a critical player and employer in the economy but it has since experienced a decline due to challenges faced in the iron and domestic steel industry, which arose primarily from global economic factors such as the oversupply of steel. This resulted in the increase of steel product imports into South Africa and cost pressures on the industry (the dti & EDD, August 2015).

However, employment trends over the period per sub-sector differed significantly. There was a 57,2% increase of technician employment in food and beverages, and a significant decrease in the basic metals (-27,4%) sub-sector. The

seasonally adjusted total volume of food and beverage production increased by 1,5% in Q3 of 2014 compared with the 1,4% growth recorded during the same quarter of the previous year. This increase might have been due to the increase in food and beverage exports (macadamia nuts and fish fillets are the major exported food products, worth R426 million and R296 million per year, respectively). (DAFF (http://www.nda.agric.za), *Quarterly Economic Review of the Food and Beverages Industry in South Africa*, September 2014, pvi)

The clothing, textiles and leather sub-sector remains a significant employer of technicians, as indicated in Figure 6. There were significant increases in the employment of engineers and technologists in the transport equipment, and food and beverages sub-sectors. The results suggest that there were significant differences in the employment ratio of engineers to technicians in the various manufacturing sub-sectors.

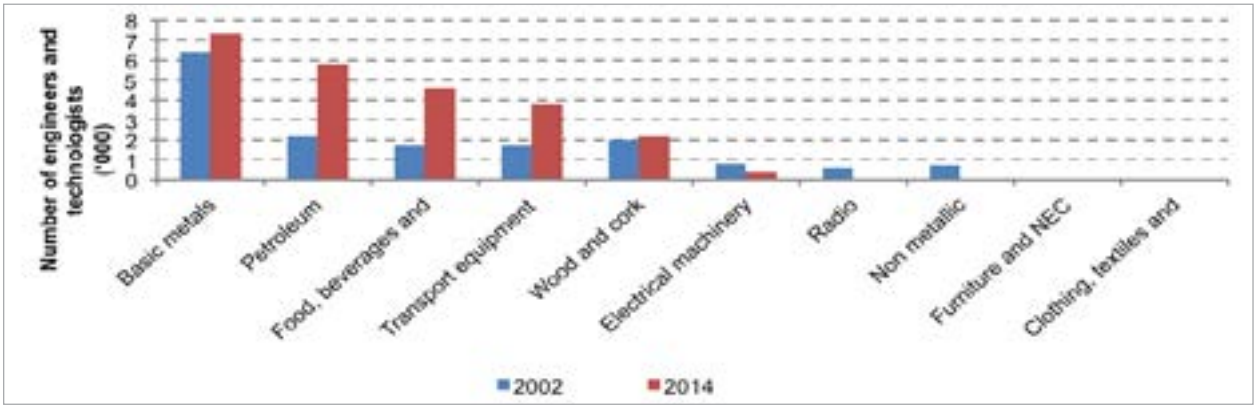
Figure 6: Number of technicians by sub-sector (2002, 2014)



Source: StatsSA, *Quarterly Labour Force Survey* (Q3) and own calculations

By 2014, most engineers and technologists were employed in the basic metals sub-sector, followed by the petroleum sub-sector, which experienced a significant increase of 165%, as shown in Figure 7.

Figure 7: Number of engineers and technologists by sub-sector (2002, 2014)



Source: StatsSA, *Quarterly Labour Force Survey* (Q3) and own calculations

Employment of Engineers, Technologists and Technicians by Education

One of the key constraints to economic growth is the mismatch between the skills demanded and those supplied. The extent to which workers are appropriately qualified in line with the requirements of the job is a key indicator of the extent of the skills mismatch.

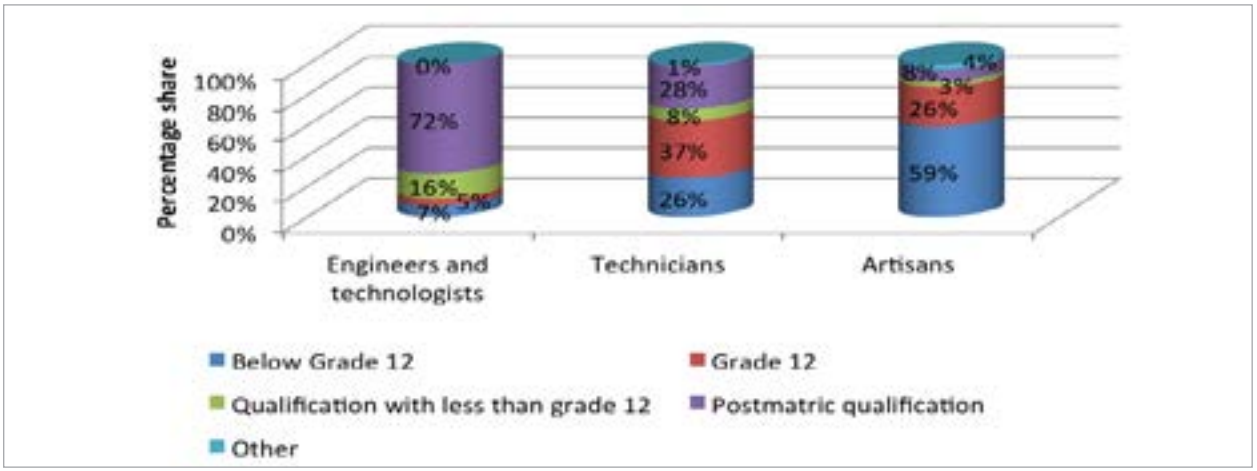
Figure 8 shows that the overwhelming majority of engineers and technologists have a postmatric qualification, indicating high levels of compliance with the basic requirements of an engineering degree. The majority of artisans are underqualified, with most (59%) having less than Grade 12 (no additional qualification) and 26% with only Grade 12. Interestingly, 8% had a postmatric qualification. The latter may be the result of the more recent phenomenon of Grade 12 being the entry requirement. Significantly, and worryingly so, there is greater dissonance between the baseline

qualification required (post-school National Diploma from a university of technology) and the actual qualifications attained among employed technicians. Thus, only 28% of technicians in the manufacturing sector had postmatric qualifications, implying that the overwhelming majority was underqualified. About 8% had a post-school qualification with less than Grade 12.

The findings suggest that 63% of employed technicians have either a Grade 12 (37%) or less than Grade 12 (26%). These results echo similar findings for the period 1996 – 2005, and in fact seemed to have worsened (Du Toit & Breier, 2008). The authors argue that the lack of experiential training in the workplace, as required for National Diploma qualifications, may be contributing to the low levels of qualification.

However, this apparent mismatch represents a challenge and an opportunity in manufacturing. Firstly, technicians may underperform as they do not possess the requisite technical and theoretical knowledge. But as assistants to professional engineers, they perform an essential function in ensuring the efficiency of the production process, hence their practical knowledge may compensate, to an extent, for their lack of qualification. This needs to be met with efforts for certification through recognition of prior learning and formal skills upgrading, as well as increased work placements for diploma students.

Figure 8: Highest education completed among engineers, technologists and technicians (percentage), Q3: 2014



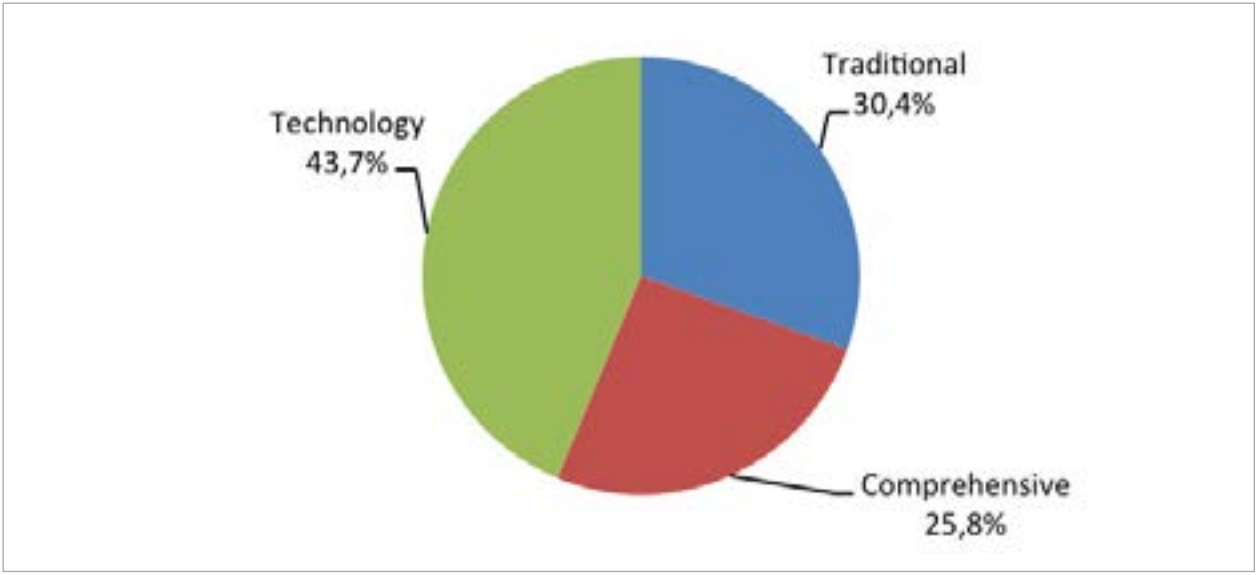
Source: StatsSA, *Quarterly Labour Force Survey* (Q3) and own calculations

Enrolment and Graduation of Engineers, Technologists and Technicians

The ratio of enrolment to graduation of engineering students provides insight into the profession's skills pipeline. There are three types of universities in South Africa: traditional, comprehensive and technological. The country's 25 public higher education institutions offer a range of study and research options for local and international students.

Figure 9 shows that the overwhelming majority of students are at universities of technology (43,7%), followed by traditional universities (30,4%) and comprehensive universities (25,8%).

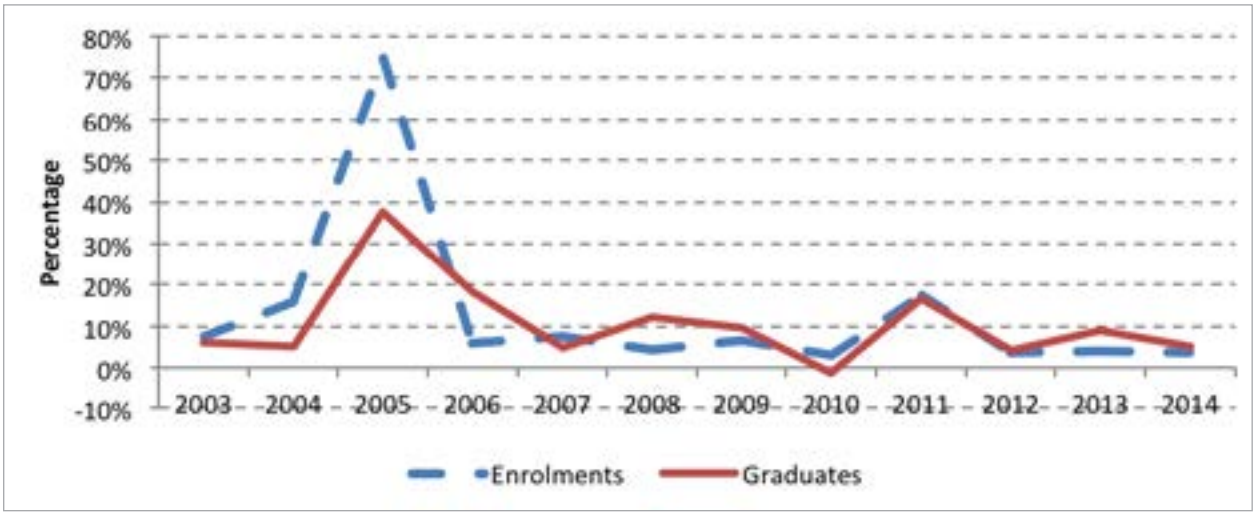
Figure 9: Types of universities in South Africa and their percentage share of engineering students (2014)



Source: Higher education management information system, Department of Higher Education and Training; own calculations (2014)

Figure 10 shows that while there was steady growth in university enrolments, graduation rates remained fairly stable from a low base. There is a big gap between the number of enrolments and the number of graduates.

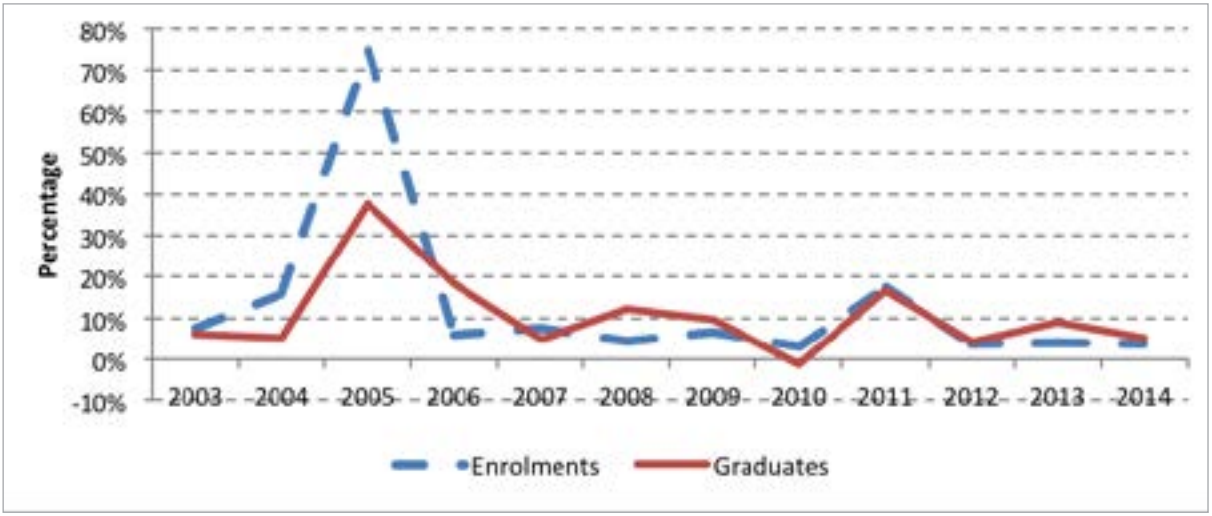
Figure 10: Trends in comprehensive, traditional and universities of technology engineering enrolments and graduates (2002 – 2014)



Source: Higher education management information system, Department of Higher Education and Training; own calculations (2002 – 2014)

There is a positive relationship between enrolments and graduates at comprehensive and traditional universities. Figure 11 suggests that in 2005, there was an unusual increase in engineering enrolments at both types of universities, amounting to more than 70% year-on-year growth, and almost 40% more graduates than the previous year. Despite these significant fluctuations early in the period, the ratio of enrolments to graduates settled to almost 1:1 between 2007 and 2014.

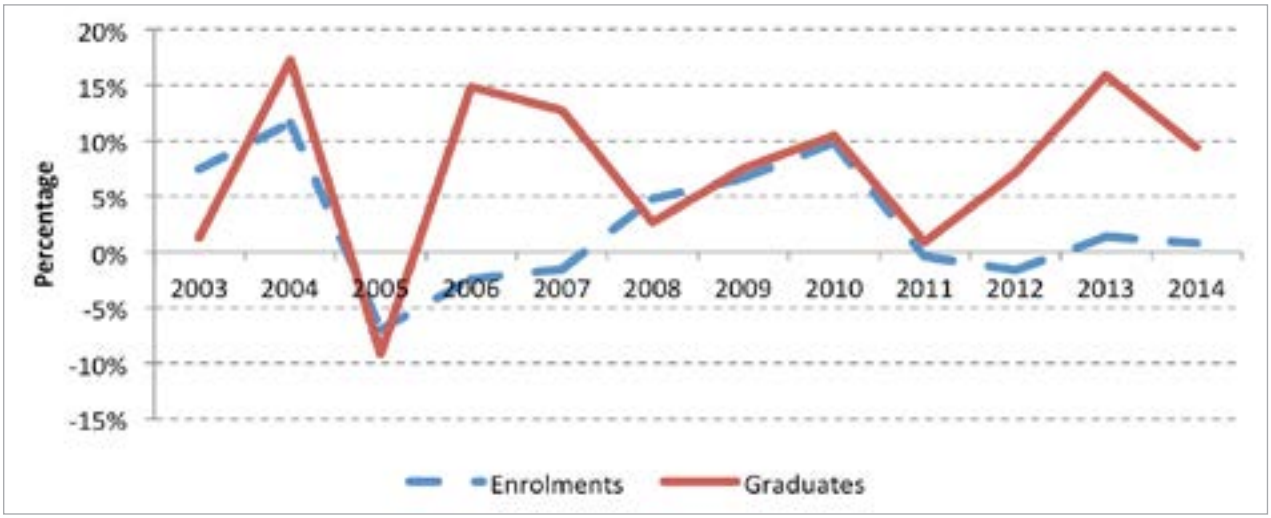
Figure 11: Annual growth in engineering enrolments and graduates at comprehensive and traditional universities (2003 – 2014)



Source: Higher education management information system, Department of Higher Education and Training; own calculations (2003 – 2014)

There is a positive relationship between enrolments and graduates at universities of technology. Figure 12 suggests that in 2005, the number of engineering enrolments at these institutions decreased by almost 8% and the number of graduates decreased by 9%. Despite some significant fluctuations over the period, the ratio of enrolments to graduates was almost 1:1 between 2008 and 2011. Towards the end of the period, the number of graduates began to far outweigh the number of enrolments.

Figure 12: Annual growth in engineering enrolments and graduates at universities of technology (2003 – 2014)



Source: Higher education management information system, Department of Higher Education and Training; own calculations (2003 – 2014)

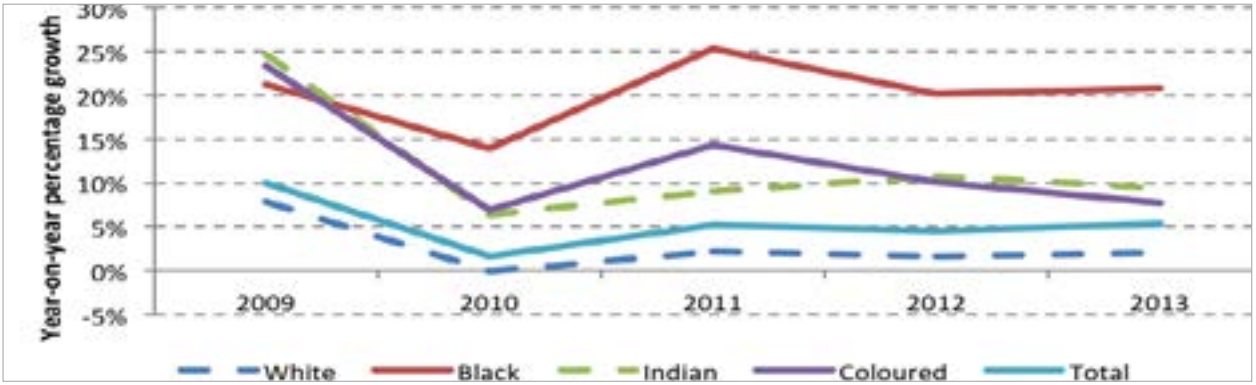
South Africa began restructuring its higher education system in 2003 to widen access to tertiary education. Smaller universities and technikons (polytechnics) were incorporated into larger institutions to form comprehensive universities.

A comparative analysis suggests there may have been a substitution effect (crossover of students from one kind of institution to the other) at play between the universities and universities of technology in 2005. In 2006, however, the number of graduates at universities of technology increased by 14,8%, but slowly decreased to align with enrolments, then grew of 10% per year until 2011.

Registration of Engineering Professionals with ECSA[2]

Figure 13 provides an analysis of annual growth trends in professional registration with ECSA. Whites represented the overwhelming share of all professional engineers registered in 2008 and 2013, with 85,6% and 75,5%, respectively. But growth in registration was the highest for black engineering professionals, who constituted just 16,4% of registrations in 2013. The decrease in registrations in 2010 could be attributed to the combined effects of the end of 2010 Fifa World Cup-related engineering projects as well as the global economic downturn.

Figure 13: Trends in the registration of engineering professionals with ECSA (2009 – 2013)



Source: ECSA annual report 2013/14

Conclusions

In as much as growth in the manufacturing sector has been unstable over the past decade, the development of skills could contribute positively to productivity. This would only be possible if steps are taken to actively address elements of the skills mismatch, as outlined in this brief. A more nuanced approach is required to improve skills development among engineering professionals to rejuvenate the engineering workforce in a balanced manner. This is a key cofactor in shifting manufacturing towards more value-added activities and beneficiation.

2 Ecsa is a statutory body established in terms of the Engineering Profession Act, 2000 (Act No. 46 of 2000).

Annexure A: Comparison of Employment Trends in Engineering Professionals, Artisans and Manufacturing in South Africa

Year	Engineering employment in manufacturing			Manufacturing employment ('000)
	Engineers and technologists ('000)	Artisans ('000)	Technicians ('000)	
2002	16	481	153	1 647
2003	6	453	141	1 560
2004	9	464	120	1 724
2005	15	545	110	1 742
2006	8	547	120	1 757
2007	16	525	109	1 776
2008	21	582	158	1 917
2009	11	482	168	1 771
2010	13	465	163	1 713
2011	16	495	135	1 737
2012	25	456	143	1 727
2013	15	434	166	1 667
2014	24	441	145	1 741
CAGR	**3,4%**	**-0,7%**	**-0,4%**	**0,5%**

Annexure B: Types of Engineering Professionals

Industrial and manufacturing engineers

Engineers generally hold a four-year Bachelor of Science (BSc) degree, specialising in engineering, or a Bachelor of Engineering (B. Eng.) degree from a either a traditional university or a comprehensive university.

Industrial engineering technologists

Engineering technologists generally hold a Bachelor of Technology (B. Tech) from a university of technology.

Industrial engineering technicians

Engineering technicians generally hold a National Diploma (NDip) from a university of technology.

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