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SKILLS DEMAND AND SUPPLY IN THE SOUTH AFRICAN ICT SECTOR 1996-2005

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Skills demand and supply in the South African ICT sector, 1996-2005

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CHAPTER 1: INTRODUCTION

Background

The South African debate about skills and the labour market has considerable longevity. In recent times attention has intensified on the problematic interaction between demand for and supply of skilled labour. The coincidence of skills shortages and graduate unemployment in sectoral and even in occupational labour markets has been further cause for concern. Warnings have been broadcast that problems with the skills composition of the labour market will erode the growth potential of the South African economy.

Government and business structures have more and more stridently expressed the need to acquire information and analysis that can support the design of programmes to ameliorate the 'skills crisis' in South Africa.

There is a growing corpus of labour market studies based on different approaches: in scale from macro to micro, in sectoral focus, in occupational focus, in methodological approach, in selection of data sources, in data analytic technique, in disciplinary origination and in theoretical framework. This variety of output has served admirably to demonstrate the complexity of the labour market and skills environment in South Africa. It is also a strength because no single approach is likely to capture the complexity of the phenomenon under study. For these same reasons, the task of synthesising the variety of academic and research production around skills and labour markets in South Africa would constitute a major challenge.

In this context, this report is part of a coordinated set of sectoral studies commissioned by the Department of Labour in 2007. It focuses on skills and employment in the ICT sector and its constituent sub-sectors between 1996 and 2005.

The ICT sector and ICT skills

The nature of the contribution of ICT to economic growth has long been a topic of heated debate. Our intention is not to engage with the voluminous literature on this subject. We simply recognize that ICTs are a multipurpose set of technologies that can enhance business processes in any organizational environment and can facilitate the expression of individual creativity and contribute to raising individual productivity at work or at leisure. The ICT sector is an important economic sector because it is in effect the 'producer sector' of ICT goods and services which are applied in myriad business and personal environments.

For these reasons, in South Africa as elsewhere, in depth analysis of the interaction of skilled and unskilled workers in the ICT labour market is a valid pursuit. Importantly for South Africa, the twin imperative for economic sector development is to boost both employment and growth. A key question therefore is whether in the decade under study the ICT sector revealed the potential to achieve both goals. A related question is what role skills may prospectively play in facilitating access to jobs and in supporting economic growth in the sector.

Perspectives on ICT skills shortages in South Africa

Information and communication technologies (ICTs) are widely assumed to be an enabler of economic growth (UNDP 2001a). South Africa's Deputy President, Phumzile Mlambo-Ngcuka, who launched the Accelerated and Shared Growth Initiative (Asgisa), indicated ICT as an important enabler of growth and development (Mlambo-Ngcuka 2006).

Concern has been expressed to the effect that there is a shortage of ICT skills in South Africa which will constrain government's goal to achieve a sustainable annual six per cent growth rate in GDP and to halve unemployment and poverty by 2014.

Claims about South Africa's apparent ICT skills shortages emanate from a range of sources such as government, training providers, industry, and writers of journal articles and media reports. We will briefly refer to examples from these media drawing attention to the various dimensions of the ICT skills shortage.

Technology change

The cyclical nature of the ICT industry is due to influences such as technology obsolescence and changing business requirements and trends, and has led to an ongoing skills shortage locally and globally, says Becky Mosehle (2006). High level specialist skills such as business analyst and programming skills are important for new generation, sophisticated networks (Carte 2006).

Technical skills

Government has identified a continuing need for software engineering skills and for advanced skills in soft and hardware development (Manuel 2007; Fraser-Moleketi 2006). In addition, rising broadband speeds and the emergence of multimedia applications, has fuelled the demand for web developer skills (The Independent 2006). The increase in cyber-crime and cyber intrusion has increased demand for ICT system security and information security skills (Hill 2006; Boltin 2006).

Project management skills

In the near future there will be a premium on appropriate project management skills as integral to upgrading the country's ICT infrastructure. Such skills will be needed *inter alia* to supervise the fibre infrastructure and networks that link stadiums to the International Broadcast Centre for the 2010 Soccer World Cup (Mazamisa 2007).

Business skills

The business environment changes constantly and ICT systems need to evolve accordingly. Business skills thus need to go hand-in-hand with ICT skills. ICT workers need to go beyond systems and technologies and build their knowledge and skills in business disciplines and the relationships between business functions and finance (Gillingham 2006).

Experience

In 2007, a chronic shortage of top SAP systems managers was reported in South Africa (The Star, 5 March 2007). According to an IDC study (Van Heerden 2006), a significant proportion of South African firms will seek advanced international skills among South African nationals who gained experience abroad.

Higher education curriculum

In the financial sector executives indicated that higher education ICT departments do not adequately infuse an understanding of the relationship between business and ICT systems into the curriculum (Boltin 2006).

There is a suggestion that higher education institutions themselves suffer ICT skills shortages and that innovative strategies are required to expand the existing ICT pool of skills in the institutions (Cross & Adam 2007).

ASGISA

Within the ASGISA initiative business process outsourcing (BPO) and the call centre industry (which requires mainly intermediate ICT skills) is gaining momentum, but higher level skills, such as call centre management skills are required for South Africa to become competitive in the global call centre industry (Perry 2008).

Equity

There is a shortage of skilled black ICT candidates (Mosehle 2006) and other designated groups in South Africa (Ndlovu 2006). Fulfilling the requirements of the ICT Charter in terms of employment equity is a problem due to a shortage of ICT skills. More investment is required in skills development and employment equity in the ICT sector, as ICT companies have tended to recruit staff instead of developing human resources internally (Coetzer 2007).

Migration

Countries such as the United Kingdom, Australia, New Zealand, Canada and Germany are experiencing skills shortages in key areas such as IT, engineering, and accounting These countries have been reliant on “brain gain” from emerging markets such as South Africa, India and China (Western Cape Corporate Placements 2006). Meanwhile the South African government is to go head-hunting in India for *ICT* experts amongst others (Fraser-Moleketi 2006).

These observations reveal that skills ‘shortages’ or ‘needs’ are driven by a range of factors that are exogenous to the firm (eg: global labour market pressures) and that are endogenous to the firm (eg: weak commitment to skilling and retaining own workers).

The observations also show that skills ‘needs’ or ‘shortages’ may be identified in a number of different dimensions. These range from purely technical skills, to managerial, to soft skills, to experience.

Furthermore, some of the skills shortages claimed may be fairly specific to a particular industrial sub-sector, and may not necessarily be of a long duration.

This report

The analysis to be presented in the report is based mainly on official sources that report labour market data according to standard occupational categories and to standard industrial categories. In turn, education supply data – the qualifications of graduates – from South African higher education institutions is presented according to standardized study field data. The analysis of these datasets over a decade provides an overview of trends in labour market supply and demand, giving some indications of the patterns of skills demand, ‘needs’ or ‘shortages’.

The report itself is structured in three main parts: Part 1 will investigate skills demand in the ICT sector workforce, and then in particular occupations that are found across all sectors.

Part 2 involves detailed analysis of the supply of skills into the labour market, particularly from public higher education institutions.

In Part 3, the report considers the relationship between demand and supply through three different methodological approaches to the question: a projection, an analysis of remuneration and a survey of vacancies.

PART ONE: DEMAND

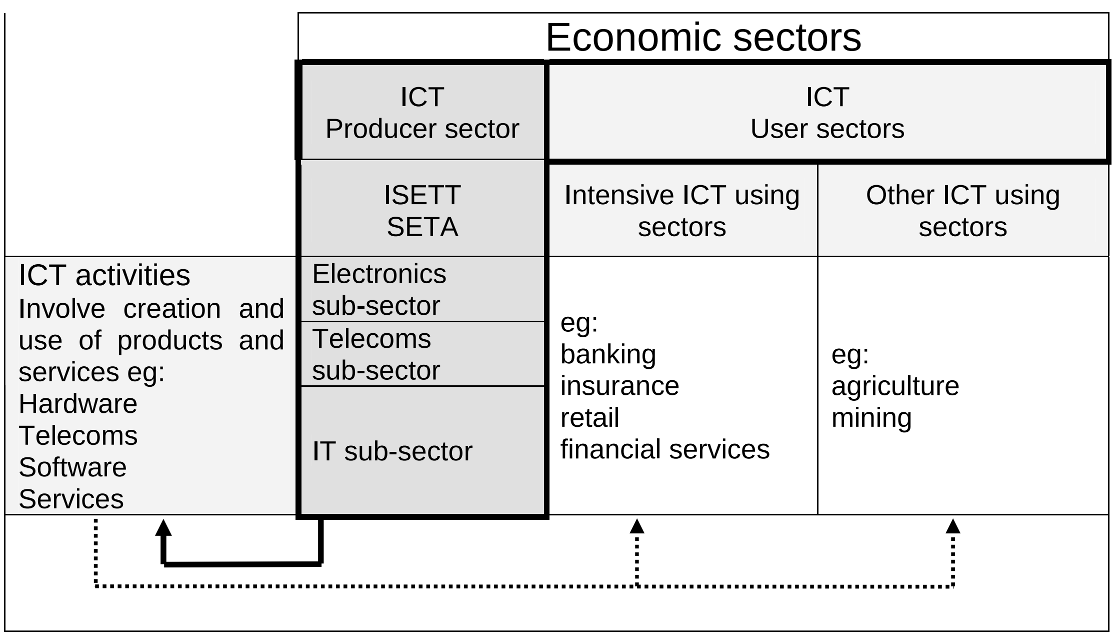
CHAPTER 2: THE ICT SECTOR IN ITS BROADER ECONOMIC SETTING

Sectoral labour demand and occupational labour demand

ICTs are integrated to some degree in business processes in all sectors of the economy. They have the potential to contribute positively towards the performance of any sector in which they are deployed. In the manufacturing sector, for instance, they can contribute strategically to the evolution of efficient yet flexible product value chains. How ICTs are deployed within a sector in a particular national economy will depend on a range of factors, including the growth potential of that sector.

At the same time, the ICT sector itself constitutes a sub-component of the national economy which influences and is influenced by the changing shape and size of the larger economy. The ICT ‘producer’ sector itself consists of three sub-divisions, electronics, telecommunications and IT services which because of their diverse activities are located in different broad industrial divisions according to the Standard Industrial Classification (SIC) system (Figure 1). IT services is categorised within the broader ‘services sector’, telecommunications in the broader ‘transport and telecommunications sector’ and electronics in the broader ‘manufacturing sector’.

Figure 1: Relationship between the ICT sector and ICT ‘user’ sectors



Source: (Paterson, 2006)

It is possible and sometimes necessary to addresses ICT skills in two ways. One approach will entail examining the ICT sector labour market. In such a case the unit of analysis would be the ICT sector and its three component subsectors. The ICT sector workforce will contain workers from all occupational categories. This means that workers with ICT skills (eg: computer programmers) will work alongside other workers (eg: clerical and administrative) in enterprises whose core business is to produce and sell ICT goods and services. Taking a sector workforce as a unit of analysis is standard practice (eg: ICT or manufacturing or construction) because each industrial activity will have characteristic labour demands for particular combinations of low to high level skills. In the first part of this report we consider these issues in detail.

Another approach will be to examine the demand for ICT workers across the economy. As we have observed here, workers with ICT skills are employed not only in the ICT sector but across all sectors which use ICT (eg: especially banking and retail and financial services but also mining and agriculture). This approach will not emphasise the sector as the unit of analysis but rather the occupational category. It is important to consider changes in the total number of computer professionals who are employed across all sectors in the entire economy. In this way we would be in a better position to draw out the general levels of demand for particular ICT specialist occupational categories.

We will proceed to briefly introduce the performance of the ICT sector mainly with reference to the period for which data analysis is undertaken – 1996 to 2005.

The shape of the South African ICT sector

The South African ICT sector in relation to other domestic industrial sectors

During the period under review, as elsewhere, the ICT sector in South Africa experienced a concerted surge of activity and growing investor confidence, followed by a sudden turnaround in the dot.com crash, coupled with the effects of global economic slowdown. Since the turbulent millennium period, the local ICT sector showed positive growth in tandem with the economy as a whole.

In terms of industry sector contribution to South Africa's Gross Domestic Product (GDP), the ICT sector was projected to reach 2,5% for 2002-2002 while sales in the sector were estimated to be 7-8% of GDP for the same period (Leadership,2002). Although all sectors of the South African economy – except for Wholesale and Retail Trade – shed labour between 1997 and 2001, there were a number of positive signs for the ICT sector, which is strongly embedded across several economic sectors, especially services. After 2001, the South African economy showed growing diversification in services exports. In particular, the category of 'other services' which includes telecommunication, financial and information services exports. In particular, in the Financial Services, Business Services, Banking, and Wholesale and Retail sectors the information intensity of business processes is high.

Size of the ICT sub-sectors

The size of each sub-sector in number of enterprises, and in relation to the average size of enterprises has a bearing on how much training is provided. In general, increasing size of an enterprise is associated with higher propensity to provide training to workers. In addition, training coordination on an industry basis should becomes easier in sectors where there are a few large players than a large number of small players, notwithstanding competition.

Telecommunications

The Telecommunications sub-sector contains the smallest proportion of enterprises in the ICT sector overall but a few of these are very large employers (Table 1). Enterprises in the telecommunications sub-sector are predominantly active in, 'television signal distribution' and 'wireless telecommunications (excluding satellite)', with some activity in 'cable network services' (Paterson, 2006, 54). South Africa is the largest telecommunications market in Africa with seven main players. Statutory protection of Telkom the major fixed line provider has only recently ended and as a consequence of slow movement towards creating a cost-competitive market, telecommunications costs in South Africa are high, and deployment of value-added services and alternative technologies have been relatively slow.

Table 1: Number of enterprises by sub-sector in the ICT sector in 2002		
	No of enterprises	**Percentage of enterprises in the ICT sector**
IT Sub-sector	5597	87
Electronics Sub-sector	165	3
Telecommunications Sub-sector	612	10
Total	6374	100

Source: ISETT SETA (2002) 3; (AMI,2002,14)

Information technology (IT)

As can be seen from Table 1 above, in enterprise numbers the IT sub-sector is by far the largest within the ICT sector in South Africa. The sub-sector is characterised by a large number of small organisations. About 80% of enterprises had less than 5 employees, and 88% had less than 10 employees in 2002 (ISETT SETA, 2002, 3).

The overwhelming majority of enterprises are involved in 'computer related services' 'repair and maintenance', 'rental and leasing' of computing machinery, and 'management services'. A number of enterprises are involved in 'customer computer programming services' and 'call centre and Customer Relationship Management Systems' based mainly on existing technologies and platforms. On the other hand, activities such as 'software publishing' and 'computer systems design' account for a small proportion of the population of enterprises in the sub-sector this implies that few enterprises concentrate on innovation (Paterson,2006, 54).

Most of the business activities of companies in this sub-sector involve implementation, deployment and support for products and technology sourced internationally. Some exceptions with local proprietary intellectual property are FrontRange with their Goldmine and Heat products and Idion with its Vision product range (Who Owns Whom, 2007).

Many global players in transaction technology are strongly embedded in the South Africa market through joint venture agreements and other alliances with local companies to develop e-commerce transaction systems. Slow and expensive Internet services, the risk of fraud and poor customer service have to some degree retarded growth in the e-commerce sector. The data storage subgroup of activities is one of the IT industry's fastest growing, driven by the need for efficient document and information management and data handling and by heightened interest in data mining (Who Owns Whom, 2007).

On the hardware side, activities involving maintenance of office, accounting and computing machines is small (including audio-visual equipment, binders, shredders and CCTV, but excluding companies that do maintenance of telecommunication components). Small and medium sized resellers, agents, franchisees and dealers buy products from major distributors, suppliers and importers. This is a very competitive segment taking into account gray products, many big international players, the rand/dollar exchange rate fluctuations, and the fast pace of technology innovation.

Onshore contracts represent a growth opportunity for South Africa with foreign companies placing call centres and transaction-processing centres in this country. In 2005, there were more than 540 business process outsourcing (BPO) call centres in South Africa that employed more than 17 000 people. South African call centre companies more than doubled from six in 2005, to 14 in the first six months of 2006. There has been significant growth in call centres for the financial services, banking, cell phone services, insurance, automotive, fast moving consumer goods and leisure industries. A challenge currently facing the call centre industry is the local telecommunications prices compared to prices in India and the Philippines. Another challenge for the call centre industry is low skills levels of entry-level workers, whose labour can be replaced by self-service systems based on VOIP technology.

Electronics

In the electronics sub-sector, major enterprise players in the industrial, power, defense, and telecoms electronics areas include: Siemens, Alcatel, Ericsson, Altech, Grintek, Spescom, Tellumat and Marconi. (DTI,2004). From the range of sectorally driven electronics activities, the electronics sub-sector appears to be quite diversified. Nevertheless, the majority of enterprises import pre-manufactured IT electronic components, while some enterprises in this sub-sector may be value-adding through identifying new applications based on pre-manufactured equipment (Paterson,2006,55).

Linked to electronics manufacturing is the manufacture of insulated wire and cable subdivision (24.4 per cent of ICT manufacturing) which includes all types of covered wire, cables and other insulated conductors. There are three major players and altogether around sixteen players in the subdivision. Looking into the African market with its great distances, low population densities and lack of infrastructure, lends itself especially to investment in mobile wireless technology (Who Owns Whom, 2007).

International performance of the ICT sector

For the ICT sector in South Africa, growth is based mainly on domestic consumption rather than export, and is based mainly in communications, and IT services, less in software development and least in hardware. Sustained export growth remains elusive. South African enterprises showed market leadership in the pre-payment, revenue management and fraud prevention systems as well as in the manufacture of set-top boxes. Business Services in particular showed the highest export growth in the 1991 – 2001 period (TIPS,2003,12-13).

Nevertheless, exports of South African ICT products remained low. South Africa's share of world trade in ICT products in 1999/2000 at 0,06%, was lower than South Africa's average over all product exports of 0,7% (Leadership, 2002) which can be attributed in part to the tendency for the ICT sector in the period after 1994, to focus on supplying a small group of large domestic clients.

The steady domestic progress of the ICT sector since the millennium has been put in some doubt in 2008 with global equity market negativity, and a looming economic recession in the United States, local electricity supply problems and rising interest rates, so South African IT business confidence is wait-and-see (Burrows,2008; Sikwane,2008). However, local ICT businesses in the infrastructure field and with government contracts will be less concerned since government expenditure including the Gautrain and the 2010 Word Cup is committed.

CHAPTER 3: EMPLOYMENT AND GROWTH IN THE ICT SUB-SECTORS

Introduction

There is a strong imperative for South African government and business to find ways of achieving the twin goals of economic growth and economic participation. If these aims are achieved in tandem, there is likelihood that gross economic and social inequality can both be reduced.

If growth in the national economy must have improved job creation as its corollary, then it is important to identify and encourage the expansion of sectors which currently exhibit or show future promise for economic growth *and* for labour absorbtion.

In this chapter we analyse the trends in GDP growth and employment growth experienced in the ICT sector through focusing specifically on its three sub-sectors. In doing so we will generate a picture of the relationship between sub-sectoral growth and sub-sectoral employment demand at the aggregate level. This will form the first step toward assessing labour demand in the ICT sub-sectors at the more detailed occupational level.

Employment and growth in the main economic sectors

The three sub-sectors that constitute what is called the 'ICT sector' are quite different forms of economic activity. In terms of the international Standard Industrial Classification (SIC) system, each sub-sector is grouped within a different broad category: the 'Electronics sub-sector' is classified within the broad manufacturing sector, the 'Telecommunications sub-sector' is classified within the larger 'Transport, storage and communication' sector, and the 'IT sub-sector' is classified within the broader 'Financial intermediation, insurance, real estate and business services' sector.

It is useful to locate each ICT sub-sector as part of a broader set of sectoral economic activities because there are macro shifts taking place in the distribution and intensity of economic activity in the South African economy.

Table 2 presents real gross value added (GVA) at basic prices as the measure of output across the economy's main sectors, from 1995 to 2005. The average annual growth rate for the whole economy was 3.3 per cent, within which significant differences in sectoral growth was evident. Clearly the tertiary sector which grew at a rate of 3.9 percent for the decade was responsible for buoying up overall growth. This sector accounted for 76 per cent of total output expansion in the period, even though its share of GVA in 1995 was 63 per cent.

Bhorat and Oosthuizen (2008:61) therefore observe that: "Even over this shorter time period, the results reflect the intensification of the changing structure of the economy – away from primary towards tertiary or services-based output." They relate this observation to a broader timescale, arguing that "Ultimately … the sectoral shift that characterised the output structure of the South African economy from the 1970s through the mid-1990s, from primary and secondary sector activities to tertiary sector activities, has continued after 1995 until the present." (Bhorat and Oosthuizen (2008: 61)

At the macro level, this is an important point of departure for an analysis of the ICT sector because one of the three ICT sub-divisions involves rendering IT related services, while many other services sector activities involve intense use of ICTs.

Table 2: Sectoral economic performance (gross value added[GVA]), 1995–2005								
	1995 (R millions 2000 prices)	**2005 (R millions 2000 prices)**	**Change**				**Share of 1995 GVA (%)**	**Share of 2005 GVA (%)**
			Total ('000s)	**Total (%)**	**Average annual rate (%)**	**Share of change (%)**		
Primary sector	85 417	99 192	13 775	16.13	1.5	4.9	11.7	9.8
Agriculture, hunting, forestry and fishing	20 850	28 684	7 834	37.57	3.2	2.8	2.9	2.8
Mining and quarrying	64 567	70 508	5 941	9.20	0.9	2.1	8.9	7.0
Secondary	181 870	235 730	53 860	29.61	2.6	19.1	25	23.3
Manufacturing	140 877	181 137	40 260	28.58	2.5	14.3	19.3	17.9
Utilities (electricity, gas and water supply)	20 592	24 082	3 490	16.95	1.6	1.2	2.8	2.4
Construction	20 401	30 511	10 110	49.56	4.1	3.6	2.8	3.0
Tertiary	461 113	675 175	214 062	46.42	3.9	76.0	63.3	66.8
Internal trade (wholesale and retail trade)	99 994	152 712	52 718	52.72	4.3	18.7	13.7	15.1
Transport, storage and communication	58 923	109 188	50 265	85.31	6.4	17.8	8.1	10.8
Financial intermediation, insurance, real estate and business services	125 955	216 632	90 677	71.99	5.6	32.2	17.3	21.4
General government services	132 945	138 373	5 428	4.08	0.4	1.9	18.3	13.7
Personal services	43 298	58 270	14 972	34.58	3.0	5.3	5.9	5.8
Total	728 400	1 010 097	281 697	38.67	3.3	100.0	100	100

Source: SARB (2005) in: Bhorat and Oosthuizen (2008, Table 3.6)

Two sub-sectors in the tertiary sector accounted for 50 per cent of the national increase in GVA between 1995 and 2005: finance/business services (32.2 per cent) and transport, storage and communication (18.7 per cent). Over the period the GVA for each grew by more than 4 per cent per annum. ICT economic activity is mainly located inside of the 'transport and communication' and 'finance/business services' sectors. 'Internal trade' refers to the retail and wholesale sub-sectors which are strong consumers of ICT services.

Moving to employment performance by sector, finance/business services increased its share of GVA from 17.3 per cent in 1995 to 21.4 per cent in 2005 over the same period boasted an increase in employment share from 6 per cent to 11 per cent (Bhorat and Oosthuizen (2008, Table 3.7). As we know, the ICT services sub-sector is located in this broader finance/business services sector.

The transport, storage and communication sector grew its GVA share from 8.1 per cent to 10.8 per cent. However its propensity to absorb employment was below the national average through the period and as a consequence, its share of employment between 1995 and 2005 remained at 5 per cent (Bhorat and Oosthuizen (2008, Table 3.7). The ICT telecommunications sector is nested in this broader sector.

The manufacturing share of GVA declined from 19.3 per cent to 17.9 per cent in the period, as did its share of employment decline from 15 per cent to 14 per cent (Bhorat and Oosthuizen (2008, Table 3.7). The ICT manufacturing sub-sector falls within this broader sector.

We will now proceed to examine the performance of the ICT sub-sectors in more detail to establish their performance in terms of GDP growth and employment growth. It is important to relate the pattern of GVA growth described above to employment levels. In particular we need to consider how the share of employment growth in the decade was distributed between the ICT sub-sectors.

Jobless growth and skill biased growth/labour demand

In their recent article, Employment shifts and the 'jobless growth' debate in South Africa Bhorat and Oosthuizen argue strongly that recent characterisations of the country's economic performance since 1994 as 'jobless growth' is undeserved and rests on "fairly weak empirical grounds" (2008,64) .

Looking across the labour force, they show that "job-shedding was not evident across any … skills categories." By skills categories, Bhorat and Oosthuizen refer to a method of grouping the nine major occupations (according to the International Standard Occupational Code [ISOC] system) into three categories - 'skilled', 'semi-skilled' and 'un-skilled' - for the purposes of analysis. [1]

[1] Their grouping is as follows: 'skilled' refers to ISOC codes 1–3; 'Semi-skilled' refers to ISOC codes 4–8; 'Unskilled' refers to ISOC code 9.

They propose that “a more accurate characterisation of post-apartheid employment trends” would be as follows:

a. in the aggregate, the economy did not experience jobless growth
b. employment expansion was fairly closely correlated with positive output growth
c. the tertiary sector drove employment and output trends
d. domestic production and employment trends suggest South Africa is a tertiary sector-based economy,
e. a structural shift in the domestic economy away from the primary sector produced jobless growth in mining and agriculture, and
f. “all three skills classifications experienced positive employment growth over the period, with the employment of skilled workers growing most rapidly, followed by semi-skilled employment.”

The claims that Bhorat and Oosthuizen make above regarding employment growth trends are upheld by the data that they present in Table 3 below. One of the main intentions of this report is to build on Bhorat and Oosthuizen’s discussion of shifting employment trends. We will now seek to identify specific aspects of their argument that inform our analysis of ICT sector employment.

In their analysis, Bhorat and Oosthuizen assume that ‘jobless growth’ has taken place where the numbers employed in a sector - or a skill category within a sector – in 2005, fell below the numbers employed in 1995. We have used bold formatting and dark shading to highlight the cells with negative percentage values which Bhorat and Oosthuizen declare are expressing ‘jobless growth’. This informs their statement to the effect that: “jobless growth in the two primary sectors is clearly evident here, as mining witnessed a secular decline in employment across all skills, and employment of low-skilled workers in agriculture declined by close to 50 per cent” (2008, 63).

In their analysis, Bhorat and Oosthuizen, observe that while “growth is generally good for all skills classes, in terms of employment, the economy’s skills-biased labour demand trajectory does continue to be a prominent feature.”(2008, 64) In what direction is this ‘skills bias’? They argue that this “pattern of skills-biased employment growth has resulted in a gradual shift in the composition of employment towards skilled occupations.”(Bhorat and Oosthuizen, 2008, 65).

Although they invoke the concept of skills-biased growth, Bhorat and Oosthuizen (2008) do not develop their analysis in this dimension because they seek to address the key issue of ‘jobless growth’. However, their argument and data provides a very useful starting point to address the issue of ‘skills-biased’ growth/labour demand in more detail with particular reference to the ICT sector.

Table 3: Change in employment growth by skills category in percentages between 1995 and 2005				
Main sector	**Skilled**	**Semi-skilled**	**Low-skilled**	**Total**
Agriculture, hunting, forestry and fishing	370.1	66.03	–49.41	–25.11
Mining and quarrying	–14.35	–1.34	–21.68	–30.68
Manufacturing	62.14	*17.14*	*13.5*	*19.29*
Utilities (electricity, gas and water supply)	47.59	*11.46*	*24.58*	*19.88*
Construction	115	100.12	159.99	110.5
Wholesale and retail trade	50.81	53.85	217.8	81.82
Transport and communication	*7.25*	34.35	85.2	29.95
Financial intermediation, insurance, real estate and business services	152.1	94.38	267.25	123.9
Community, social and personal services	*13.68*	*–12.46*	*21.2*	*2.2*
Total	43.07	33.52	26.44	*28.71*

Source: Stats SA OHS 1995; Stats SA LFS 2005(2) in: Bhorat and Oosthuizen (2008, Table 3.8)
Note: 'Skilled' refers to ISOC codes 1–3; 'Semi-skilled' refers to ISOC codes 4–8; 'Unskilled' refers to ISOC code 9.

We suggest that in order to identify sectors where skills-biased growth/employment demand is evident it is insufficient to refer to 'jobless growth' although the latter phenomenon may well be associated with skills-biased growth/employment demand. For instance, in Table 3 above, the most extreme example of skills-biased growth appears to be in the 'Agriculture, hunting, forestry and fishing' sector which experienced a massive increase in high skills and an absolute decline among low-skilled workers between 1995 and 2005.

Equally, we argue that skills-biased growth/employment may be evident irrespective of whether there is or isn't jobless growth. This is because 'skills-bias' refers to relative change in the skills composition of a sector where the ratio of high skills increases relative to semi-skilled and/or low-skilled categories. Shifts of such a kind can occur whether aggregate unemployment is decreasing, stable or increasing over time

Bhorat and Oosthuizen argue that their analysis "provides another important layer of information for understanding the unevenness of employment growth at the sectoral level (2008, 63). The macro-level analysis that Bhorat and Oosthuizen presented is by their own admission in contrast to their own previous analyses over shorter time periods (see: Oosthuizen and Bhorat 2004, for the 1995–2002 period, and Bhorat 2003) (2008, 64). We are more confident in the analysis based on the time-scale of a decade as undertaken by Bhorat and Oosthuizen (2008) and will use a similar temporal scale for the purposes of our analysis, given the need to examine labour demand over a longer period and to attempt to abstract these longer term trends from short term variations.

Bearing in mind the argument above, we now proceed to: examine ICT sub-sector growth and then ICT sub-sector job creation. Thereafter we consider the relationship between the two and the implications for future labour absorbtion.

ICT sub-sector gross domestic product

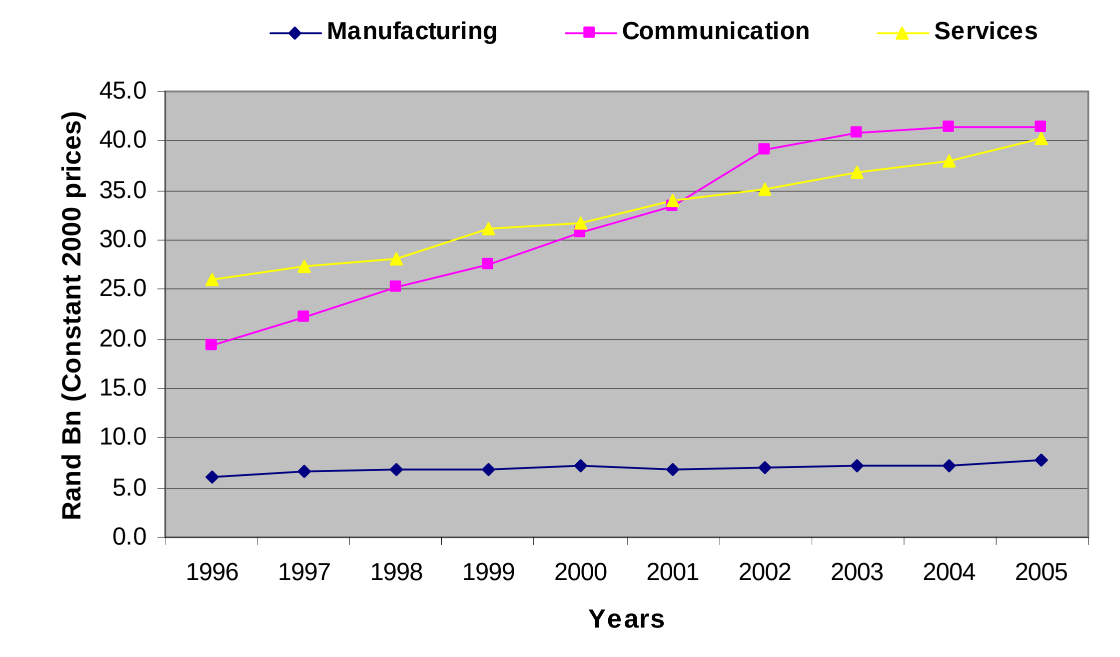
A comparison of GDP generation across ICT sub-sectors shows how ICT services gained ground on Communications to post a slightly higher share of GDP, with the former generating 46.7 percent and the latter 44.4 per cent of GDP in the 2000-2005 period. Manufacturing contributed the balance of roughly one-tenth of GDP (8.9 per cent) (Table 4). Notably only ICT services increased its share of GDP between the two periods.

Table 4: Share of gross domestic product (GDP) in the ICT sub-sectors in percentages, 1996 to 2005

ICT sub- sector	1996-1999	2000-2005	% difference between 1996-1999 and 2000-2005
ICT Manufacturing	11.3	8.9	-2.4
Communication	48.3	44.4	-3.9
ICT Services	40.4	46.7	6.3
	100	100	

Although the ICT sector as a whole generated an annual average GDP growth of 4.9 per cent, there was substantial variation between the sub-sectoral contributions. The lowest growth was achieved in the ICT manufacturing sub-sector (2.7 per cent), whereas ICT services and communication sectors showed better performance at 5.0 per cent and 8.8 per cent per annum growth respectively (Figure 2).

Figure 2: Gross domestic product (GDP) for the ICT sector, 1996 to 2005

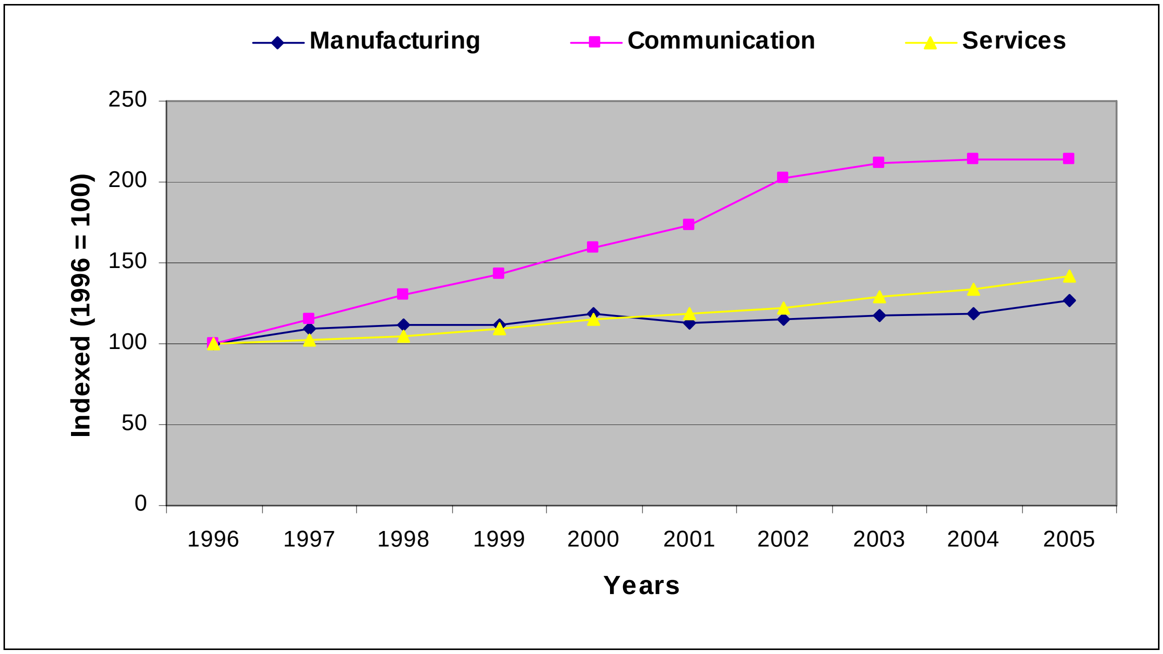


Industry	Average per annum Rand Bn (constant 2000 prices) 1996-1999	2000-2005	Average annual growth % (1996 - 2005)
Manufacturing	6.6	7.2	2.7
Communication	23.6	37.8	8.8
Services	28.2	36.0	5.0

Source: Quantec dataset (2007) integrated from: Statistics South Africa: Survey of Total Employment and Earnings; October Household Surveys and Population Censuses; Department of Labour: Manpower Surveys; Development Bank of South Africa: Stadardised Employment Series. Note: Refer to Appendix A for details of SIC Codes for each sub-sector

If we index the growth described above in raw numbers, we can see more clearly how the communication sub-sector expressed a strong spurt of growth from 1996 to 2003 whereafter the impetus tapered off (Figure 3). Nevertheless, the Communications GDP trend is far more impressive than that of the other two sub-sectors. The IT services sub-sector showed a substantially slower growth trajectory but improved consistently throughout the entire period. ICT manufacturing displayed the weakest GDP performance – following a weak up-swing until 2000, growth fell back to barely recover the 2000 level five years later.

Figure 3: Indexed gross domestic product (GDP) trends for the ICT sector, 1996 to 2005



Source: Quantec dataset (2007) integrated from: Statistics South Africa: Survey of Total Employment and Earnings; October Household Surveys and Population Censuses; Department of Labour: Manpower Surveys; Development Bank of South Africa: Stadardised Employment Series.
Note: Refer to Appendix A for details of SIC Codes for each sub-sector

We now move to consider sub-sectoral employment

ICT sector employment

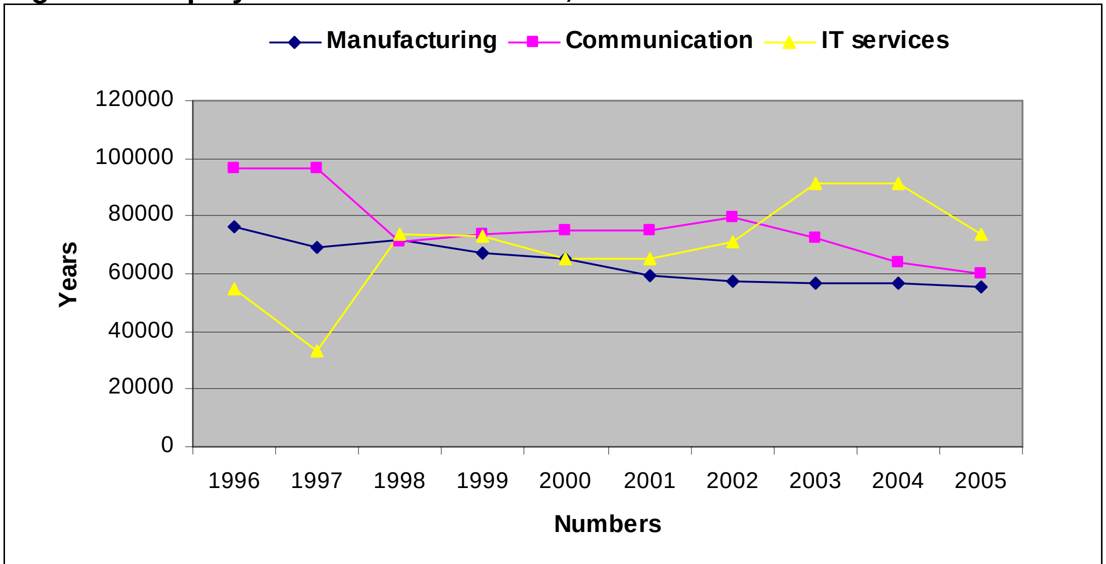
Over the period in question, the balance of employment shifted away from manufacturing and communication towards services. The share of employment in ICT services increased by nearly 10 per cent, while the share of communication and manufacturing each declined by -4.9 per cent and -4.8 per cent respectively (Table 5).

Table 5: Share of employment in the ICT sub-sectors in percentages, 1996 to 2005				
ICT sub- sector	**1996-1999**	**2000-2005**	**Average**	**% difference between 1996-1999 and 2000-2005**
ICT Manufacturing	33.2	28.4	30.9	-4.8
Communication	39.4	34.5	37	-4.9
ICT Services	27.4	37.1	32.1	9.7
	100	100	100	

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

Not only was the ICT services sub-sector fast increasing its employment share, it was also the only sub-sector that achieved positive annual average employment growth of 3.4% over the 1996 to 2005 period (Figure 4). The other two sub-sectors, manufacturing and communications recorded negative average annual employment growth rates of -3.5 per cent and -5.2 per cent.

Figure 4: Employment in the ICT sector, 1996 to 2005



Industry	Average employed per annum 1996-1999	Average employed per annum 2000-2005	Average annual growth (1996 - 2005)
Manufacturing	71158	58386	-3.5
Communication	84439	70972	-5.2
IT services	58581	76298	3.4
	214178	205656	-1.7

Source: Quantec dataset (2007) integrated from: Statistics South Africa: Survey of Total Employment and Earnings; October Household Surveys and Population Censuses; Department of Labour: Manpower Surveys; Development Bank of South Africa: Stadardised Employment Series.

Note: Refer to Appendix A for details of SIC Codes for each sub-sector

If we then index these employment numbers, the trend lines in each sub-sector are more clearly delineated.

Communication employment went into decline in the 1997-98 year, and held to a virtually flat profile over the following four years until 2002 (Figure 5). This was followed by a further slump in employment that continued from 2003 to 2005. By that stage, employment had dropped forty points below its indexed value.

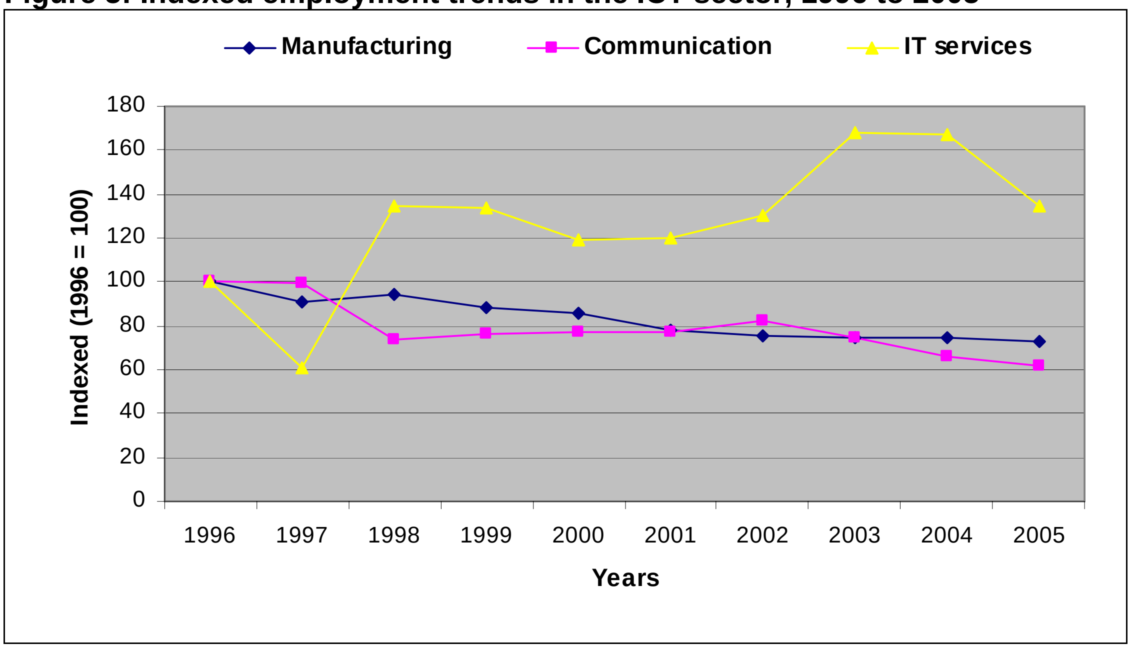
Manufacturing declined steadily and after 1996 to thirty points below its indexed value.

ICT services employment appeared more volatile than the other two sectors between 1996 and 1998. This apparent volatility may be partly explained by the use of employment data extracted direct from the StatsSA LFS and OHS datasets. The employment profile for the other two sectors was obtained from the Quantec dataset which has been smoothed.[2]

The incline of ICT services employment was definitely positive over the decade, peaking in 1998-1999 and again in 2003-2004. Despite a downturn in 2005, employment in the ICT services sector finished over thirty points above the 1996 index value.

The indexed data reveals that IT services comfortably outperformed the other two sectors in employment generation over the decade.

Figure 5: Indexed employment trends in the ICT sector, 1996 to 2005



Source: Quantec dataset (2007) integrated from: Statistics South Africa: Survey of Total Employment and Earnings; October Household Surveys and Population Censuses; Department of Labour: Manpower Surveys; Development Bank of South Africa: Stadardised Employment Series.
Note: Refer to Appendix A for details of SIC Codes for each sub-sector

Growth and employment in the ICT sub-sectors

The analysis presented above is summarized in Table 6 below which refers to the two key indicators (employment and GDP). This draws our attention to the relationship between growth and employment in each ICT sub-sector.

[2] Information that has been averaged or processed with a curve-fitting algorithm so that the line produced is free from singularities that result when raw data is plotted on a graph.

Table 6: Gross domestic product (GDP) and employment in ICT sub-sectors, 1996 to 2005				
ICT sub- sector	GDP		Employment	
	Share in %	Average annual growth	Share in %	Average annual growth
ICT Manufacturing	9.8	2.7	30.9	-3.5
Communication	45.6	8.8	37	-5.2
ICT Services	44.5	5	32.1	3.4
	100	4.9	100	-1.7

What does the historical performance of the three sectors in the past decade reveal? We have reproduced the table above but have inserted simple categorical statements that could be said to reflect the performance of each sub-sector for each indicator (Table 7).

Table 7: summary of ICT sub-sector growth and employment trajectories				
ICT sub- sector	GDP		Employment	
	Share in %	Growth	Share in %	Growth
ICT Manufacturing	Small	Low	Moderate	Low negative
Communication	Large	Strong	Moderate	Strong negative
ICT Services	Large	Medium	Moderate	Positive

ICT Manufacturing sub-sector (small share, low growth GDP, declining employment) This sub-sector produces a minor share of ICT sector GDP and has a low growth trajectory. Its employment share is three times larger than its GDP share. This means that its GDP per worker ratio is not as favourable as the other two sectors. Furthermore, employment is in slow decline.

These characteristics are similar to trends in the broader manufacturing sector.

Communication sub-sector (high growth, large share of GDP, moderate employment but severe job losses)

This sub-sector produces a large share of ICT sector GDP with a strong growth path. It has a moderate labour market size but suffered significant job losses.

These characteristics appear to be consistent with job-shedding capital intensive technology sector development.

ICT Services sub-sector (Large share of GDP with medium growth, positive job creation on a moderate employment share)

This sub-sector generates a large share of GDP with good growth - though lower than communication. It sustained the fastest growing share of employment through the period.

These characteristics are shared with broader non-traditional services activities.

If industrial strategists have confidence that these trends will continue into the future, then sector role-players – industry, government, investors - may seriously consider investing in growth in the ICT services sub-sector as the best prospect for labour absorbtion. However, further analysis is necessary to establish what kinds of labour could/would be absorbed.

We will now proceed with an in-depth analysis of employment patterns within each sub-sector. This is an important step because so far we have referred to employment only in the aggregate, which means that we must still explore the skills composition and changes in that skills composition for each sub-sector over the decade in question. Once the skills make-up of the three sub-sectors are unpacked, this should shed some light on the complex relationship between economic growth, job creation, skills needs and technology.

CHAPTER 4: DISTRIBUTION OF EMPLOYMENT BETWEEN THE ICT SUB-SECTORS, AND WITHIN EACH SUB-SECTOR

Introduction

We will now examine employment within each ICT sub-sector in more detail. Employment data from the Labour Force Survey (LFS) (1996-1999) and the October Household Survey (2000-2005) (OHS) is categorized according to the Standard Industrial Classification (SIC) system to the three digit level.[3] This makes it possible to analyse which economic activities below the second digit (ICT sub-sector) level generate stronger employment and job creation potential.

By looking at employment data together with growth data we can assess the likelihood of achieving economic growth with labour absorbtion disaggregated below the sub-sectoral level. Analysis of the distribution of employment between the ICT sub-sectors and within the ICT sub-sectors from 1996 and 2005 can provide important insights into possible labour and skills demand trends in the current and in future periods.

We first take note of the sub-sectoral employment characteristics. We then examine patterns of employment in more detail, at the third digit SIC Code level to uncover which economic activities generate stronger employment activities.

Lastly, we draw historical trend lines showing the level of confidence with which employment trends in the main sub-sectors may be expected to continue.

Employment between ICT sub-sectors

The ICT sector overall achieved practically no employment growth (0.02 per cent) over the ten years 1996 to 2005 (Table 8).

Table 8: Formally employed workers in the ICT sector and sub-sectors, 1996 to 2005

ICT sub-sector	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Annual average
Manufacturing	30411	31012	16493	38169	22157	39107	46083	34098	39789	47619	34494
Telecommunication	127164	46663	84880	85461	75664	79313	86577	81106	73151	94468	83445
Services	59661	34376	79062	77069	66424	72720	73721	95919	93382	75628	72796
ICT sector total	217236	1E+05	180435	200698	164245	2E+05	206380	2E+05	206323	2E+05	190735

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

However the sub-sectoral share of employment changed between the 1996-1999 and the 2000-2005 periods (Table 9). Telecommunications the biggest employer with nearly half of all jobs in the first period dropped to a 41.0 per cent share of the ICT sector workforce in the second period. On the other hand, the IT Services share of

[3] The datasets used to inform the analysis presented in this chapter differ from the datasets used for the previous chapter. In the previous chapter we used GDP and employment data from Quantec, which are based on Quantec's pre-defined SIC Code selections for each sub-sector. In this and following chapters, the authors use LFS and OHS data based on SIC Code selections per sub-sector according to the South African definition of ICT sub-sectors. We use this data because it allows disaggregation to the third digit level. Refer to Appendix B for full details.

employment increased by 4.7 per cent, and the manufacturing share rose more moderately by 2.8 per cent.

Based on annual average employment numbers for the 2000-2005 period the telecommunications and IT services sub-sectors were almost equivalent in size accounting for 41 per cent and 39.9 per cent of the workforce respectively. Manufacturing accounted for the balance of employment with just under two in every ten (19.1 per cent) ICT sector workers.

Sub-sector	1996 - 1999			2000 - 2005			% increase-
	Employed	Annual average	decrease	Employed	Annual average	% share	decrease
Manufacturing	116085	29021	16.3	228853	57213	19.1	2.8
Telecommunication	344168	86042	48.4	490279	122570	41	-7.4
Services	250168	62542	35.2	477794	119449	39.9	4.7
ICT sector	710420	177605	99.9	1196926	299232	100	NA

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

We now proceed to describe the pattern of employment *within* each ICT sub-sector.

Employment in the ICT manufacturing sub-sector

What we refer to here as the 'ICT manufacturing sub-sector' contains two main sub-groups.

The first consists of businesses involved in the manufacture of insulated wire and cable (SIC359) and businesses involved in the manufacture of office, accounting and computing machinery (SIC363) which respectively employed 24.4 per cent and 24.1 per cent of the workforce in ICT manufacturing from 1996-2005.[4] They are administered and serviced by the manufacturing sector education training authority (SETA) or MERSETA. As can be seen, they constitute very nearly half of all employment in what we have called the ICT manufacturing sub-sector',

The second group of businesses are located within the ISETT SETA and are referred to as the 'Electronics' chamber in that SETA. The sub-group with the largest employment share of 18.4 per cent is involved in the manufacture of appliances and instruments for measuring, checking, testing, navigating and for other purposes except for optical instruments (SIC374). The other three electronics sub-groups shared roughly 10 per cent of employment each: electronic components 12.7 per cent; television, radio transmission, line telephony & telegraphy 10.3 per cent; and television and radio receivers, sound, video and other recording, reproducing apparatus and associated goods 10.2 per cent (Table 10).

[4] These two groups are normally located in the domain of the manufacturing sector education training authority (SETA) or MERSETA.

Table 10: Employment in the ICT manufacturing by sub-group 1996-2005												
Sub-group and SIC code	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**Annual average**	**% Share**
359: Manufacture of office, accounting & computing machinery	4004	11326	2672	12711	3067	4888	10669	10260	7961	15437	8299	24.1
363: Manufacture of insulated wire and cable	4949	4383	4930	7201	7191	14987	14193	3529	18429	4313	8410	24.4
371: Manufacture of electronic valves and tubes and other electronic components	13182	5324	2639	2763	1698	756	2820	8237	3255	3106	4378	12.7
372: Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy	360	1760	2565	6282	3175	5350	5835	6106	1448	2510	3539	10.3
373: Manufacture of television & radio receivers, sound or video recording or reproducing apparatus & associated goods	5180	6296	940	2679	4144	5242	5995	2193	1215	1201	3508	10.2
374: Manufacture of medical appliances and instruments & appliances for measuring, checking, testing, navigating and for other purposes, except optical instruments	2736	1923	2746	6533	2883	7885	6572	3773	7481	21052	6358	18.4
Total	30411	31012	16493	38169	22157	39107	46083	34098	39789	47619	34494	

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)
Note: On account of rounding, some total in the rows and columns may not add up precisely

Of interest are changes in the share of employment over the decade in question. Big employment increases were reflected among enterprises producing insulated wire and cable (8.9 per cent) and general medical and other instrumentation (9.7 per cent) (Table 11). There was a substantial decline in employment among enterprises making electronic components (-11.9 per cent).

Table 11: Change in employment in electronics manufacturing by sub-group, 1996-1999 and 2000-2005							
Sub-group and SIC code	**1996 - 1999**			**2000 - 2005**			**% increase-decrease**
	Employed	**Annual average**	**% share**	**Employed**	**Annual average**	**% share**	
359: Manufacture of office, accounting and computing machinery	30713	7678	26.5	52308	10462	22.9	-3.6
363: Manufacture of insulated wire and cable	21463	5366	18.5	62660	12532	27.4	8.9
371: Manufacture of electronic valves and tubes and other electronic components	23908	5977	20.6	19893	3979	8.7	-11.9
372: Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy	10967	2742	9.4	24433	4887	10.7	1.3
373: Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods	15095	3774	13	20003	4001	8.7	-4.3
374: Manufacture of medical appliances and instruments and appliances for measuring, checking, testing, navigating and for other purposes, except optical instruments	13938	3485	12	49658	9932	21.7	9.7
ICT Manufacturing: Total	116085	29021	100	228853	45771	100	NA

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

The conditions driving these shifts deserve further attention given that the Department of Trade and Industry has observed in government's recently released National Industrial Policy Framework (NIPF) that: "South Africa has also not sufficiently integrated into rapidly growing areas of global trade, such as electro-technical products"(DTI,2007a,24). We presume that this refers directly to the sector of enterprises making electronic components but which suffered a decline in employment. Would increased intervention contribute to improved growth and labour absorbtion? If so, what kind of intervention with what focus?

Employment in the IT Services sub-sector

For the period 1996 to 2005, software consultancy and supply (SIC862) alone contributed the lion's share of employment in the ICT services sub-sector accounting for nearly four in every ten workers (37.1 per cent) (Table 12). However, when hardware consultancy (11.8), wholesale traders in equipment (11.5 per cent), maintenance and repair services (7.7 per cent) and equipment rental (4.9 per cent) are grouped together as businesses active in servicing general hardware and network needs, their combined share of total employment (35.9 per cent) is approaching the same proportions as the software consultancy and supply group of activities.

Given the absolute importance of the software systems that 'sit' on computer platforms, it is somewhat surprising that employment in software related activities and services is not larger. Likewise, the small percentages of employment in data processing and especially data base activities are surprising, since value-adding to data holdings through data mining is currently seen as a strategic means of raising enterprise competitive advantage.

The nature of economic activities inside of the ‘software consultancy and supply’ sub-group is of particular interest given that the NIPF has identified IT services broadly as a potential sector for diversification.

Lastly ‘Other computer activities’ has a relatively large value but cannot be related to any particular activity unless new IT services activities are identified and coded separately in the future by StatsSA.

Table 12: Employment in IT services by sub-group, 1996 to 2005

Sub-group and SIC code	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Average	% Share
615: Wholesale trade in machinery, equipment and supplies	13129	12316	10336	10456	8224	8535	4403	9903	930	5558	8379	11.5
852: Renting of other machinery and equipment	1435	2349	454	2155	4086	1936	4105	5697	7478	5667	3536	4.9
860: Computer and related activities	31630	9149	45665	3681	0	0	0	0	1338	173	9164	12.6
861: Hardware consultancy	548	4996	5562	8750	12048	7342	11148	10854	21190	3216	8565	11.8
862: Software consultancy and supply	4119	1586	10569	34522	28260	32213	33441	44591	42476	38602	27038	37.1
863: Data processing	349	0	1192	1648	363	0	943	1851	5958	1793	1410	1.9
864: Data base activities	1913	814	2068	839	705	8593	5656	7405	297	1147	2944	4
865: Maintenance and repair of office, accounting and computing machinery	1864	1198	3215	5068	9941	6373	9468	7738	7561	3593	5602	7.7
869: Other computer related activities	4674	1968	0	9950	2797	7728	4558	7881	6154	15878	6159	8.5
	59661	34376	79061	77069	66424	72720	73722	95920	93382	75627	72797	100

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

We now consider how share of employment has changed across the various ICT services sub-activities between 1996-1999 and 2000-2005.

There is an apparent 25.7 per cent increase in the workforce engaged in software consultancy and supply activities, bringing its share of all IT service employment in the second period to 46 per cent (Table 13). But this is misleading. The category of computer and related activities (SIC860) declined to almost zero in the 2000-2005 period. This anomaly is consistent with the allocation of employment associated with various software service related activities from SIC860 to SIC862 in the second period. Let us assume that this assumption is correct. If we then add the 1996-1999 employment shares of SIC860 and SIC862 together, we obtain a share of 56.3 per cent from which we infer that the employment share of software services may actually have declined to 46 per cent between the two periods. This needs to be followed up with StatsSA.

Businesses active in servicing general hardware and network needs generally contributed 37.2 per cent to employment, a small increase on the previous period. There was a sharp dip in employment numbers in the wholesale trading of equipment, and this may be partially explained by sluggish sales in hardware after Y2K - which precipitated substantial spending on hardware - and low levels of investor confidence in the IT industry immediately after the .com crash.

Table 13: Change in employment in IT services by sub-group, 1996-1999 and 2000 2005							
Sub-group and SIC code	1996 - 1999			2000 - 2005			% increase- decrease
	Employed	Annual average	% share	Employed	Annual average	% share	
615: Wholesale trade in machinery, equipment and supplies	46237	11559	18.5	37553	9388	7.9	-10.6
852: Renting of other machinery and equipment	6393	1598	2.6	28969	7242	6.1	3.5
860: Computer and related activities	90125	22531	36	1511	378	0.3	-35.7
861: Hardware consultancy	19856	4964	7.9	65798	16450	13.8	5.8
862: Software consultancy and supply	50796	12699	20.3	219583	54896	46	25.7
863: Data processing	3189	797	1.3	10908	2727	2.3	1
864: Data base activities	5634	1409	2.3	23803	5951	5	2.7
865: Maintenance and repair of office, accounting and computing machinery	11345	2836	4.5	44674	11169	9.4	4.8
869: Other computer related activities	16592	4148	6.6	44996	11249	9.4	2.8
Total	250167	62542	100	477795	119449	100	

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

Employment in the Telecommunications sub-sector

As we have observed above, the telecommunications sub-sector employed the largest number of workers across the ICT sector as a whole (Table 14). This economic activity is not broken down to the third ISIC level. Most noteable is the fact that telecommunications employment declined by 7.4 per cent across the two periods (Table 15).

Table 14: Employment in the Telecommunications sub-sector, 1996 to 2005												
Sub sector	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Annual average	% Share
Telecommunication	127164	46663	84880	85461	75664	79313	86577	81106	73151	94468	83445	43.7
ICT sector	217236	112051	180435	200698	164245	191140	206380	211123	206323	217715	190735	100

Table 15: Change in employment in the telecommunications sub-sector, 1996-1999 and 2000-2005							
	1996 - 1999			2000 - 2005			
Sub-sector	Employed	Annual average	% share	Employed	Annual average	% share	% increase- decrease
Telecommunication	344168	86042	48.4	490279	122570	41.0	-7.4
ICT sector	710420	177605	99.9	1196926	299232	100.0	NA

Summary

To summarise, between 2000 and 2005, the two larger sub-sectors each employed four in every ten ICT sector workers. The first, telecommunications, suffered a declining share of ICT employment.

The second, IT services increased its share of employment in which the sub-group 'software consultancy and supply' was a strong employer (46 per cent). This is consistent with the importance of software to business processes in the widest possible array of organisational environments: from the private to the public sector, from global enterprises to the SMME, and to small office-home office (SOHO) users. When hardware consultancy, wholesale trade in equipment, maintenance and repair services and equipment rental are grouped together as businesses active in servicing general hardware and network needs, their combined share of total employment (35.9 per cent) is close to the size the software consultancy sub-group. One would have expected the former to be larger given the sluggish hardware market after 2000.

The smaller manufacturing sub-sector employed one-in-five ICT sector workers. Enterprises in the manufacture of computing machinery and of insulated wire and cable together employed four in every ten ICT manufacturing workers. Big employment increases were also reflected among enterprises producing insulated wire and cable which perhaps reflects rising business opportunities as African telecommunication markets open up.

The third biggest group, electronics, showed a substantial decline in employment, whereas enterprises engaged in manufacture of medical and other instrumentation and appliances increased their employment share by the same magnitude.

Employment trends in selected ICT sub-sectors and sub-groups

Based on the discussion above, we selected five ICT sub-sectors/sub-groups with a view to creating employment trend-lines for each over the 1996 to 2005 period. The selected sub-sectors/sub-divisions are:

- ICT manufacturing,
- telecommunications,
- software consultancy and supply,
- hardware consultancy, and maintenance and repair of office, accounting and computing machinery.

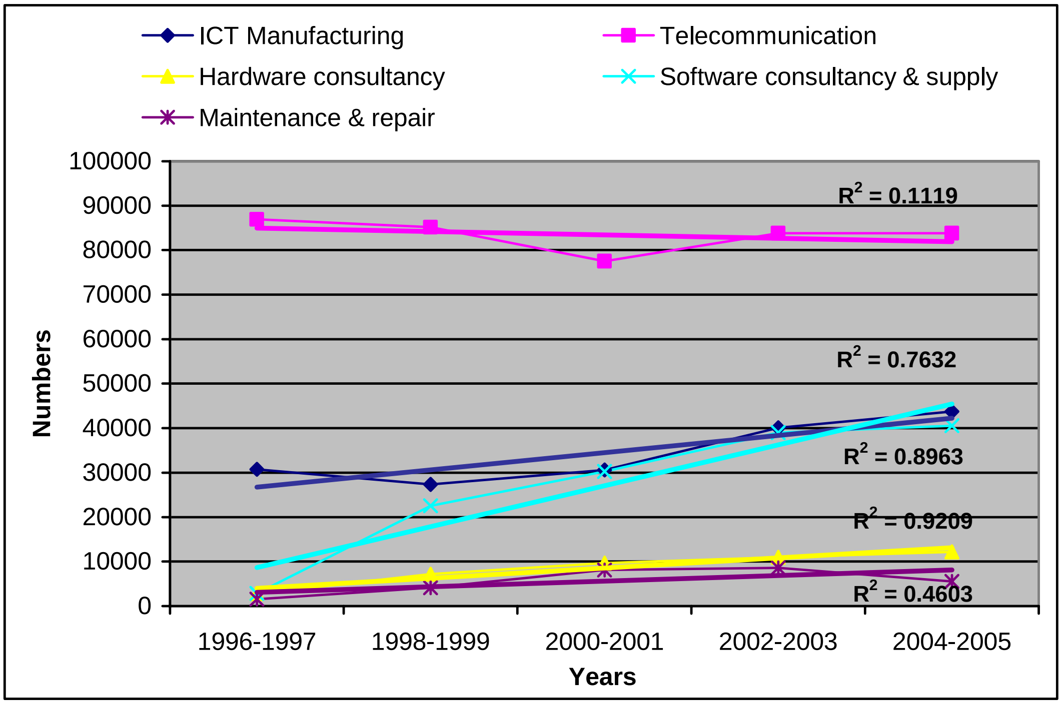
A line was drawn to show the general direction of the trend in each case (Figure 6). The r-squared linear regression method was applied to show the strength or consistency of upward/downward employment trends for the selected sub-sectors/sub-groups.[5] A value close to one indicates a high linear reliability.

The two sub-groups with the strongest r-squared (R^2) values closest to one were: hardware consultancy (R^2=0.9209) and software consultancy and supply (R^2=0.8963). Because the trends in these two subgroups have the highest confidence levels based on trends in employment growth in the decade 1996-2005, this suggests that the existing trends in these sub-groups are likely to be sustained in the future - barring any significant changes in the environment.

[5] Linear regression analysis can be undertaken when the investigator has reason to believe that a linear relationship exists between two variables, x and y – usually an independent and a dependent variable. Basic linear regression sets out to find a straight line that best 'fits' the data, where the variation in data above and below the line is minimised. An equation which describes the fitted line can be derived. An r-squared value (a correlation coefficient) can also be calculated, which provides a measure of the reliability of the linear relationship between x and y values. The r-squared value estimates the goodness of fit of the line and represents the % variation of the data explained by the fitted line. Where r-values approach 1 this indicates strong linear reliability (Clemson University,2000; University of Leicester,1998). In this exercise, we are not doing a scatter-plot of data points. We are describing measured changed in a single variable over time. We are employing the r-value simply to obtain a measure of the linear reliability of progressive change in the phenomenon under investigation. This can serve as an indicator of whether the direction of change can be predicted in the future with greater or lesser confidence.

What is significant in these R^2 results is not necessarily the incline of the trend – hardware has a far gentler upward trend than software consultancy – but the predictability of the trends. That said, quite evidently the software consultancy and supply trend is remarkable because of both its consistency and the sharp rate of increase in employment it describes. In other words, the indications for continued and strong growth in employment are most evident in software consultancy and supply. This fit supports the view that ICT services are likely to provide continued employment growth in the future.

Figure 6: Employment trends in the major subdivisions of the ICT sector, 1996 to 2005



Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)
Note: On account of large annual data fluctuations in the OHS and LFS, data points were calculated at two year intervals from which the trend lines were drawn for the 1996 to 2005 period. Each data point serves as an average over two years as indicated on the horizontal axis of the Figure above.

CHAPTER 5: EMPLOYMENT BY OCCUPATION IN THE ICT SUB-SECTORS

Introduction

We have built a picture of employment in the ICT sub-sectors and in turn of employment in their economic sub-groups. We must now address the important variable of occupation. Gross employment numbers may signal trends in job creation or job destruction within an economic sector or sub-sector, but this information needs further elaboration at the occupational level. The planning for interventions to improve supply of skills must be undertaken – data allowing – at a reasonably high degree of disaggregation (eg: by occupation or qualification).

In this section we first decompose changes observed in overall employment to the occupational level. Consequently, we are able to reveal how sub-sectors are characterized by different combinations of occupational employment. This may assist us in responding to the question: Within the dynamics of broad employment gains or losses in the period, were there specific changes in the occupational make-up of the ICT sub-sectors?

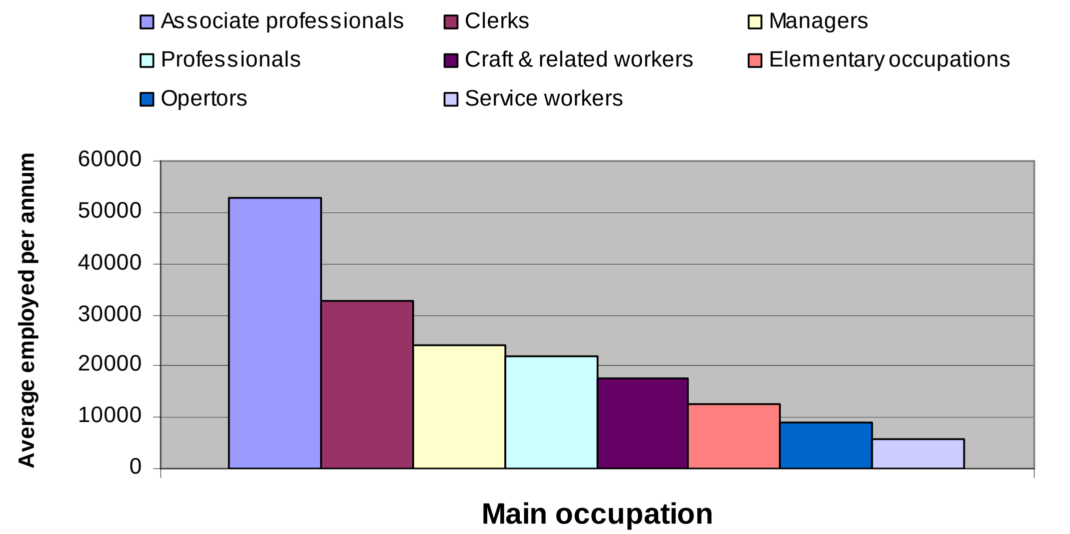
Thereafter, we briefly consider shifts in employment of Associate Professionals and Professionals accross the ICT sub-sectors. Associate professionals and professionals are the two largest occupational employment categories in the ICT sector.

General pattern of occupational employment

We begin by briefly looking at employment by occupation across the whole ICT sector in the decade 1996-2005. Comfortably the largest occupational group was associate professionals which constituted three in every ten workers (Figure 7). One quarter of the employed were managers (13.6 per cent) and professionals (12.4 per cent). The proportion of craft and related workers (10.0 per cent) and operators (5.2 per cent) was smaller than might have been expected - there were more elementary workers than operators. The smallest share was taken by service workers (3.2 per cent).

It should be noted that these occupational proportions are aggregated to the ICT sector as a whole. In some respects - as will be discussed later - there were marked differenced between the occupational profiles of the ICT sub-sectors.

Figure 7: Employment in the ICT sector by main occupation, 1996 to 2005



Average employed per annum (1996 to 2005)

	Associate professionals	Clerks	Managers	Professionals	Craft & related workers	Elementary occupations	Operators	Service workers	Total
n	52824	32693	23925	21908	17632	12533	9094	5624	176234
%	30.0	18.6	13.6	12.4	10.0	7.1	5.2	3.2	100

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

Pattern of occupational employment between ICT sub-sectors

We continue by briefly looking at the distribution of occupational employment in the three main sub- sectors averaged over the decade. Thereafter we examine changes in occupational shape over time.

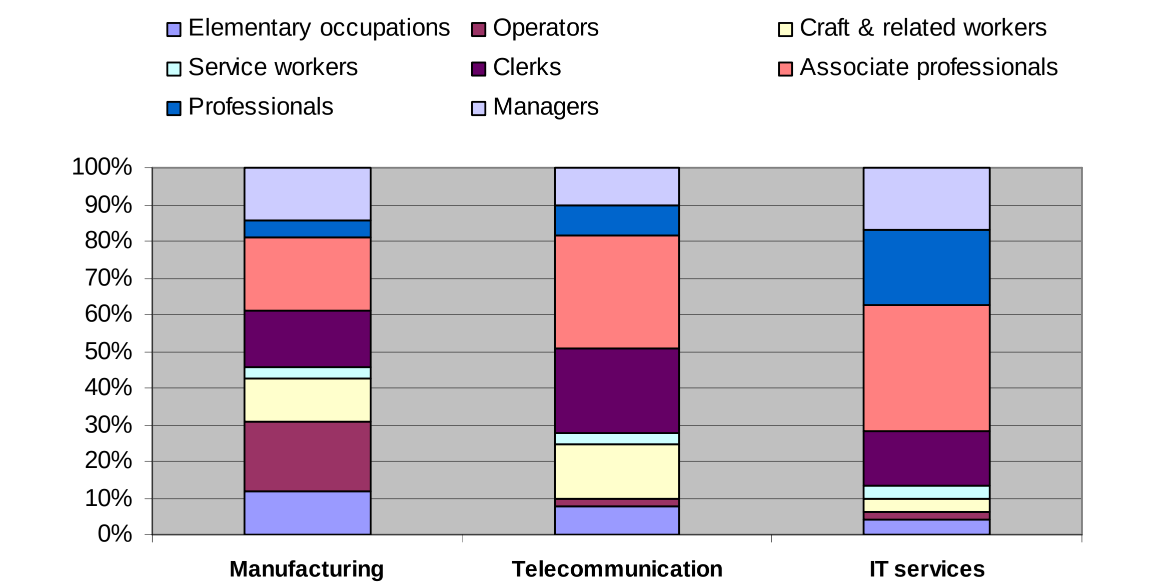
The ICT sub-sectors expressed different patterns of demand for occupational groups as might be expected of different industrial activities (Figure 8). Representation of professionals and associate professionals increases from the smallest share in 'manufacturing' through 'telecommunications' to the largest share in 'ICT services'.

Together, managers, professionals and associate professionals constituted 39.2 per cent, 49 per cent and 71.6 per cent of all employment in the manufacturing, telecommunications and ICT services sub-sectors respectively. This demonstrates how skills intensity differed vastly across the three sectors. As expected, in the 'manufacturing' sub-sector, operators constituted a substantial group together with elementary workers and craft and related workers.

There were also isomorphic features in the occupational profiles. It is clear that the occupational group with largest representation across each of the sub-sectors is associate professionals. However, the associate professional occupational group is markedly smaller in manufacturing than the other two sub-sectors.

The proportion of service workers is relatively small across all three sub-sectors. It is interesting that this should be the case even in the 'IT services' sub-sector. This strongly suggests shows that the nature of services activity in the latter sub-sector requires high-skill level workers to service client needs (i.e.: professionals and associate professionals).

Figure 8: Employment in the ICT sector according to sub-sector and main occupation, 1996 to 2005



Main occupations	Average employed per annum, 1996-2005								
	ICT manufacturing			Telecommunication			IT services		
	n	%		n	%		n	%	
Managers	4645	14.2		7721	10.3		11559	16.9	
Professionals	1522	4.7	39.2	6159	8.2	49.0	14226	20.8	71.6
Associate professionals	6643	20.3		22878	30.5		23303	34.0	
Clerks	4919	15.1		17324	23.1		10450	15.2	
Service workers	962	2.9		2327	3.1		2335	3.4	
Craft & related workers	4006	12.3	60.8	11185	14.9	51.0	2441	3.6	28.4
Operators	6057	18.5		1558	2.1		1479	2.2	
Elementary occupations	3917	12.0		5853	7.8		2762	4.0	
Total	32672	100		75006	100.0		68556	100.0	

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

Change in occupational share of employment within each ICT sub-sector

We now move on to examine changes in occupational shape over time within each ICT sub-sector. We do this by looking at changes in the distribution of workers across the main occupational categories between the two periods, 1996-1999 and 2000-2005.

In the case of each sub-sector, we rank occupations by their share of sub-sectoral employment for the recent period. We then impose the same order for the previous period so that change in occupational representation is visible by looking retrospectively from the recent period.

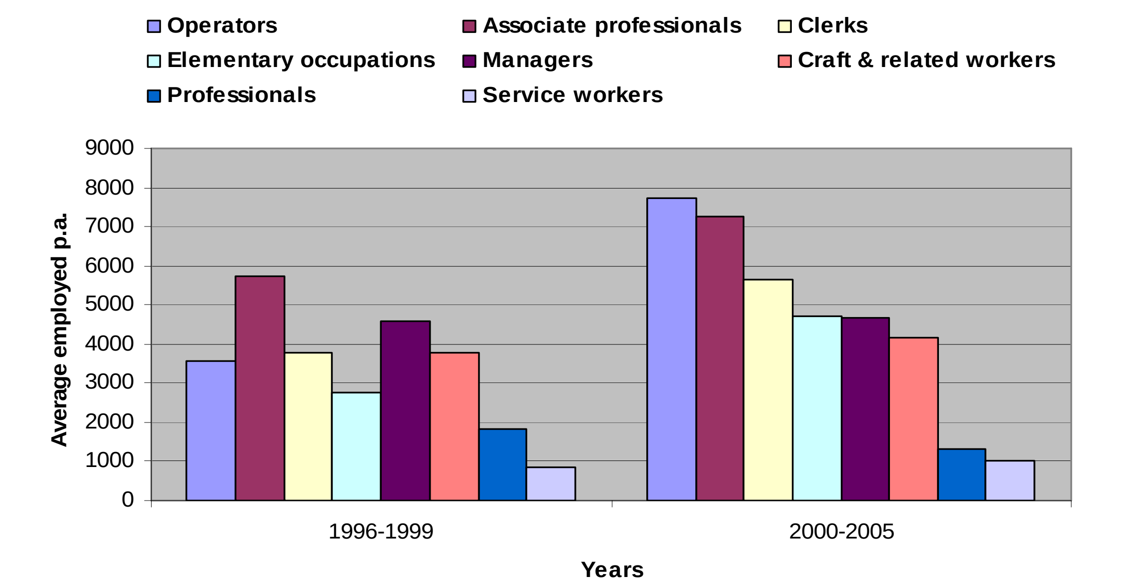
ICT Manufacturing

In the latter period 2000-2005, the average annual employment increase was 5.7 per cent.

In that period, operators emerged as the single biggest occupational group in ICT manufacturing (Figure 9). This suggests that investment in plant and production equipment increased. Furthermore, the proportion of managers, professionals and associate professionals together fell from 38.3 per cent to 32.6 per cent between the two periods – a clear decline of high skills. A 2.6 per cent decline in the share of craft and related workers, alongside a decreased share of professionals and associate professionals, points towards lower representation of technically skilled workers in the overall shape of ICT manufacturing.

As indicated earlier, we have grouped the IT manufacturing sub-group (usually included in the manufacturing sector which is the responsibility of MERSETA) with the IT electronics sector (included in the domain of the ISETT sector). We would expect differences in occupational emphasis between these two groups, perhaps with the former decreasing the size of its management and professional ranks more than the latter.

Figure 9: Employment in ICT manufacturing, 1996-1999 and 2000-2005



Main occupation	Average employed per annum 1996-1999 n	1996-1999 %	2000-2005 n	2000-2005 %	% Difference
Operators	3566	13.3	7718	21.1	7.8
Associate professionals	5738	21.3	7247	19.8	-1.5
Clerks	3797	14.1	5667	15.5	1.4
Elementary occupations	2739	10.2	4702	12.9	2.7
Managers	4587	17.0	4684	12.8	-4.2
Craft & related workers	3772	14.0	4162	11.4	-2.6
Professionals	1841	6.8	1310	3.6	-3.2
Service workers	867	3.2	1025	2.8	-0.4
Total	26906	100	36515	100	

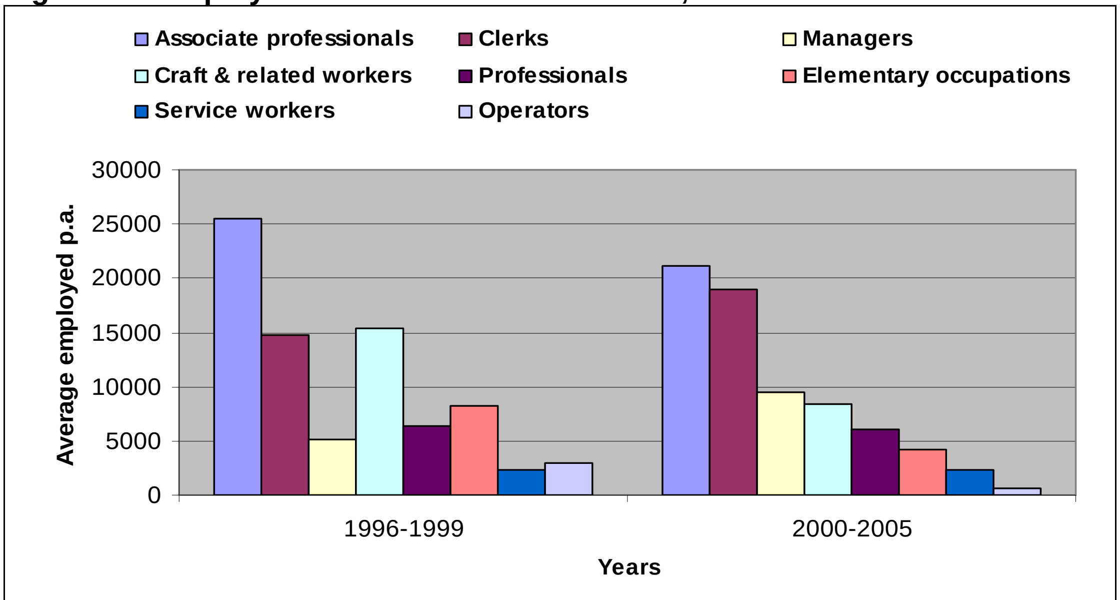
Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

Telecommunications

In the telecommunications sub-sector, occupations whose shares declined most sharply between the two periods were craft and related workers (-7.2 per cent), elementary workers (-4.4 per cent), and operators (-2.7 per cent) (Figure 10). The overall 11.5 per cent drop in average annual employment in this sub-sector is probably attributable directly to job losses in these categories. This pattern reveals a sector with much reduced demand for intermediate technical skills and low skills workers.

Notwithstanding an overall decline in workforce numbers, there was increased job creation among clerical workers (8.4 per cent) and management (7 per cent). Indeed, the high-skill professional and management group of occupations increased their share of employment from 45.8 per cent to just over half of the workforce (51.5 per cent) in the second period. These shifts seem to reflect a telecommunications sub-sector slowing down its emphasis on roll-out and hardware systems deployment, and focusing more on maintenance and managing value-added services off telecommunications systems as reflected in the increased employment of clerical workers.

Figure 10: Employment in Telecommunications, 1996-1999 and 2000-2005



Main occupation	Average employed per annum 1996-1999 n	1996-1999 %	2000-2005 n	2000-2005 %	% Difference
Associate professionals	25449	31.6	21164	29.7	-1.9
Clerks	14782	18.3	19019	26.7	8.4
Managers	5068	6.3	9490	13.3	7
Craft & related workers	15332	19.0	8420	11.8	-7.2
Professionals	6344	7.9	6036	8.5	0.6
Elementary occupations	8273	10.3	4240	5.9	-4.4
Service workers	2401	3.0	2278	3.2	0.2
Operators	2920	3.6	650	0.9	-2.7
Total	80569	100	71297	100	

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

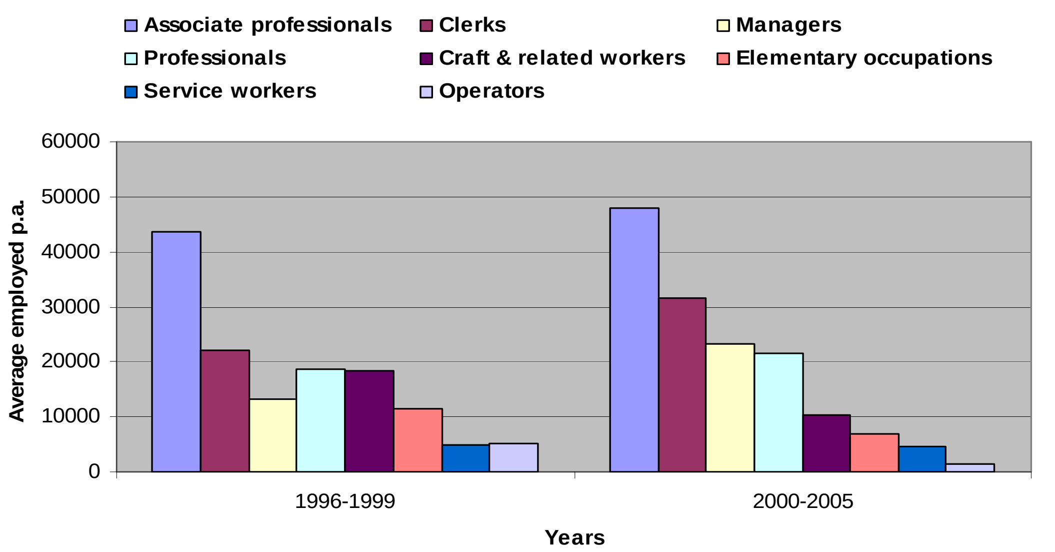
IT Services

In the IT services sub-sector, there was a 7.3 per cent increase in average annual employment between the two periods - 1996-1999 and 2000-2005. The single biggest occupational category in this sub-sector was associate professionals showing a minor increase in overall share of employment (Figure 11). Managers (6.3 per cent) and clerical workers (5.3 per cent) showed the most sizeable proportionate increases between the periods.

All other occupations suffered declining employment, which was marked among the craft and related (-6.3 per cent), elementary (-3.7 per cent) and operator (-2.7 per cent) categories. Comparison of annual average employment size between the two periods reveals that all of these categories lost jobs in real terms.

Managers, professionals and associate professionals shared 54.8 per cent of jobs in the first period and this rose to 62.8 per cent in the latter period. If clerks - 21.4 per cent share of employment in the 2000 to 2005 period - are added to this group, the increasingly white collar and high skilled character of the ICT services sub-sector is strongly apparent.

Figure 11: Employment in IT services, 1996-1999 and 2000-2005



Main occupation	Average employed per annum				
	1996-1999		2000-2005		% Difference
	n	%	n	%	
Associate professionals	43733	31.8	47814	32.4	0.6
Clerks	22096	16.1	31560	21.4	5.3
Managers	13122	9.5	23385	15.8	6.3
Professionals	18572	13.5	21595	14.6	1.1
Craft & related workers	18372	13.4	10463	7.1	-6.3
Elementary occupations	11386	8.3	6769	4.6	-3.7
Service workers	4969	3.6	4457	3.0	-0.6
Operators	5264	3.8	1552	1.1	-2.7
Total	137512	100	147595	100	

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

Summary

The discussion in this section suggests a general pattern of declining emphasis on low skills, declining emphasis on intermediate technical skills, and indifferent demand for service workers. The implication is that in the near future, the ICT sector broadly will be unlikely to absorb labour in the lower technical clerical and unskilled occupational categories. On this basis, we must conclude general assumptions made about potential labour absorbtivity of the ICT sector in these occupational categories is not consistent with the nature of labour force change in the sector.

CHAPTER 6: SKILLS LEVELS IN THE ICT SECTOR AND ITS SUB-SECTORS

Introduction

This chapter focuses on changes in the occupational skill levels of workers within the ICT sub-sectors.

The purpose of investigating this phenomenon is to assess whether in the ICT sector, the qualifications possessed by cohorts of workers within an occupational category increased over time.

Increased skills levels within an occupational category may occur because: there are increased expectations of employers to hire workers with better qualification; the supply institutions are supplying more graduates with higher qualification levels; older generations of workers with older and lower qualifications are retiring, allowing younger and better qualified workers to enter the occupation; or employers are effectively providing opportunities for improved skilling and career pathing for employed workers.

We begin by briefly providing a broad perspective on differences in the aggregate skills levels of workers in the ICT sub-sectors.

We then look in more detail at the intersection of occupation and skill level. This is based on the observation that there is not a direct relationship between the occupational category of a worker and her skills level. It is to be expected that there will be workers in the same skill category with different skills levels and training backgrounds. The aim however is to compare whether over a decade, the aggregate skills levels within a particular occupation have shifted.

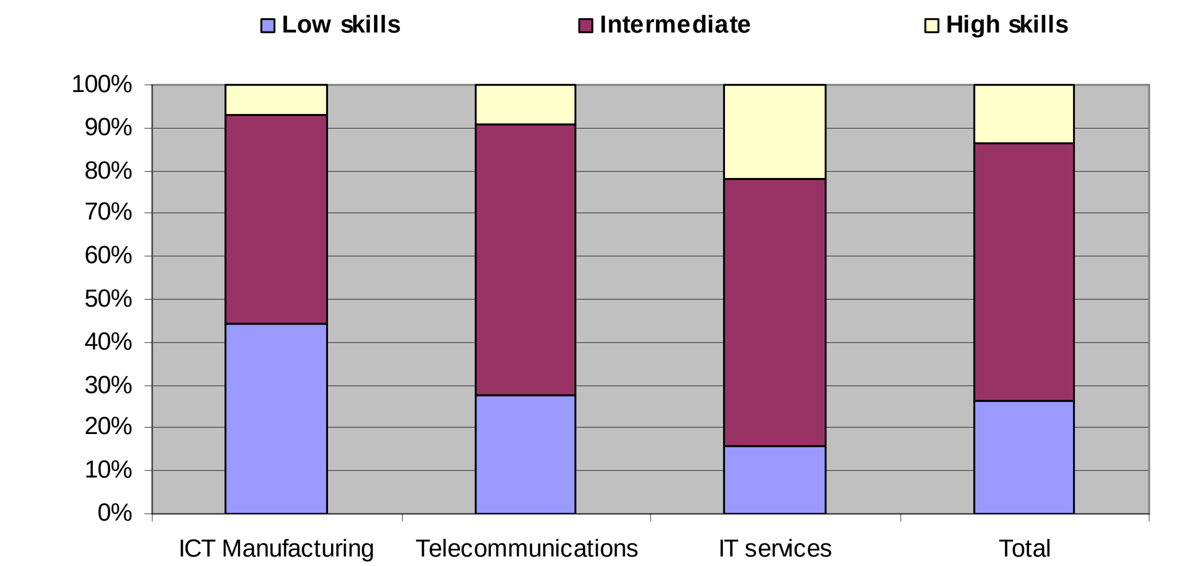
Skills levels across ICT sub-sectors 1996-2005

Averaged over the period 1996 to 2005, skills levels in the ICT sector were predominantly at the intermediate level which is to say that 59.8 per cent of workers possessed intermediate level qualifications. Smaller proportions of the workforce in the ICT sector were at the low skills level (26.4 per cent) while only 13.8 per cent were at a high skills level (Figure 12).

The distribution of skills among workers in each of the sub-sectors reveals the following pattern. The proportion of high skill workers was smallest in manufacturing (7.1 per cent), larger in telecommunications (9.3 per cent) while the largest proportion was in services (21.8 per cent). The distribution of low skill workers was largest in manufacturing (44.2 per cent) and decreased in size in telecommunications (27.6 per cent), to the smallest level in services (15.7 per cent).

This general pattern seems to confirm the distribution of occupations by skill level within each of the ICT sub-sectors. But we must bear in mind that the occupational status of a worker does not directly correspond with the skills ranking of her qualification(s). We pursue this aspect further in the discussion below.

Figure 12: Skills levels in the ICT sector, 1996 to 2005



Skills level	Average annual employed by level of skill (1996 to 2005)			
	ICT Manufacturing	Telecommunications	IT services	Total
	n	n	n	n
Low skills	16195	19577	10834	46605
Intermediate	17841	44824	42940	105604
High skills	2619	6614	15016	24249
Total	36654	71014	68789	176458

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

Occupational skill levels within the ICT sector

From time to time analysts/researchers employ occupational category as a proxy for skill level. In some instances this is a necessity because there is no data on qualifications available. As with all proxy measures, it carries disadvantages. Skills may be as defined by occupational category or by the qualifications a worker holds. But these two categories do not necessarily coincide.

There is not a direct relationship between the occupational category of a worker and her skills level. In any given occupational category is it possible to find incumbents with different skills levels that are defined by their accumulated education and training rather than by their designated occupation.[6] However, certain occupations are necessarily closely associated with high skill levels while certain occupations are associated with low skills levels. But this does not remove the possibility that over time there could be changes in the skills levels of workers who are classified in the same occupational category.

It is to be expected that in occupations such as ‘professionals’ and ‘managers’, large proportions of incumbents will have intermediate and high skills levels. By the same token, it should be expected that among those employed as elementary workers, the majority will have low skill to intermediate skills.

[6] This could be simply attributed to differences between workers of different age cohorts, where older more experienced workers would have picked up further qualifications.

Obviously, the three skills categories used, namely ‘low’, ‘intermediate’ and ‘high’, are not watertight and there will be some overlaps and inconsistencies in categorizing worker/respondents, depending on how they report their educational background and qualifications. Nevertheless, by cross-tabulating skills levels with occupations, we are able to gain insight into changing skills levels of workers within each occupation category.

Earlier in this document, we discussed how the distribution of workers per occupational category changed in the decade 1996-2005. The analysis gave an indication as to how the occupational structure of businesses in the sector changed. These changes arose as enterprises realigned their human resources - in relation to other factors of production and external challenges - in order to most efficiently deliver on strategic business objectives. The evidence shows that in some ICT sub-sectors, more workers were being hired in occupations such as professionals and associate professionals and fewer workers were being hired as operators. These changes reflect a degree of occupational bias in the hiring patterns of enterprises in the sub-sector – which supports the hypothesis that skills biased technology change, is taking place in the South African ICT sector.

We are pursuing this line of thinking by examining the distribution of skills *within* each occupational category to establish whether the skills levels of workers per occupational category has increased over the period in question. In adopting this approach we may be in a position to show how skills bias towards higher skills has occurred in the ICT sector through two processes: first, occupations with higher skills requirements are steadily increasing in their share of the workforce, and second, within occupational categories levels of skills are increasing.

ICT manufacturing sub-sector

Between the 1995-1999 and the 2000-2005 periods, in the ICT manufacturing sector, the share of workers with low level skills decreased by 7.1 per cent to 35.8 per cent, and the share of workers with intermediate skills increased by 7.2 per cent to 54.2 per cent (Table 16). There was no change in the proportion of workers with high level skills.

We now turn to the occupational level.

The occupational group which benefited significantly from increases in skills levels was ‘clerks and service workers’ where low skilled worker proportions declined by 17.4 per cent, while intermediate and high skill proportions increased by 6.6 per cent and 10.8 per cent respectively. These changes suggest that enterprises in the sector were prioritizing these facets of their business and consequently were upgrading skills levels in the administration and sales functions. This was probably driven by greater emphasis on IT enabled business processes.

Among ‘craft and related workers’ and ‘operators’ the proportions of low skilled workers declined substantially while the proportions of those with intermediate skills increased. This change could reflect the implementation of more sophisticated technologies in production which required higher level skills.

There was a sizeable change in the skills levels of managers where the proportion of managers with high skills increased from 15.2 per cent to 32.2 per cent of all managers. Such a change may further support the thesis that business processes were increasingly information rich, and required higher level strategic management competencies.

Table 16: Level of skill and occupation in the ICT manufacturing sector, 1996 -1999 and 2000-2005					
Occupation	Period	Average employed per annum			
		Low skill	Intermediate skill	High skill	Total
Managers	1996-1999	23.8	61.0	15.2	100
	2000-2005	13.6	56.2	30.2	100
Professionals	1996-1999	6.8	40.7	52.5	100
	2000-2005	0.0	43.3	56.7	100
Associate professionals	1996-1999	26.1	60.3	13.6	100
	2000-2005	23.0	69.3	7.6	100
Clerks & service workers	1996-1999	43.8	56.2	0.0	100
	2000-2005	26.4	62.8	10.8	100
Craft & related workers	1996-1999	55.1	37.6	7.2	100
	2000-2005	45.2	49.9	4.9	100
Operators	1996-1999	79.2	20.8	0.0	100
	2000-2005	61.5	38.5	0.0	100
Elementary occupations	1996-1999	67.1	32.9	0.0	100
	2000-2005	50.5	48.7	0.7	100
Total	1996-1999	42.9	47.0	10.1	100
	2000-2005	35.8	54.2	10.1	100

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

Telecommunications sub-sector

On aggregate, in the telecommunications sub-sector, the share of the workforce that was low-skilled declined by 16.6 per cent to 20.9 per cent, while the proportion of intermediate workers increased by 10 per cent to 67.1 per cent and the proportion of high skilled workers increased by 6.6 per cent to 12 per cent (Table 17). Clearly the skills profile shifted in favour of higher skills overall.

At the occupational level, the skills levels of professionals in the sub-sector increased dramatically with a 9.8 per cent decline in those with low skills, a 17.2 per cent increase in those with intermediate skills and a substantial increase of 27.1 per cent in the group with high skills. This meant that in the second period, high skills personnel comprised 60.9 per cent of all professionals in the telecommunications sub-sector. By comparison, the skills composition of 'associate professionals' improved mildly.

Meanwhile in the same period, there were sizeable improvements in the skills levels of 'operators' where operators with intermediate skills more than doubled from 20.1 per cent to 43.3 per cent. Low skilled 'craft and related workers' declined from nearly one half (48.2 per cent) to less than one third (31.7 per cent) of all workers in that category.

Table 17: Level of skill and occupation in the telecommunications sub-sector, 1996 -1999 and 2000-2005

Occupation	Period	Percentage			
		Low skill	Intermediate skill	High skill	Total
Managers	1996-1999	9.7	70.3	20.0	100
	2000-2005	8.6	60.2	31.2	100
Professionals	1996-1999	18.2	47.9	33.8	100
	2000-2005	8.4	30.7	60.9	100
Associate professionals	1996-1999	28.1	67.9	4.1	100
	2000-2005	19.4	74.8	5.8	100
Clerks & service workers	1996-1999	32.1	65.9	2.0	100
	2000-2005	18.1	78.8	3.1	100
Craft & related workers	1996-1999	48.2	51.8	0.0	100
	2000-2005	31.7	67.5	0.7	100
Operators	1996-1999	79.9	20.1	0.0	100
	2000-2005	56.7	43.3	0.0	100
Elementary occupations	1996-1999	78.2	21.8	0.0	100
	2000-2005	59.9	40.1	0.0	100
Total	1996-1999	37.5	57.1	5.4	100
	2000-2005	20.9	67.1	12.0	100

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

IT services sub-sector

Overall in the IT services sub-sector, the share of employment taken by low skill workers declined by 8.7 per cent to 12.8 per cent, there was a marginal decrease in the proportion of intermediate skill workers who were the majority (62 per cent) and the share of high skill workers rose by 9.3 per cent to 25.1 per cent (Table 18).

Now we shift analysis to the occupational level.

Skill levels in the professional occupational category shifted strongly upward, where proportions of low skill and intermediate skill professionals declined to 1.3 per cent and 39.3 per cent respectively. In turn, the proportion of high skill professionals increased from four-in-ten to six-in-ten.

A significant shift occurred among craft and related workers where the proportion of workers with intermediate skills increased by more than thirty percent to 71 per cent, while the share of low skill workers declined by more than thirty percent to the 29 per cent level.

In the ‘clerks and service workers’ as well as the ‘managers’ categories, proportions of high skill workers increased by about 10 per cent.

Table 18: Level of skill and occupation in the IT services sub-sector 1996 -1999 and 2000-2005					
Occupation	**Period**	**Percentage**			
		Low skill	**Intermediate skill**	**High skill**	**Total**
Managers	1996-1999	10.9	62.7	26.4	100
	2000-2005	2.5	61.2	36.3	100
Professionals	1996-1999	8.6	49.8	41.6	100
	2000-2005	1.3	39.3	59.3	100
Associate professionals	1996-1999	9.8	82.2	8.0	100
	2000-2005	13.2	75.9	10.9	100
Clerks & service workers	1996-1999	29.3	67.5	3.1	100
	2000-2005	17.3	69.4	13.3	100
Craft & related workers	1996-1999	61.7	38.3	0.0	100
	2000-2005	29.0	71.0	0.0	100
Operators	1996-1999	63.7	36.3	0.0	100
	2000-2005[1]	100.0	0.0	0.0	100
Elementary occupations	1996-1999	76.2	23.8	0.0	100
	2000-2005	68.5	31.5	0.0	100
Total	1996-1999	21.5	62.6	15.8	100
	2000-2005	12.8	62.1	25.1	100

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)
Notes: 1 The data for operators in the 2000-2005 period is an anomaly. This probably occurred because the number of operators in the IT services sector was so small – annually only about 1.1 per cent of IT services sector employment

Summary

To summarise, the data shows that between the two periods, proportions of low-skill workers declined in all sub-sectors, but especially in telecommunications (Table 19). This may reflect a reduced emphasis on building telecommunications infrastructure and a stronger emphasis on developing telecommunications services.

Although the evidence points to a general increase in skill levels, there were different patterns in each of the three sub-sectors (Refer to Table 19).

In ICT manufacturing, a shift transpired between the low and intermediate skill levels in favour of higher proportions of workers with intermediate skills. Alhough there was no increase in the proportion of high skill workers, the aggregate skills profile of ICT manufacturing shifted upwards.

In IT services a general rise in skill levels was apparent, through a decrease in low skills together with an increase in high skills proportions, while the proportion of intermediate skills was virtually unchanged. In the telecommunications sub-sector, a sharp decrease in low skills workers occurred simultaneously with increased shares among both intermediate and high skill workers.

The changes in the proportionate share of skills levels noted above should not be considered in isolation but in relation to changes in relative size - in employment numbers - of each occupational group.

Table 19: Level of skill by sub-sector, 1996-1999 to 2000-2005 in percentages					
Occupation	**Period**	**Average employed per annum**			
		Low skill	**Intermediate skill**	**High skill**	**Total**
ICT manufacturing	1996-1999	42.9	47.0	10.1	100
	2000-2005	35.8	54.2	10.1	100
		-7.1	7.2	0	
Telecommunication	1996-1999	37.5	57.1	5.4	100
	2000-2005	20.9	67.1	12.0	100
		-16.6	10	6.6	
IT services	1996-1999	21.5	62.6	15.8	100
	2000-2005	12.8	62.1	25.1	100
		-8.7	-0.5	9.3	

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

The changes in skill levels that we have identified within occupations, across occupations or across the sub-sectors confirm a palpable shift towards increased skill levels across the decade. These changed skill levels can be the outcome of demand from employers for a higher skill quantum among workers, increased intermediate to high skills graduate production by education institutions and through in-service training by employers and employees.

The question is: Could the increased skill levels observed here have been more prominent? Had the supply institutions been able to make skilled workers available in larger numbers, would the results of the analysis have revealed even stronger upward shifts in the skills based of the ICT sub-sectors? And, could these trends have been strengthened by employer initiatives to raise worker skills?

The evidence strongly suggests that there was an increased employer requirement for higher skills levels that was relatively independent of the demand for more skilled workers. We have shown that formal employment in the telecommunications sector declined over the decade, that formal employment in the ICT manufacturing sector was stagnant, while only the IT services sub-sector exhibited signs of employment growth and the potential to absorb labour in the future. Nevertheless *all* exhibited features of rising skill levels.

Improvements in skill levels within each occupation or within each sector could be obtained by a *reduction in low skill* proportions and/or *an increase in higher skill* proportions. One mechanism that would promote such a change would be churn in the labour force. There are several ways in which changes in skill levels within occupational categories can be induced: hiring more workers and/or job shedding. In addition, strategies undertaken by employers such as refocusing recruitment practices, and changing training and promotion practices in internal labour markets can also have the desired effects. An additional supply side element already noted, is improvements in the graduate outputs of skilled workers from institutions. Further research may usefully contribute to understanding how the shifts in skills described above were achieved.

Finally, we must acknowledge that an examination of skills levels, albeit important, is not the only dimension from which we can interrogate skills demand and supply. Further investigation needs to be undertaken into types of skills and quality of skills which cannot be entertained within the constraints of the OHS and LFS datasets.

CHAPTER 7: RACE, GENDER, AGE AND SKILLS IN THE ICT SECTOR

Introduction

In all sectors of the economy, the distribution of skills according to race group and gender needs to be addressed to assess the impact of various equity measures after 1994. The historical association between race, gender and access to educational opportunities produced and reproduced a working population in which disproportionate numbers of black workers held low skill jobs. The extent to which this legacy has been shifted in the ICT sector labour market must be monitored.

From the supply-side, low numbers of black students access university because many do not have the requisite grades in key 'gateway' subjects such as mathematics and science. Others do not have access to funding for higher education studies. Low numbers at the point of access inevitably constrain the scale and equity characteristics of graduate output. There is also attrition from other factors in targeted groups (eg: early termination of studies, repeating academic years, changing course of study).

Demand side ICT skill shortages are also a phenomenon associated with the aftermath of apartheid discrimination. For employers, finding appropriately qualified blacks or women may not be easy given where flows of appropriately qualified blacks from education are limited. Moleke Paterson and Roodt observe that the "…need to meet equity legislation means that firms are focusing on the recruitment of blacks and women which in effect excludes whites and creates shortages where there are no candidates from the target groups available." (2003, 654) However, they also question the apparent "inability of employers to take advantage of the available pool of blacks and women" in the labour market to set up their own skills programmes and career pathing (Moleke Paterson Roodt, 2003,645).

ICT sector employment by race

Over the 1996 to 2005 period the proportion of black and white persons employed in the ICT sector was 50.8 per cent and 48.8 per cent respectively (Table 20). African, Coloured and Indian workers constituted 33.3 per cent, 11.4 per cent and 6.1 per cent of the workforce in the sector.

Table 20: Average number of workers employed per annum in the ICT sector by race, 1996-2005

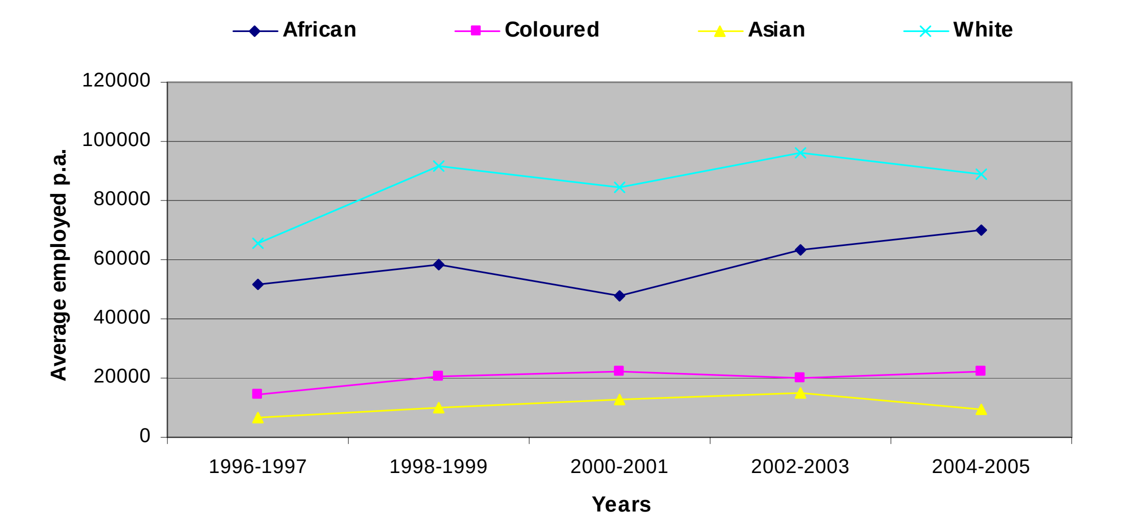
Race	n	%	
African	58132	33.3	
Coloured	19877	11.4	50.8
Indian	10725	6.1	
White	85278	48.8	48.8
Unspecified	581	0.3	
Total	174593	100	100

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

We now consider whether the race share of workforce numbers shifted over the decade.

Employment in the ICT sector increased at an average annual growth rate of 1.5 per cent between 1996 and 2005. In real terms, employment across all race groups increased (Figure 13). However, the percentage increase in African workers at 1.2 per cent was slightly lower than the increase in White workers at 1.3 per cent. The proportion of Coloured workers increased strongly at 3.8 per cent while growth among Indian workers was slowest at 0.2 per cent per annum over the period.

Figure 13: Employment trend in the ICT sector, according to race, 1996 to 2005



Race	Average employed per annum					Ave annual growth (1996-2005)
	1996-1997	1998-1999	2000-2001	2002-2003	2004-2005	
	n	n	n	n	n	%
African	51440	58087	47933	63290	69912	1.2
Coloured	14653	20517	22253	19996	21965	3.8
Asian	6390	9926	12823	15211	9277	0.2
White	65347	91504	84533	95884	89122	1.3
Unspecified	0	715	692	0	1497	
Total	137829	180748	168234	194381	191773	1.5

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

Employment by race within the ICT sub-sectors

A comparison of the distribution of employment by race group in the three ICT sub-sectors, averaged over the decade, reveals two sub-sectors with very similar employment profiles: manufacturing and telecommunications. African workers (±40 per cent) followed by White workers (±35 per cent) dominate followed by much smaller proportions of Coloured (±10 per cent) and Indian workers (±5 per cent) (Table 21).

Even though the manufacturing sub-sector share of ICT sector employment grew, while the telecommunications sub-sector share declined between the 1996-1999 to 2000-2005 periods, this difference did not generate significant changes in the race distribution of employment. The proportions of Coloured workers increased by 4.3 per cent in manufacturing and that of Indian workers increased by 3.2 per cent in telecommunications. But these adjustments did not distract from similar proportionality between the two sub-sectors.

The IT services sub-sector stands out from the other two, because the racial profile of its workforce is quite different. At a glance, it is clear that the standout feature of this sub-sector is its much smaller African workforce (17.9 per cent) and much larger white workforce (65.1 per cent). The data reveals that virtually two thirds of workers in the IT services sub-sector were White in the decade under scrutiny. The share of Coloured (10 per cent) and Indian (6.5 per cent) workers in the IT services sub-sector is of a similar order to the other two sectors. We ask why this is the case, given that there are growing expectations that the IT services sub-sector can generate employment and a concomitant expectation that this can occur on an equitable basis.

It could be that the high skills premium in the IT services sub-sector is presenting difficulties in finding qualified black workers to meet equity requirements. The upward demand for higher skills observed in this report provides an indication that generating the required skills may present significant challenges in the context of equity targets. Assuming that growth and diversification of the IT services sub-sector takes place there may major pressure to supply graduates who are sufficiently skilled and have an appropriate equity profile.

Table 21: Employment in the ICT sector by race and subdivision, 1996-1999 and 2000-2005

Race	1996-1999		2000-2005		%
	n	%	n	%	Difference
ICT manufacturing					
African	12163	43.0	15683	42.2	-0.8
Coloured	2821	10.0	5322	14.3	4.3
Indian	1790	6.3	2455	6.6	0.3
White	11496	40.7	13438	36.1	-4.6
Unspecified	0	0.0	303	0.8	0.8
Total	28270	100	37201	100	-
Telecommunication					
African	31679	43.7	31062	43.6	-0.1
Coloured	10384	14.3	8486	11.9	-2.4
Indian	2751	3.8	5017	7.0	3.2
White	27624	38.1	26733	37.5	-0.6
Total	72437	100	71297	100	-
ICT services					
African	10922	18.6	13633	17.9	-0.7
Coloured	4380	7.5	7597	10.0	2.5
Asian	3617	6.2	4965	6.5	0.3
White	39305	67.1	49675	65.1	-2
Unspecified	357	0.6	427	0.6	0
Total	58581	100	76298	100	-
ICT sector					
African	54763	34.4	60378	32.7	-1.7
Coloured	17585	11.0	21405	11.6	0.6
Asian	8158	5.1	12437	6.7	1.6
White	78425	49.2	89846	48.6	-0.6
Unspecified	357	0.2	730	0.4	0.2
Total	159288	100	184796	100	-

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

Occupation shifts in employment – providing space for equity?

The means of changing the profile (eg: demographic profile or skills profile) of a workforce or occupational group is through ensuring that targeted groups can access jobs vacated through the normal course of replacement demand (ie: replacing workers who have left the workforce due to retirement or other reasons). We suggest that where the employment profile of a sector shifts between occupational groups (ie: where the occupations themselves gain or lose their share of total employment) these moments present opportunities for equity targets to be approached – at least in occupational categories that are growing. This is based on the assumption that it is easier to change the profile of an occupational group which is expanding than contracting.

Accordingly, we compare occupational share of employment between the 1996-1999 and the 2000-2005 periods in the ICT sector (Table 22).

First, for each occupational category we calculate real employment growth between the two periods (see Column (a)). Second, for all occupations, we calculate whether their share of total employment increased between 1996-1999 and 2000-2005 (see Column (d)).

Table 22: Average annual employed in ICT sector by race and occupation, 1996-1999 and 2000-2005

Occupation	Period	Average annual employment per period	(a) % increase in average annual employment between periods	(b) % share of employment 1996-1999	(c) % share of employment 2000-2006	(d) % diff c-b=
Managers	1996-1999	16841	66.7	10.9	15.2	4.3
	2000-2005	28069				
Professionals	1996-1999	19748	16.0	12.8	12.4	-0.4
	2000-2005	22905				
Associate professionals	1996-1999	45934	19.9	29.7	29.8	0.1
	2000-2005	55061				
Clerks	1996-1999	24205	53.8	15.7	20.1	4.5
	2000-2005	37227				
Service workers	1996-1999	5694	-3.7	3.7	3.0	-0.7
	2000-2005	5482				
Craft & related workers	1996-1999	21634	-29.2	14.0	8.3	-5.7
	2000-2005	15311				
Operators	1996-1999	8472	9.4	5.5	5.0	-0.5
	2000-2005	9270				
Elementary workers	1996-1999	12110	-5.3	7.8	6.2	-1.6
	2000-2005	11471				
Total	1996-1999	154636	19.5	100	100	
	2000-2005	184796				

Between the 1996-1999 and 2000-2005 periods, there were only three occupations which showed an increase in real employment as well as an increased share of sector employment relative to other occupations. These were: managers with a 66.7 per cent share in real employment and 4.3 per cent increase relative to other occupations. Similarly employment of clerks increased by a substantial 53.8 per cent, while their share of employment against other occupations improved by 4.5 per cent. Importantly, their increased share of total employment made clerks (20.1 per cent) and managers (15.2 per cent) the two largest occupational categories in the ICT sector after associate professionals.

The associate professional category also increased in real employment size (19.9 per cent) and increased its employment share (0.1). However, associate professionals merely kept pace with overall employment increases, only showing a minute increase in share of all employment.

The data suggests that the main occupational categories which will expand are high-skill and white-collar. Graduate production needs to be focused on sub-occupations within these skills categories.

Gender and skills in the ICT sector

Gender and employment in the ICT sector and within ICT sub-sectors

The ICT sector was male dominated over the 1996 to 2005 period, as approximately seven in ten workers in the sector were male. Nevertheless, there was some change. The overall proportion of female workers increased from 26.9 per cent to 31.4 per cent between the 1996-1999 and the 2000-2005 periods (Table 23).

Between the two periods, improvements in the representation of female workers took place in ICT manufacturing (up 8.8 per cent) and in telecommunications (up 8.3 per cent). Meanwhile the female share of employment in the IT services sub-sector declined (3.4 per cent). Average annual growth rates of 12.8 per cent, 4.5 per cent and -1.8 per cent in ICT manufacturing, telecommunications and IT services were recorded.

It is interesting that more females were employed in the telecommunications sector during a phase in which overall employment growth was in decline. Also intriguing is that female's share of the IT services labour market declined in spite of the fact that general employment in this sector was increasing. Further investigation is needed to explore these apparently gendered patterns of employment across the three sectors.

Table 23: Employment and gender in the ICT sub-sectors, 1996-2005

Gender	Average annual employment in each period				Average annual growth 1996-2005
	1996-1999	%	2000-2005	%	
ICT manufacturing					
Male	19661	69.5	22569	60.7	1.2
Female	8609	30.5	14631	39.3	12.8
Total	28270	100	37201	100	5.0
Telecommunication					
Male	55348	76.4	47824	67.1	-3.4
Female	17089	23.6	23473	32.9	4.5
Total	72437	100	71297	100	-1.6
ICT services					
Male	41431	70.7	56290	73.8	5.3
Female	17150	29.3	20007	26.2	-1.8
Total	58581	100	76298	100	3.4

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

Gender and skill levels

In the 1996 to 1999 years, there were proportionately fewer female workers with low skills than male workers with low skills, and proportionately more female workers than male workers with intermediate skills in the ICT sector (Table 24). This means that the skills balance among female workers was slightly better than among male workers in the early period.

This situation was reversed in the later 2000 to 2005 period. The distribution of male workers showed lower proportions of low skills workers, and higher proportions of high and intermediate skills than was the case among female workers.

In other words, in the latter period, male workers in the sector in general had higher skills levels than female workers. This must be tempered by observing that there were more female workers in the IT services sub-sector with high skills than males. Also, in the IT services sub-sector, the share of high skill workers among females increased faster than among males between the two periods.

Table 24: Gender and employment in ICT sub-sectors by level of skill in percentages, 1996-2005

Sub-sector	Year	Low skill	Intermediate skill	High skill	Unknown	Total
Females						
Manufacturing	1996-1999	46.2	47.5	5.2	1.2	100
	2000-2005	34.1	*58.9*	6.6	0.4	100
Telecommunication	1996-1999	31.0	67.3	1.6	0.0	100
	2000-2005	21.2	67.0	10.8	1.0	100
Services	1996-1999	15.9	69.9	14.2	0.0	100
	2000-2005	14.3	56.7	*27.7*	1.4	100
Total females	1996-1999	28.6	63.9	7.2	0.3	100
	2000-2005	22.2	61.5	15.4	1.0	100
Males						
Manufacturing	1996-1999	41.6	45.2	11.4	1.7	100
	2000-2005	35.8	49.6	12.0	2.6	100
Telecommunication	1996-1999	38.7	52.9	6.2	2.1	100
	2000-2005	20.6	66.5	12.5	0.4	100
Services	1996-1999	23.1	60.2	16.1	0.7	100
	2000-2005	9.8	64.2	25.5	0.4	100
Total males	1996-1999	33.7	54.2	10.6	1.5	100
	2000-2005	18.7	62.4	18.0	0.8	100

Finally, we note that the skill differences according to gender as described here appear to be much smaller than skills differences between sectors or between race groups.

Age, and skills in the ICT sector

Age profile of ICT employees

Employers quite routinely observe that experience is an asset in the ICT sector. One of the challenges is to understand the concept of experience and what people mean when they refer to it. Within the scope of this paper, it is not possible to address these issues in depth, but rather to employ the available empirical data (hopefully) in an analytically useful way.

Although age is not necessarily related to experience, we will employ data from the Labour Force Survey to draw attention to a few age-demographic features of the workforce in the ICT sector that may be useful in a discussion of skills needs in the sector.

First, we have drawn data that describes the age profile of the workforce across the three main sub-sectors (Table 25 and Figure 14). This data shows that of the three sub-sectors, telecommunications and IT services appear to have a much younger workforce. The ICT manufacturing workforce has a markedly larger (45.2 per cent) proportion of workers aged 40 and older. By comparison, the same age group accounted for only 28.2 per cent and 32.2 per cent of telecommunication and IT services employment respectively (Figure 15).

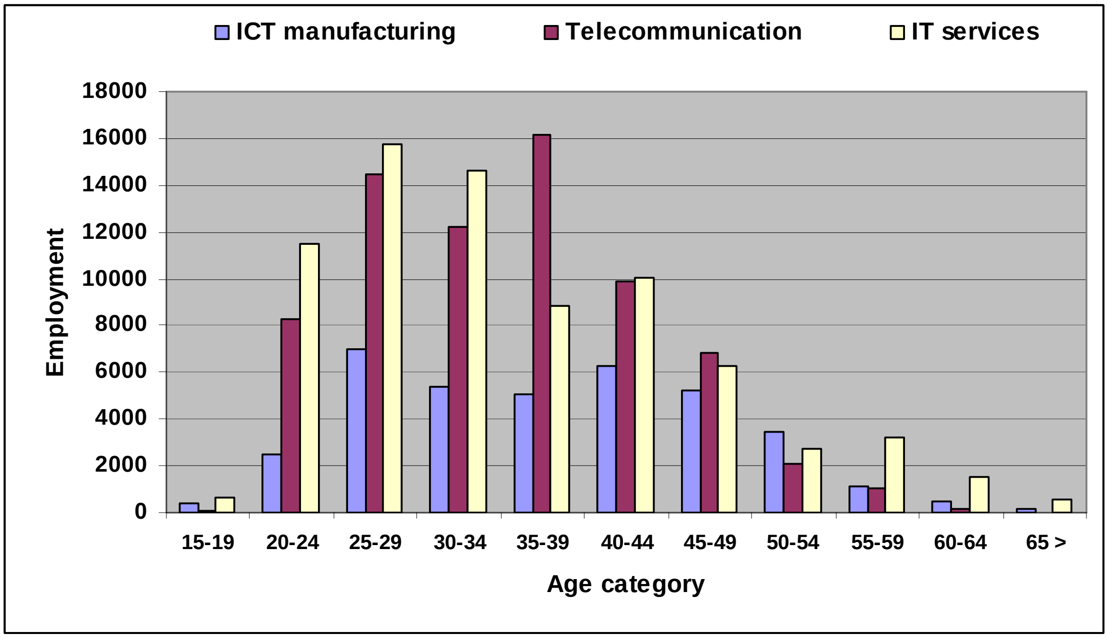
This could already be proving problematic for the ICT manufacturing sub-sector when older workers in the ICT sector retire and not enough younger candidates with some workplace exposure are available to replace the more experienced workers. It may be that current concerns expressed about obtaining appropriately ‘experienced’ workers are articulated especially strongly by employers in the ICT manufacturing sector. Their concerns may well be grounded on a real shortage of older and more experienced employees, rather than a generic expectation conveyed by employers to find more employees with ‘experience’. The latter type of employer, who expects IT workers with experience readily available from the labour market, may also be guilty of abrogating their responsibility to ‘grow their own timber’.

Table 25: The ICT sector by age and sub-sector, 2000-2005

Age group	**Average employed per annum**											
	ICT manufacturing			**Telecommunication**			**IT services**			**ICT sector**		
	n	**%**		**n**	**%**		**n**	**%**		**n**	**%**	
15 to 19	437	1.2		62	0.1		655	0.9		1154	0.6	
20 to 24	2500	6.7		8283	11.6		11464	15.0		22247	12.0	
25 to 29	7008	18.8	54.8	14457	20.3	71.8	15758	20.7	67.8	37223	20.1	66.7
30 to 34	5396	14.5		12239	17.2		14629	19.2		32264	17.5	
35 to 39	5029	13.5		16155	22.7		8879	11.6		30063	16.3	
40 to 44	6292	16.9		9893	13.9		10077	13.2		26262	14.2	
45 to 49	5243	14.1		6837	9.6		6272	8.2		18352	9.9	
50 to 54	3473	9.3	45.2	2108	3.0	28.2	2746	3.6	32.2	8327	4.5	33.3
55 to 59	1165	3.1		1068	1.5		3184	4.2		5417	2.9	
60 to 64	497	1.3		195	0.3		1539	2.0		2231	1.2	
65 and older	161	0.4		0	0.0		575	0.8		736	0.4	
Total	37201	100		71297	100		76298	100		184796	100	

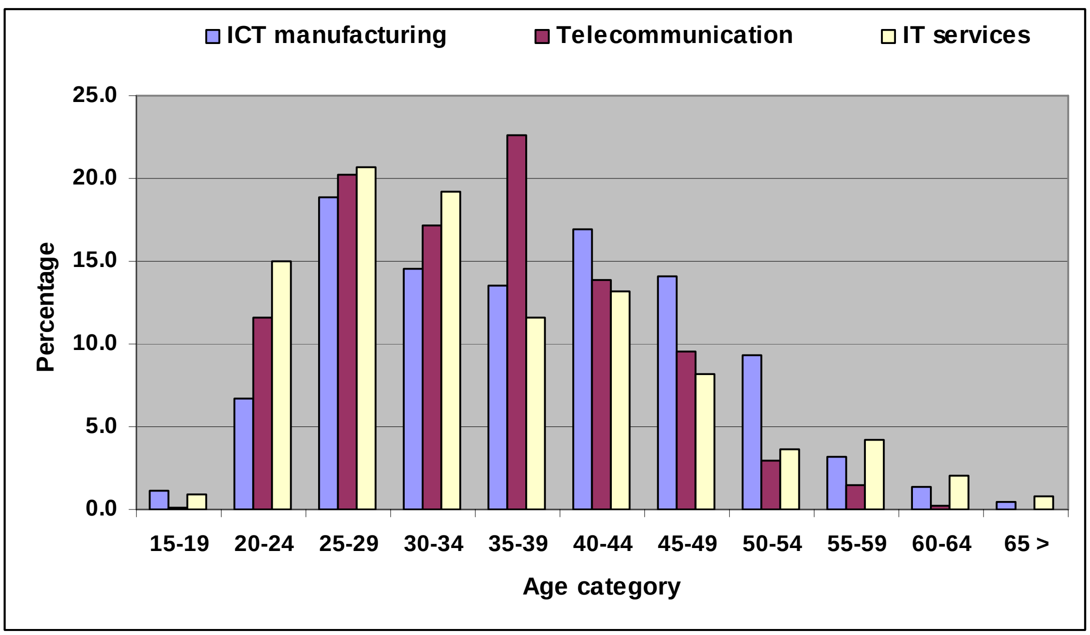
Source: Quantec, 2007 (StatsSA LFS data for 2000 – 2005)

Figure 14: Employment number by age and ICT sub-sector, 1996-2005



Source: Quantec, 2007 (StatsSA LFS data for 2000 – 2005)

Figure 15: Employment by age and ICT sub-sector in percentages, 1996-2005



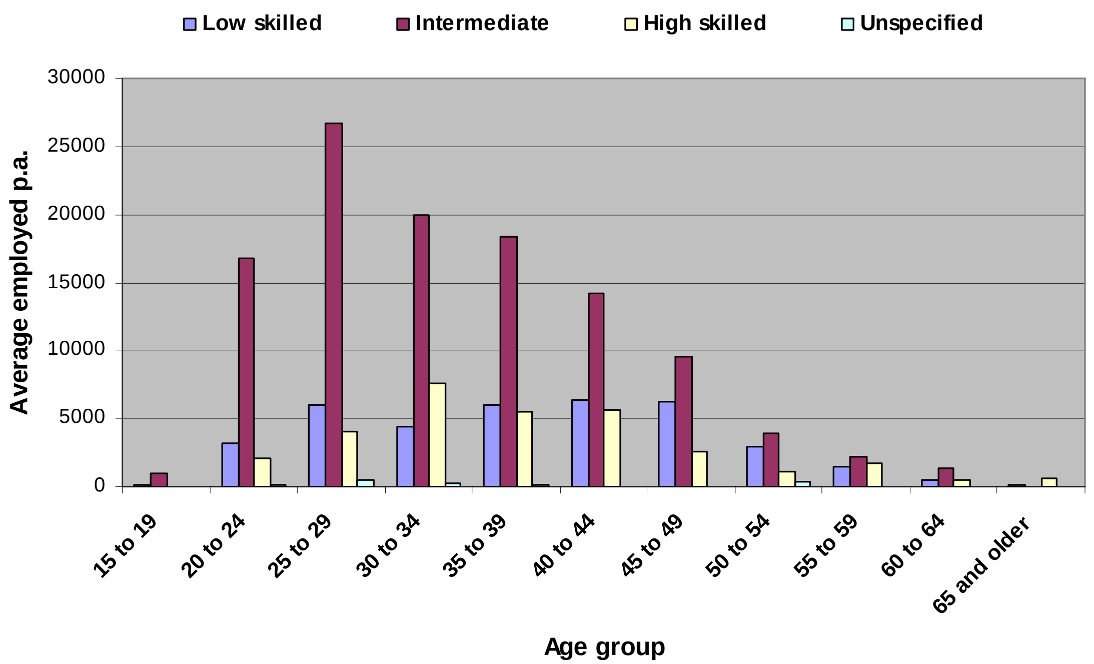
Source: Quantec, 2007 (StatsSA LFS data for 2000 – 2005)

Age and skill levels of ICT sector workers

We have extracted data on the proportions of currently employed workers by age and skill level.

It is immediately apparent that increases in the size of the sector workforce in recent years have been achieved mainly through increases in the number of intermediate skill workers (Figure 16). The number employed per age category is highest in the 25 to 29 year age group.

Figure 16: Employment in the ICT sector by age and skill level, 2000 to 2005



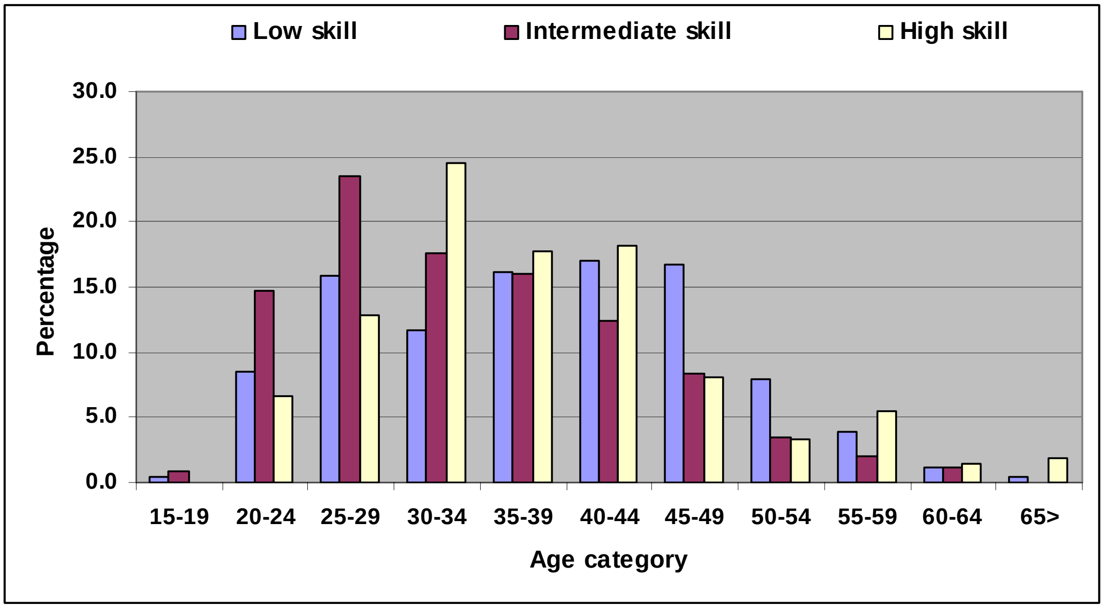
Age group	Low skilled		Intermediate		High skilled		Unspecified	
	n	%	n	%	n	%	n	%
15 to 19	165	0.4	989	0.9	0	0.0	0	0.0
20 to 24	3219	8.6	16772	14.7	2074	6.7	182	11.4
25 to 29	5946	15.8	26750	23.5	3996	12.8	531	33.2
30 to 34	4402	11.7	19992	17.5	7644	24.5	225	14.1
35 to 39	6042	16.1	18321	16.1	5518	17.7	182	11.3
40 to 44	6404	17.1	14166	12.4	5655	18.1	38	2.3
45 to 49	6296	16.8	9513	8.3	2514	8.1	29	1.8
50 to 54	2994	8.0	3892	3.4	1051	3.4	389	24.3
55 to 59	1484	4.0	2221	1.9	1687	5.4	25	1.5
60 to 64	444	1.2	1344	1.2	444	1.4	0	0.0
65 and older	161	0.4	0	0.0	575	1.8	0	0.0
Total	37557	100	113960	100	31159	100	1601	100

Source: Quantec, 2007 (StatsSA LFS data for 2000 – 2005)

Furthermore, the largest proportion of intermediate skill workers is also in the 25 to 29 year age group. Put differently, the proportion of intermediate skilled workers increases as age cohorts get younger until the 25 to 29 year age group (Figure 17).

While the shape of age cohorts is increasingly dominated by intermediate skills workers, we do not know whether the proportionate relationship between intermediate and high and low skill workers is appropriate for the efficient functioning of the sector.

Figure 17: Employment in the ICT sector by age and skill level in percentages, 2000 to 2005



Source: Quantec, 2007 (StatsSA LFS data for 2000 – 2005)

CHAPTER 8: EMPLOYMENT SIZE OF THE ICT WORKFORCE

Introduction

Thusfar, the analysis has addressed ICT skills with emphasis on the ICT sector labour market where the unit of analysis was that sector and its three component sub-sectors. Consequently, the analysis has revealed the growth paths and labour demands that characterize the ICT sub-sectors. This approach foregrounded the occupational structures of each sub-sector and how different skills needs characterized each different industrial activity. This analysis is important because it contributes to the accumulation of data and analysis relevant to sectoral and sub-sectoral growth and job creation strategies.

However, there are limitations to this approach when questions are asked about the demand for ICT workers across the economy. We have observed that workers with ICT skills are employed not only in the ICT sector but across all sectors of the economy. It is therefore necessary to undertake analysis where the occupation rather than sector is the unit of analysis. This makes it possible to investigate total demand for computer professionals who may be employed across all sectors in the entire economy. Subject to the availability of disaggregated data, the levels of demand for certain ICT-related specialist occupational categories may be interrogated.

It is the latter approach to exploring ICT skills that will be pursued in this chapter. To confirm this shift in analytic approach: in the previous chapters we investigated skills needs of the *ICT sector labour force*, whereas in this chapter we will investigate the skills needs of the *ICT work force*. In the preceding chapters, the analysis rested on a definition of the ICT sector and subsectors, whereas in this chapter the analysis will rest on a definition of what occupations are considered part of the cross-sector ICT workforce.

Defining ICT occupations

The combined impact of technological innovation and the re-engineering of workplace occupational structures, has over time contributed to the creation, destruction and reshaping of occupations across industries. The range of occupations that incorporate the use of ICT or are transformed by ICT constantly widens. Systems of occupational classification have lagged behind these changes. Analysts may or may not agree on which set of occupations can be legitimately classified as ICT-related.

Consequently we elected to stage this analysis. In the first stage we adopt a broad definition of ICT in order to identify and select a set of occupations that may - in our view - be taken as representative of the ICT workforce as a whole. In the next stage of the analysis we focus in detail on the employment features and possible skills needs of only four occupations that, by common usage, may be taken less controversially to be core ICT occupations

To return to our first stage involving the identification of ICT-related occupations. We have identified workers in the following occupations which occur across all sectors of the economy: Computer professionals, Computer associate professionals, Electronic and telecommunications engineers, and Electronic and telecommunications technicians. To this group, we add media-related occupations including graphic design, digital imaging and broadcasting. We argue that the high penetration of ICT in these subfields of media/multimedia, and the evolution of hybrid occupations which combine ICT use with other skills, justifies their inclusion in a calculation of the larger ICT workforce. We also added 'operations researchers/managers', a sub-set of the occupational group of mathematicians and related professionals. [7]

We briefly review our simple selection approach here not to argue for its inherent 'correctness' but rather to present it as one possible approach to estimating the size of the ICT workforce. We recognize that there is probably no single 'correct' approach to estimating the size of the ICT workforce.

The size of the ICT workforce

The above set of occupational categories we populated with data from the OHS and the LFS and from this we could calculate the size of the ICT workforce – according to our definition - and the relative share of the different occupations in relation to the overall ICT workforce.

The average annual number of ICT workers employed between 1996 and 1999 was 126 880 per annum, rising to 154 941 per annum in the 2000 to 2005 period (Table 26).[8] Based on these figures, we calculate that employment of ICT workers rose 22.1 per cent between these two periods.

Table 26: Employment of ICT related professionals and associate professionals, 1996 to 2005

ICT occupations	Average employed per annum					
	1996-1999	%	2000-2005	%	1996-2005	%
Computer professionals	27651	21.8	29833	19.3	28960	20.2
Computer associate professionals	27652	21.8	32154	20.8	30353	21.1
Electronics & telecommunication engineers	3074	2.4	2386	1.5	2661	1.9
Electronics & telecommunication engineering technicians	27441	21.6	45408	29.3	38221	26.6
Photographers & image/sound equipment operators	12335	9.7	11169	7.2	11635	8.1
Broadcasting & telecommunication equipment operators	5106	4	4028	2.6	4459	3.1
Graphic / Industrial designers	21480	16.9	28929	18.7	25950	18.1
Mathematicians & related professionals	2140	1.7	1035	0.7	1477	1
Total	126880	100	154941	100	143716	100

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

At the occupational level, across the nine year period from 1996-2005 computer professionals and computer associate professionals constituted 20.2 per cent (28 960) and 21.1 per cent (30 353) respectively of the number of workers employed in the identified occupational categories. So, computer professionals and associate professionals constituted over 40 per cent of the ICT workforce within our broad definition of ICT workers.

[7] How we narrowed maths graduates

[8] As in our data analysis in previous chapters, we have removed annual fluctuations in employment numbers by creating an average employment figure for each of the two periods 1996-1999 and 2000-2005.

Between 1996 and 2005, the next largest occupational group was electronic and telecommunication engineering technicians at 26.6 per cent (38 221) whereas the related electronic and telecommunication engineers group constituted only 1.9 per cent (2 661) of the ICT workforce.

It is important to note the 1:1 ratio between higher level computer professionals vis a vis intermediate skilled computer associate professionals. In contrast, in the electronic and telecommunication engineering field, intermediate skilled technicians outnumber engineers at a ratio of 14.4:1.

Of the media-related occupations, 3.1 per cent (4 459) were broadcasting and telecommunication equipment operators, 8.1 per cent (11 635) were photographers and image or sound equipment operators and 18.1 per cent (25 950) were graphic or industrial designers, together constituting 29.3 per cent of all ICT workers.

The proportionate share of each occupational group was relatively stable over the nine year period. This is with the exception of the electronic and telecommunication engineering technicians category which increased by 39.3 per cent between the 1996-1999 and 2000-2005 periods. In contrast, electronic and telecommunication engineer numbers decreased by 22.4 per cent.

The ratio of computer professionals as to computer associate professionals was virtually 1 : 1 in the 1996-1999 period and this shifted to 1 : 1.1 in the 2000-2005 period which means that the ratio of employment between these two groups stayed very constant. In contrast, the ratio of electronics and telecommunication engineers to electronics and communications technicians was 1 : 8.9 in the first period rising to 1 : 19.0 in the second period.

This highlights the critical relationship between engineers and technicians and requires us to ask what sort of ratio is acceptable in the electronics and telecommunications industry. Further analysis will be required to assess how these ratios evolve and whether they are optimal or sub-optimal (ie: that may reflect shortages of either engineers or of technicians) for sector development.

Focusing on specific ICT occupations

We have engaged in this exercise to make the point that even though keeping track of national ICT workforce size is important in relation to other macro trends, it is not a statistic that can be used for sector or occupational level planning to inform strategies that can combat skills shortages or oversupply. The reason for this is that the list of occupational types used to obtain an aggregate picture of the ICT workforce should be disaggregated for the purpose of further analysis. This is because these occupational types form part of analytically disparate occupational labour markets that are defined partly by ICT sub-sectoral economic activity and partly by links to different knowledge fields.

To make this point clearer, in the table below we map (Table 27) four ICT occupations against their corresponding ICT sub-sectors as defined by the ISETT SETA.

Table 27: ICT occupations against corresponding ICT sub-sectors as employed by the ISETT SETA	
ICT Sub-sector	**Core ICT occupation**
Electronics	Electronics and telecommunication engineers (high skill) Electronics and telecommunication engineering technicians (intermediate skill)
Telecommunications	
Information Technology	Computer professionals (high skill) Computer associate professionals (intermediate skill)

The table shows two occupational groups, each consisting of a complementary high skill and an intermediate skill occupation. These occupational groups have evolved to meet the changing skills/labour inputs required by the respective industry sub-sectors, while education institutions have evolved qualifications to approximate required occupational skills profiles.

Each occupational group is specialized so electronics and telecommunications engineers and computer professionals cannot easily substitute for each other. Each group possesses it's own set of knowledge and skills that are obtained through attending specialised post-school and higher education programmes leading to qualifications relevant to the respective fields.

There is evidence of increased convergence between the technology fields of electronics and information technology driven by ongoing product and service development in industry, which may over time lead to increased overlap between these two fields in terms of professional training. Even though the skills and knowledge profiles of electronics and information technology graduates may be slowly converging they still remain relatively independent systems of expertise which respond differently to industry needs. In particular, the demand for computer professionals derives from their participation in a range of business processes ranging from software development to providing consulting services. Consequently, the drivers of demand for 'computer professionals' and for 'electronics and telecommunications engineers' still differ, notwithstanding levels of convergence.

For these reasons, in the analysis that follows we will focus exclusively on the four occupational categories, namely computer professionals and computer associate professionals (CPAP) and electronic and telecommunication engineers and technicians (ETET).

Distribution of computer professionals and associate professionals by economic sector

An important starting point for analyzing the distribution of computer professionals in the economy is to assess the propensity for different sectors to absorb these workers. Presumably, sectors in which there is high information intensity will employ higher proportions of CPAPs.

Annual fluctuations in employment data make it difficult to reveal employment trends over the period 1996 to 2005. Averages were calculated at 2-year intervals to moderate the fluctuations.

It is clear from Table 28 that employment of computer professionals is dominated by the financial and business services sector. In fact during the period under review, the financial and business services sector increased its proportionate share of computer professionals. In 1996-1997 half (11 397) of computer professionals and more than a third (9990) of computer associate professionals worked in this sector but these proportions grew strongly. By 2004-2005, as many as 74.3 per cent (22 263) and 70.6 per cent (9 303) of CPAPs respectively were employed in the sector. Put differently, according to the LFS and OHS data, more than seven in every ten Computer professionals were absorbed into the financial and business services sector.

Table 28: Distribution of computer professionals and associate professionals by economic sector, 1996-2005

Occupation by economic sector	1996-1997		1998-1999		2000-2001		2002-2003		2004-2005	
	n	%	n	%	n	%	n	%	n	%
Agriculture	0	0	239	0.7	0	0	0	0	0	0
Mining	271	1.2	629	1.9	132	0.4	345	1.2	305	1
Manufacturing	2314	10.3	2788	8.5	3209	10.2	2405	8.6	3538	11.8
Electricity	366	1.6	413	1.3	637	2	481	1.7	728	2.4
Construction	0	0	0	0	0	0	0	0	0	0
Trade	1516	6.8	318	1	2237	7.1	1362	4.8	610	2
Transport	2047	9.1	2709	8.2	2881	9.2	964	3.4	1085	3.6
Finance	11397	50.8	23284	70.9	19781	63	19738	70.2	22263	74.3
Services	3426	15.3	2475	7.5	2537	8.1	2823	10	1437	4.8
Other Activities	1112	5	0	0	0	0	0	0	0	0
computer professionals	22446	100	32857	100	31413	100	28119	100	29967	100
Agriculture	0	0	74	0.3	0	0	0	0	0	0
Mining	703	2.6	484	1.7	1419	3.2	691	1.8	141	1.1
Manufacturing	5629	20.9	752	2.6	1690	3.8	4778	12.3	1673	12.7
Electricity	280	1	469	1.7	1041	2.4	470	1.2	109	0.8
Construction	0	0	626	2.2	0	0	188	0.5	0	0
Trade	2896	10.8	2531	8.9	3852	8.7	3131	8	1008	7.7
Transport	4732	17.6	1842	6.5	3058	6.9	4429	11.4	937	7.1
Finance	9990	37.1	18364	64.7	25107	56.7	21464	55	9303	70.6
Services	1791	6.7	3237	11.4	7802	17.6	3592	9.2	0	0
Other Activities	908	3.4	0	0	0	0	258	0.7	0	0
Unspecified	0	0	0	0	316	0.7	0	0	0	0
Computer associate professionals	26927	100	28378	100	44286	100	39002	100	13172	100

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

The only other sector which attracted more than 10 per cent of the population of CPAPs was manufacturing. In 1996-1997 10.3 per cent (1 516) of computer professionals worked in manufacturing and this increased slightly to 11.8 per cent (3 538) in 2004-2005. In contrast there was a sharp decrease in the proportion of computer associate professionals employed in the sector, from 20.9 per cent (5 629) in 1996-1997 to 12.7 per cent (1 673) in 2004-2005. The factors contributing to this shift would need to be investigated further.

In the financial and business services sector and in the manufacturing sector, changes occurred in the proportions between employment of high level and intermediate level computer professionals. These changes worked in opposite directions. In the financial and business services sector, the number of intermediate skilled Computer associate professionals increased to the point where there was virtually a 1:1 relationship with the higher skilled Computer professionals. In the manufacturing sector, in 1996-1997 intermediate skilled Computer associate professionals outnumbered Computer professionals by 7:3 but by 2005/2005 the situation was reversed and Computer associate professionals were themselves outnumbered 7:3 by Computer professionals. This is assuming the sharp reversal described in the manufacturing sector is not an artifact of the LFS and OHS survey methodologies

It is important to seek explanations for these shifts in the skills make-up of sectors which employ large numbers of CPAPs. Did the ICT skills requirements in these sectors change:

- because new technologies adopted across the industry altered the optimal ratio of high to intermediate skills in enterprises? or,
- because enterprises across the industry adopted new business models which reduced/increased the need for intermediate ICT skills? or,
- because changes in labour market availability after 2000 affected the balance of professionals to associate professionals?
- because actions by enterprises created career path opportunities through which workers were promoted to full professional status, perhaps with access to additional training?

Such questions must be posed and adequate explanations need to be found. These are the kinds of questions that will help us to understand the drivers of ICT skills shortages or over-supply and to respond accordingly.

Similar questions are relevant also to sectors which employ smaller numbers of computer professionals, such as the ‘Trade’ and the ‘Transport storage and communications’ and ‘Social and personal services’ sectors. We simply make this general point about the employment of Computer professionals in these sectors without analyzing the detail. This is because, as we have observed earlier, small numbers in the data returns from limited sample surveys such OHS and LFS are weighted to approximate the total numbers of the population in the sample frame, and there is some doubt as to the reliability of small numbers in the tables, because of this. This is why it is appropriate to interrogate this data in order to draw out the broad trends and not to engage on a very detailed level with small numbers. For example, it is very unlikely that in the entire construction industry there were zero Computer professionals or associate professionals employed.

Distribution of computer professionals and associate professionals within manufacturing and within financial and business services

Our analysis shows that eight out of ten CPAPs worked in the financial and business services sector or in the manufacturing sector. Given the need to be circumspect about the validity of small numbers, we decided to disaggregate only these two sectors at the industry level.

Over the 2004-2005 period, within the financial and business services sector the overwhelming majority (54.5 per cent) of CPAPs worked in software consultancy and supply, while 13.6 per cent worked in the hardware consultancy, 7.2 per cent worked in monetary intermediation (plus 2.5 per cent in ‘other financial intermediation’), and 4.4 per cent worked in legal, accounting, bookkeeping and auditing environments (Table 29). There is a relatively sizeable share of employees in ‘other computer related activities’ but further investigation would be required to establish what constitutes this group.

Turning to the manufacturing industry, the bulk of CPAPs working in manufacturing were employed in motor vehicle manufacture (54.1 per cent) with a further 16.9 per cent working in the manufacturing of office, accounting and computer machinery industry. Relatively small numbers were employed in the manufacture of basic iron and steel (8.1 per cent) and of electronic components (7.6 per cent). The latter statistic gives some indication of how small the electronic component manufacturing sector is in South Africa, while the much larger percentage working in the manufacturing of office accounting and computer machinery sub-sector are engaged largely in assembly of computers rather than manufacturing.

Table 29: Distribution of computer professionals and associate professionals by sub-divisions within manufacturing and financial and business services, 2004-2005

Detail Industry	CPAPs	
	n	%
Manufacturing		
Petroleum refineries / synthesisers	278	5.3
Manufacture of basic iron and steel	420	8.1
Manufacture: Office, accounting & computer machinery	879	16.9
Manufacture: Electronic components	398	7.6
Manufacture of motor vehicles	2819	54.1
Manufacture of bodies for motor vehicles	207	4
Manufacture of furniture	211	4
Total	5211	100
Financial and Business Services		
Monetary intermediation	2264	7.2
Other financial intermediation n.e.c.	803	2.5
Renting of other machinery and equipment	139	0.4
Hardware consultancy	4290	13.6
Software consultancy and supply	17203	54.5
Data base activities	722	2.3
Maintenance of office, accounting & computer machinery	51	0.2
Other computer related activities	3391	10.7
Legal, accounting, bookkeeping and auditing activities	1392	4.4
Architectural, engineering & other technical activities	573	1.8
Business activities n.e.c.	737	2.3
Total	31566	100

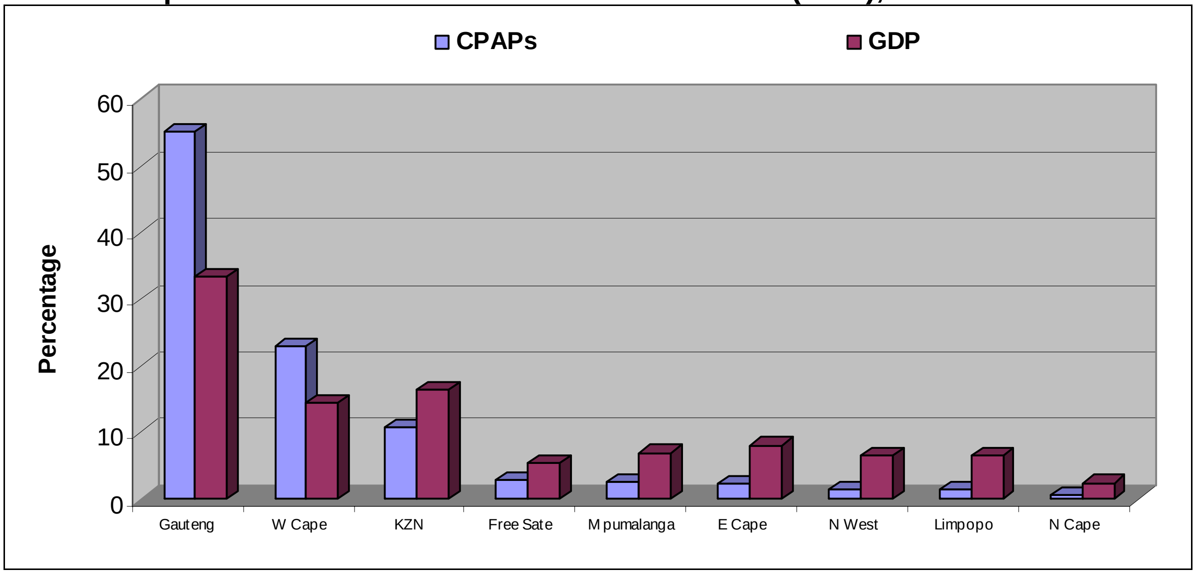
Source: Quantec, 2007 (StatsSA LFS data for 2004 – 2005)

Distribution of computer professionals and associate professionals by province

At the macro level, it is important to analyse the spatial distribution of computer professionals, since this provides a sense of the broad labour market situation within which local ICT skills shortages and oversupplies can be contextualized.

The importance of the provincial distribution is immediately apparent when we see that practically nine in every ten computer professionals are located in one of three provinces: Gauteng (55.2 per cent), Western Cape (23.0 per cent) and KwaZulu-Natal (10.7 per cent). In each of the other six provinces the share of computer professionals is below 3 per cent (Figure 18).

Figure 18: Average provincial distribution of computer professionals and associate professionals and Gross Domestic Product (GDP), 2000-2005



Source: Quantec, 2007 (StatsSA LFS data for 2000 – 2005)

We would expect Gauteng, the Western Cape and KwaZulu-Natal to attract the highest proportion of computer professionals, because they are the three largest provincial economies. A simple comparison between percentage share of computer professionals employed and percentage contribution to the national GDP bears this general assumption out. However, the comparison reveals how the share of computer professionals in Gauteng and the Western Cape is disproportionately larger than their provincial share of GDP (Figure 18 and Table 30). The concentration of industry types which are high intensity users of computer professionals (e.g.: computer services, financial services, banking and insurance,) in metropolitan areas such as Cape Town and Durban explains the higher density of computer professionals relative to GDP in the Western Cape and KwaZulu-Natal provinces. In addition, large urban areas with better amenities and larger job-markets with more opportunities also tend to attract computer professionals.

This high-level picture tells us how the supply and demand of computer professionals must be understood in a spatial dimension. Clearly difficulties in filling computer worker vacancies will be experienced in the provinces which have smaller GDPs and an even smaller computer professional workforce. We can further infer that the spatial concentration of ICT professionals will be mainly in urban settlements which will further distort access to ICT professionals in provinces where the population is largely rural.

Table 30: Provincial distribution of CPAPs and GDP, 2000 to 2005			
Province	**Average employed p.a. (2000 – 2005)**		**GDP**
	n	**%**	**%**
Gauteng	34246	55.2	33.4
Western Cape	14241	23.0	14.5
KwaZulu-Natal	6625	10.7	16.5
Free Sate	1789	2.9	5.4
Mpumalanga	1598	2.6	6.9
Eastern Cape	1335	2.2	8.1
North West	935	1.5	6.5
Limpopo	912	1.5	6.5
Northern Cape	306	0.5	2.4
Total	61987	100	100

Source: Quantec, 2007 (StatsSA LFS data for 2000 – 2005)

On a cautionary note, we must recognize that the level of disaggregation needed for focused regional or sub-occupational planning purposes will require larger samples to be drawn so that sample error is contained to an acceptable level.

PART TWO: SUPPLY OF SKILLED ICT WORKERS

CHAPTER 9: SOURCES OF SUPPLY OF THE HIGH SKILL ICT WORKFORCE

Introduction

There are various routes of 'supply' of skilled workers into a national occupational labour market (eg: graduates from public education institutions and private training service providers, in-service training, in-migration etc.). And there are routes out of the same market into global movement of skilled labour.

In South Africa, the main contributor to ICT skilling in terms of volume and variety of learning opportunities is the private sector. It is estimated that around three-quarters of ICT workers hold post-school qualifications from private training service providers (Roodt, 2003; Moleke, Paterson, Roodt, 2005). Private training providers offer courseware to meet various needs including: for those who do not qualify to enroll at a university or university of technology; for those who cannot afford higher education fees; for those who can only study part time; for those who require product or application-specific training, or who wish to upgrade or broaden their skills in particular ICT sub-fields; and also for enterprises seeking training specific to their unique in-house software environments.

Most private sector training courses available on the market are of short duration, focused on particular IT implementation environments, and strongly emphasise practice rather than theory.[9] Consequently, a very small proportion of learning opportunities at private ICT training institutions could be said to be equivalent to a higher education qualification such as an undergraduate degree which provides a coherent programme of learning at a high-skills level with a strong theoretical base.

In the analysis that follows, we will address the contribution of South African public education institutions to the supply of ICT professionals, in particular graduate production from the higher education sector. We begin by briefly considering the contribution of public ordinary schools and the FET Colleges to production of intermediate skill ICT workers.

ICT-related programmes offered at the FET level in public education institutions

Public ordinary high schools

A small number of high school students have the opportunity to enroll for Computer Science as a subject up to the Senior Certificate examination. Access to this subject is

[9] The ISETT SETA is registering IT training providers that seek NQF and Department of Labour/SETA accreditation or that seek accreditation of their courseware. The ISETT SETA website lists 30 accredited private training providers. An extensive list of providers is provisionally accredited and approved. However international software and training vendors with their own global qualification systems will probably not see the necessity to submit to local accreditation. As a result their training numbers will remain unknown.

dependent on which schools have a computer centre and a teacher qualified to teach the subject to Grade 12. The distribution of schools which are equipped to offer Computer Science is increasing through various infrastructure development programmes especially in Gauteng Province (GautengOnline) and in the Western Cape Province (Khanya Project), but is still limited to mainly urban schools within high socio-economic status communities associated with the former White departments of Education pre-1994.

The 4197 candidates who passed Computer Science as a subject for the Senior Certificate examination on the Higher Grade[10] in 2005 constituted 1.61% of all those who achieved an overall pass with endorsement (260 653) to enroll for study at a higher education institution (Table 31). A Higher Grade pass in Computer Science did not on its own entitle a candidate to enroll for a course of study related to computers in a higher education institution. This opportunity is based on a candidate obtaining a combination of satisfactory grades including ‘gateway’ subjects such as science, mathematics and language. Computer Science as a Matric subject is not a pre-requisite for entry into Computer Science study in a South African higher education institution. To the knowledge of the authors, research such as a tracer study has yet to be undertaken to assess the contribution of Computer Science as a subject to the career and study prospects of school leavers.

Table 31: Candidates who passed Computer Science in the Senior Certificate examination by province in 2005

Province	HG	HG %	SG	SG%
Gauteng	1 601	38.1	4 096	30.3
Kwazulu-Natal	1 202	28.6	2 300	17.0
Western Cape	525	12.5	2 820	20.9
Mpumalanga	230	5.5	696	5.2
North West	191	4.6	491	3.6
Limpopo	154	3.7	921	6.8
Eastern Cape	141	3.4	715	5.3
Free State	109	2.6	1 302	9.6
Northern Cape	44	1.0	171	1.3
Total	4 197	100	13 512	100

Public FET colleges

In the Further Education and Training (FET) colleges, students may enroll for ICT-related instructional offerings (ie: courses) as part of study programs leading to qualifications.

ICT-related courses are offered at National Qualification Framework (NQF) Levels 1-4 (where Level 4 is the equivalent level to Grade 12 in ordinary public schools) and at Levels 5-6 (which are equivalent to undergraduate and graduate diploma’s and certificates in higher education institutions).[11]

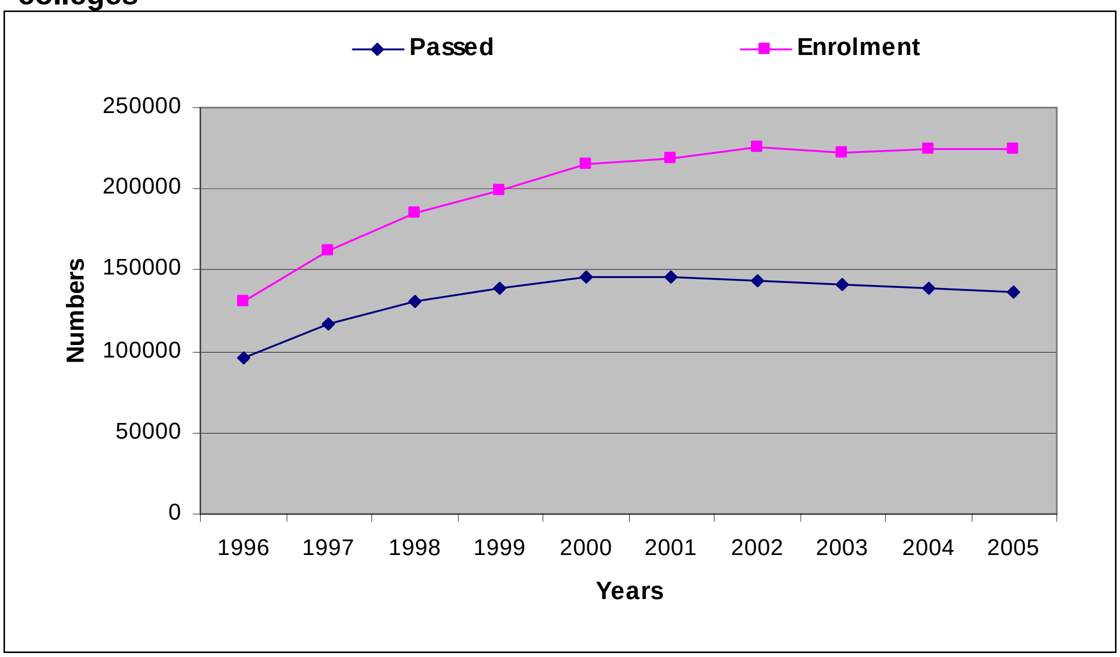
[10] The higher grade and standard grade distinction has since been phased out.
[11] In a limited number of these institutions, training is provided in the form of International Computer Driver’s License (ICDL) or similar types of internationally or locally benchmarked courseware.

It is not a simple task to establish the impact of these instructional offerings. The unit of data made available by the National Department of Education refers to individual courses (the number of times a course has been enrolled for or passed), and not per student who has completed a whole qualification.[12] Figure 19 below shows that enrolment for ICT-related courses between 2001 and 2005 was in the region of 220 000 while the number of courses passed hovered just under 150 000 for the same period. In gross terms, this means that in a any given year a large number of FET College students who were registered across all the NQF Levels 1 to 6, each passed one or more courses offered in the following four areas: Computer Studies, Electronics and Telecommunications Trades, ICT and Telecommunications and Telecommunications Trades. Courses are offered on a semester basis so it is possible for a student to enroll for more than one course in a year – ie: at least one course in each semester/trimester.

Students who passed one or more courses in these four fields would not necessarily have been studying towards an ICT focused qualification or career path. For instance, a business studies student could take one or more ICT-related courses as electives to broaden her skills base rather than to qualify specifically for an ICT occupational opportunity.

There was an total average annual growth of 6.2 per cent in all ICT-related subject enrolment, and an average annual growth of 4.0 per cent in pass rates over the period 1996 to 2005. However, it is quite clear that enrolments and pass rates reached a plateau shortly after the millennium. If anything, pass rates began a slight decline since 2000/2001.

Figure 19: Enrolment and pass rates in ICT related course offerings at FET colleges



Source: DoE (1996 to 2005) Appendix B

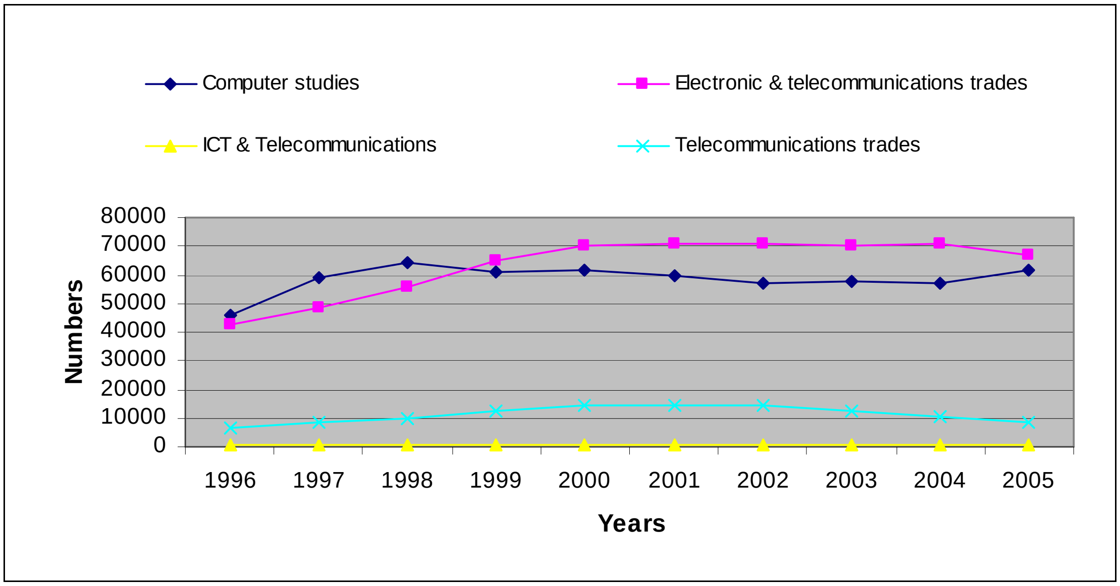
Breaking the totals down according to the four fields of study shows that highest numbers of passes were obtained in 'Computer Studies' and 'Electronic and

[12] National Department of Education data is not provided by race or gender.

Telecommunications Trades' (Figure 20). The number of passes in these two fields of study were of similar magnitude and followed similar trends. The number of passes in 'Telecommunication Trades' and in 'ICT and Telecommunications' were much smaller.

Over the period 1996 to 2005, the highest average annual growth (5.2 per cent) in pass rates was in electronic and telecommunication trades, then in computer studies (3.3 per cent), and telecommunication trades (2.3 per cent), while pass rates in 'ICT and telecommunications' had a negative average annual growth of -7.2 per cent over the period.

Figure 20: Trends in the pass rates of ICT-related courses at FET colleges, 1996 to 2005



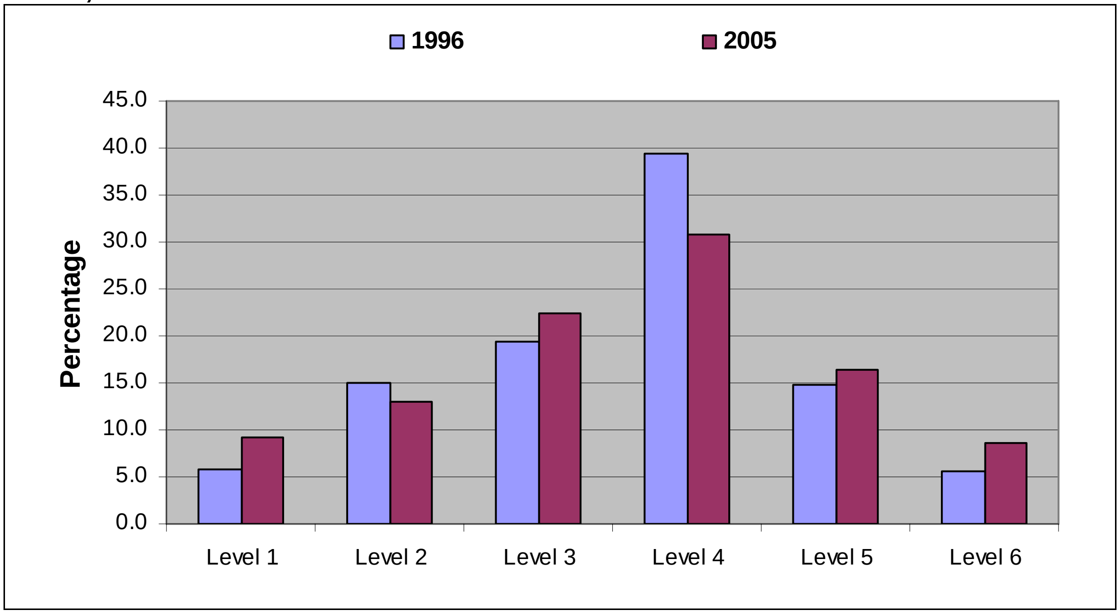
Source: DoE (1996 to 2005) Appendix C

Of particular relevance to this study is the distribution of courses passed by NQF level. Given that the focus here is on intermediate to high level skills, it is useful to establish what proportion of courses were passed at NQF Levels 5 and 6 which are equivalent to higher education qualification levels.

Figure 21 shows that in 2005, courses passed at Levels 5 and 6 constituted about 25% of all courses passed. Based on the discussion above we must assume that only a sub-group of all students who enrolled for one or more ICT-related course at Levels 5 and 6 would complete a qualification dedicated to an ICT-related career. In addition, the modularized course structure provides for students to register for vocationally useful courses on an ad-hoc basis that is not intended to lead to a whole qualification. We therefore estimate that substantially less than one in four students would complete a qualification specifically in the ICT field.

FET graduates who hold a qualification which includes some form of intermediate-level ICT course cannot be counted as part of the high skills ICT graduate production. It is not possible to gauge what proportion of intermediate skill level FET graduates may still be part of the skills pipeline leading to high level skills acquisition at a later stage. Clearly more attention needs to be paid to understanding the implications of FET College graduate output for intermediate to high level ICT skills production in South Africa.

Figure 21: Pass rates in ICT related courses at FET colleges according to NQF level, 1996 to 2005



Source: DoE (1996 to 2005) Appendix B

ICT-related programmes offered at the HET level

The dynamics of labour demand and labour supply in the field of ICT, are quite complex. On the one hand, the fields of knowledge, and the kinds of qualifications involving ICT that are offered in higher education are overlapping and quite diverse. On the other hand, the job opportunities encompassed by the term ICT are also diverse and overlapping. Consequently, the kind of one-to-one relationship between a qualification and an occupation that might be expected, such as in certain professions (eg: between a teaching degree and a teaching post or between a medical doctor's degree and a general practitioners post) cannot be as easily assumed in the ICT field.

The reasons for this include: rapid uptake of ICT across a range of different occupations and fields (eg: graphic arts and design), applicability of 'pure' disciplines such as mathematics to ICT (eg: operations research); convergence of fields such as 'computer science' and 'computer engineering'. The complex dynamics behind these processes cannot be unpacked here, the main point being that there is not a direct relationship, for example, between the production of graduates from computer science, and the existence of a particular set of job opportunities only for people with a computer science qualification.

An additional factor that contributes to an imprecise relationship between qualifications and job vacancies is substitution. This occurs where a worker with particular qualifications that qualify her for an occupation may - with industry experience and/or short term industry training – successfully occupy a different occupation. The phenomenon of transferability or mobility of workers between occupations cannot be ruled out in the broad field of ICT.

Graduates in fields of study cognate to ICT

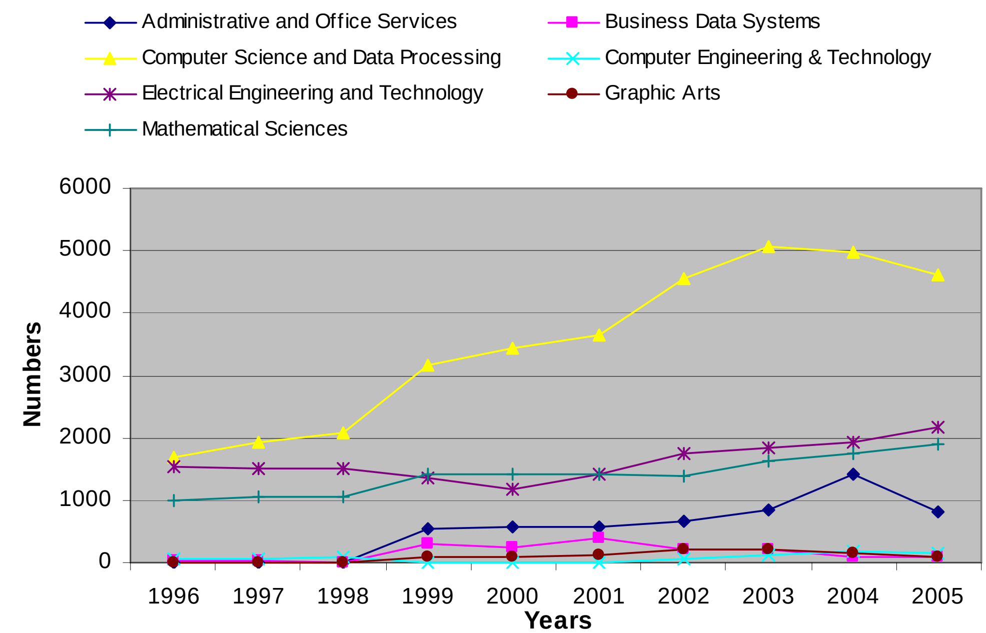
Thus, to properly understand the broad context of demand and supply among ICT related occupations, it is necessary to refer to a range of qualifications from study fields that are cognate to computer science that may contribute to supply. Therefore, we have identified several cognate fields of higher education study which will contribute to the overall production of high skills ICT workers. We suggest that changes in the graduate outputs from these study fields could impact on the overall situation regarding demand and supply of high level ICT skilled workers.

As shown in Figure 22, the number of graduates from the computer engineering and technology study field had an average annual growth of 14.3 per cent, off a low base of 47 graduates in 1996. Similarly, graduates in business data systems grew at 12.6 per cent per annum off a low base of 36 graduates.

In the same period, mathematical science graduates grew annually at 7.3 per cent, while those in electrical engineering and technology grew at 3.8 per cent over the period. For the newer fields such as ‘graphic arts’ and ‘administrative and office services’, since 1999 the average annual growth in these fields of study was 0.4 per cent and 7.0 per cent respectively.

Although the graduate output from these study fields is smaller than that of computer science and data processing, we cannot exclude them from the broader picture of graduate output that could contribute in some measure to meeting the demand for skills in the ICT field.

Figure 22: Graduates in ICT-cognate fields of study, 1996 to 2005



ICT related fields of study	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Average annual growth (1996-2005)
Administrative & Office Services	0	0	0	531	572	576	660	858	1431	799	7.0
Business Data Systems	36	35	11	291	227	377	220	208	83	104	12.6
Computer Science & Data Processing	1675	1941	2083	3160	3437	3655	4546	5078	4976	4598	11.9
Computer Engineering & Technology	47	48	102	3	15	13	60	111	180	156	14.3
Electrical Engineering & Technology	1543	1493	1508	1367	1182	1404	1755	1826	1930	2156	3.8
Graphic Arts	0	0	0	87	84	124	215	216	139	89	0.4
Mathematical Sciences	1010	1067	1047	1430	1423	1425	1394	1616	1762	1902	7.3

Source: DoE (1996 – 2005) [13]

The following chapter will analyse enrolment and graduate production in two specific study fields: computer science and data processing, and electrical engineering and technology. It was decided not to analyse computer engineering and technology since there is still a very low enrolment in this field. For some time, graduate output in this field will also be small. It is difficult to reliably draw trends from small numbers.

[13] Data for the supply-side analysis was obtained from the Department of Education's Higher Education Management Information System (HEMIS) with fields of study classified according to the Classification of Educational Study Matter (CESM). This database has data on all enrolment and graduates from universities and universities of technology.

We now turn to examine graduate production by qualification level.

Graduates by qualification level in ICT-cognate fields of study, 2005

We have argued above that it is necessary to take into account the graduate output of ICT-cognate fields of study. In order to obtain a more complete picture of the possible contribution from these fields, we must consider graduate output by qualification level.

This procedure helps to provide a more realistic take on the possible contribution of graduates from study fields other than computer science and data processing. For instance the field of 'computer engineering and technology' does not include diplomas and certificates and for this reason can be considered a generally high-skilled group. In contrast, the graduates of 'electrical engineering and technology' and 'administrative and office services' are dominated by certificates and diplomas which implies that their contribution to high level skills is proportionately delimited (Table 32).

Table 32: Graduates by qualification level in ICT cognate fields of study in percentages, 2005

	Certificate / Diploma	Degree	Postgraduates	Total
Computer Science and Data Processing	36.9	46.7	16.4	100
Computer Engineering & Technology		74.6	25.4	100
Electrical Engineering and Technology	54.7	33.3	12.1	100
Mathematical Sciences	9.0	60.3	30.7	100
Business Data Systems		31.6	68.4	100
Administrative and Office Services	83.9	15.4	0.8	100
Graphic Arts	41.9	58.1		100

Source: DoE (2005)

What the above analysis tells us is that, other than computer science and data processing, the fields such as Business Data Systems and Computer Engineering and Technology may indeed contribute considerably though unevenly to the output of ICT field related graduates into the labour market. However at this stage, we cannot explore how this graduate production could impact on ICT employment and skills shortages.

CHAPTER 10: ENROLMENT AND GRADUATE PRODUCTION: COMPUTER SCIENCE AND DATA PROCESSING & ELECTRICAL ENGINEERING AND TECHNOLOGY

Computer Science and Data Processing

Enrolment in computer science and data processing 1996-2005

It is important to begin by considering student enrolment parameters, because changes in enrolment reflect changes in enthusiasm for taking up higher education based ICT-related occupational training among prospective students, among potential new entrants to the ICT labour market and also among the currently employed. The size of higher education enrolments in any given year is an important parameter which sets the upper limits on the potential number of persons who could graduate with ICT qualifications some time later.

Overall, enrolments at universities and universities of technology in the study field of computer science and data processing rose steadily over the period 1996 to 2005. This amounted to an average annual increase of 1.9 per cent in certificate/diploma enrolments, 6.2 per cent in degree enrolments, and a 6.8 per cent increase in postgraduate enrolments, as indicated in Table 33.

The proportions of black candidates enrolling for certificate or diploma qualifications in the field of computer science and data processing increased over the period, as measured in annual average growth. Starting with certificate/diploma courses measured in average annual terms over the decade, black female enrolment (6.5 per cent) and black male enrolment increased (5.8 per cent) over the period, whereas there was negative growth in the enrolment of white males (-11.6 per cent) and females (-14.2 percent)

A similar pattern was evident for degree courses in the computer science and data processing study field where the enrolments among black males (12.7 per cent average annual increase) and females (12.9 per cent average annual increase) rose over this period, while enrolments of white males and females decreased. In real terms, black male and black female enrolment tripled in size between 1996 and 2005. White male enrolment numbers dropped over the period at a rate of -0.7 per cent per year and white female enrolment declined quite sharply at a rate of -9.2 per cent per year.

Postgraduate enrolments grew off a small base. Measured in annual average growth, there was a substantial rise of 19.2 per cent and 12.8 per cent in black female and male postgraduate enrolments respectively, while white male enrolments rose 4.5 per cent over the period, and white female enrolment declined in annual average (-3.1 per cent) terms and in real terms.

Table 33: Enrolment in computer science and data processing by race group and gender, 1996-2005

Qualification	Race	Gender	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Average annual growth (1996 - 2005)
Certificate / Diploma	Black	Men	1535	2236	2947	3658	3322	2093	1936	2341	2330	2544	5.8
		Women	1101	1684	2463	3243	3089	1523	1551	2076	1858	1934	6.5
	White	Men	1122	1101	990	880	664	394	443	407	341	370	-11.6
		Women	431	399	415	430	326	142	175	126	120	109	-14.2
	Un-known	Men	0	0	0	22	0	1	1	1	0	0	0.0
		Women	0	0	0	24	0	1	0	1	1	0	0.0
	Total		4188	5420	6815	8257	7401	4154	4105	4952	4650	4957	1.9
Degree	Black	Men	396	429	523	616	1404	1916	1988	1884	1180	1164	12.7
		Women	238	344	439	534	1112	1454	1350	1240	758	708	12.9
	White	Men	543	620	589	558	759	944	1072	958	678	511	-0.7
		Women	286	300	299	297	278	344	351	257	167	120	-9.2
	Un-known	Men	0	0	0	1	0	1	0	2	5	4	0.0
		Women	0	0	0	0	0	0	0	1	1	3	0.0
	Total		1464	1694	1850	2006	3553	4657	4761	4342	2790	2509	6.2
Post-graduates	Black	Men	62	94	82	69	77	109	159	234	201	185	12.8
		Women	21	55	52	49	37	58	79	123	104	104	19.2
	White	Men	184	184	164	145	128	217	298	324	264	273	4.5
		Women	73	57	52	47	48	81	100	113	80	55	-3.1
	Un-known	Men	0	0	0	0	0	0	0	3	0	0	0.0
		Women	0	0	0	0	0	0	0	0	0	0	0.0
	Total		341	390	350	311	289	464	636	798	648	618	6.8
Total	Black	Men	1993	2760	3552	4344	4803	4118	4083	4459	3711	3893	7.7
		Women	1360	2083	2954	3825	4238	3035	2980	3439	2720	2746	8.1
	White	Men	1850	1905	1744	1583	1551	1554	1813	1689	1282	1153	-5.1
		Women	789	756	765	774	652	566	626	496	367	284	-10.7
	Un-known	Men	0	0	0	23	0	2	1	6	5	4	0.0
		Women	0	0	0	24	0	1	0	2	2	3	0.0
	Total		5993	7504	9015	10573	11243	9275	9502	10092	8088	8083	3.4

Source: DoE (1996 – 2005)

Enrolment share for 2005 by race and gender

If we look more closely at the recent 2005 distribution of enrolment by race group (Table 34) at the different qualification levels, the following pattern emerges: black candidates dominate enrolment at diploma/certificate level (90.3 per cent) and to a slightly lesser extent at the degree level (74.6 percent) while white candidates constitute the majority of enrolment at the post-graduate level which is dominated by white males. The share of black enrolments decreases as the level of qualification rises. This can be ascribed to the relatively poor background in mathematics and science subjects that many black students experience at school who may not then qualify to enter certain academic programmes. Access to study finance plays a major role. Decreasing black student enrolment at higher levels of qualification, can be attributed the attraction to enter the labour market immediately upon completion of the initial qualification or to difficulties in completing the study programme because of lack of funding, disadvantaged school background or insufficient academic support.

We need to investigate further the position of very substantial numbers of diploma and certificate students, who are mostly black. By establishing the academic background of students, whether they are enrolled on a part-time or a full time basis, what the curriculum of such programmes is, what the vocational-theory balance of such diploma/certificate programmes are, will assist us in assessing the contribution of such qualifications to: broadening the ICT skills base, improving equity of access to the workplace, and to opportunities for further study towards a higher qualification.

Table 34: Proportionate share of enrolment by qualification level, race and gender, 2005

	Diplomas and certificates		Degrees		Post-graduate degrees	
	n	%	n	%	n	%
Black Male	2544	51.3	1164	46.4	185	29.9
Black Female	1934	39	708	28.2	104	16.8
White Male	370	7.5	511	20.4	273	44.2
White Female	109	2.2	120	4.8	55	8.9
Unclassified	0	0	4	0.2	0	0
Unclassified	0	0	3	0.1	0	0
Total	4957	100	2509	100	618	100

Source: DoE (1996 – 2005)

In the sections that follow, we examine the demographics of Computer Science and Data Processing graduates from higher education.

Graduates

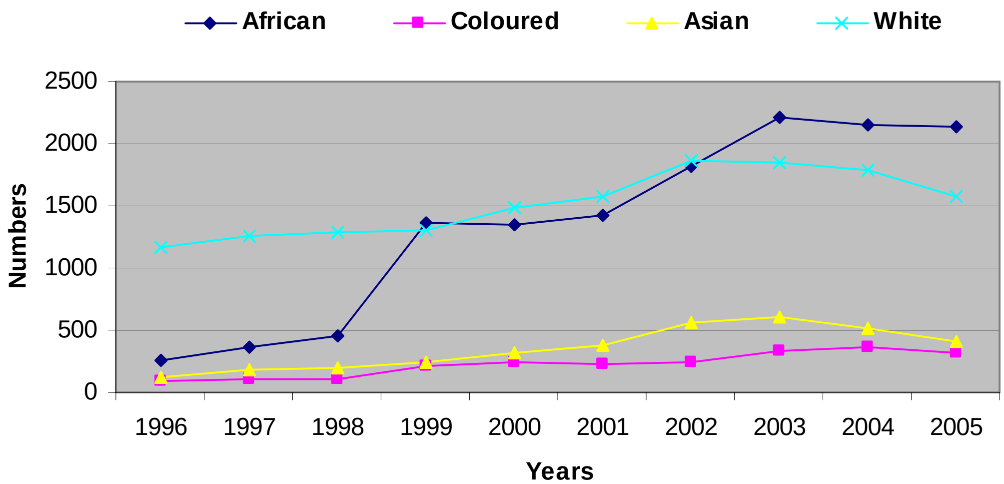
Graduates from Computer Science and Data processing 1996 to 2005

Over the period 1996 to 2005 the number of computer science and data processing graduates grew substantially (Figure 23). In real terms, graduate output rose from 1 645 in 1996 to 4 449 in 2005, yielding an annual average increase of 11.7 per cent.

Within this overall increase, growth in graduate output by race group was uneven. The highest growth rate was visible for African graduates with an average annual growth of 26.5 per cent. Coloured and Indian graduate production in computer science and data processing obtained average annual growth of 15.5 and 14.0 per cent respectively. White graduate production experienced the lowest average annual increase at 3.3 per cent.

Clearly, the main locus of growth was with African graduates whose numbers significantly exceeded white graduates for the first time in 2003. The share of white graduates peaked in 2002 and declined over the ensuing years. In effect, African graduate production increased sevenfold, whereas white graduate production increased by 34.4 per cent over the decade.

Figure 23: Graduates from HE institutions in computer science and data processing by race, 1996 to 2005



Race	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Average annual growth (1996-2005)
African	259	357	457	1368	1348	1423	1822	2210	2158	2143	26.5
Coloured	86	106	108	215	240	227	235	327	362	316	15.6
Asian	128	189	191	239	312	374	559	605	514	415	14.0
White	1172	1263	1293	1300	1488	1574	1863	1841	1794	1575	3.3
Total	1645	1915	2049	3122	3388	3598	4479	4983	4828	4449	11.7

Source: DoE (1996 – 2005)

Graduates by qualification level and race

This section examines graduates by qualification level and race, two important dimensions according to which we need to monitor change. In the period under consideration, a double shift occurred: degree'd graduate numbers increased over certificate/diploma graduate numbers, and black graduate numbers increased over white graduate numbers.

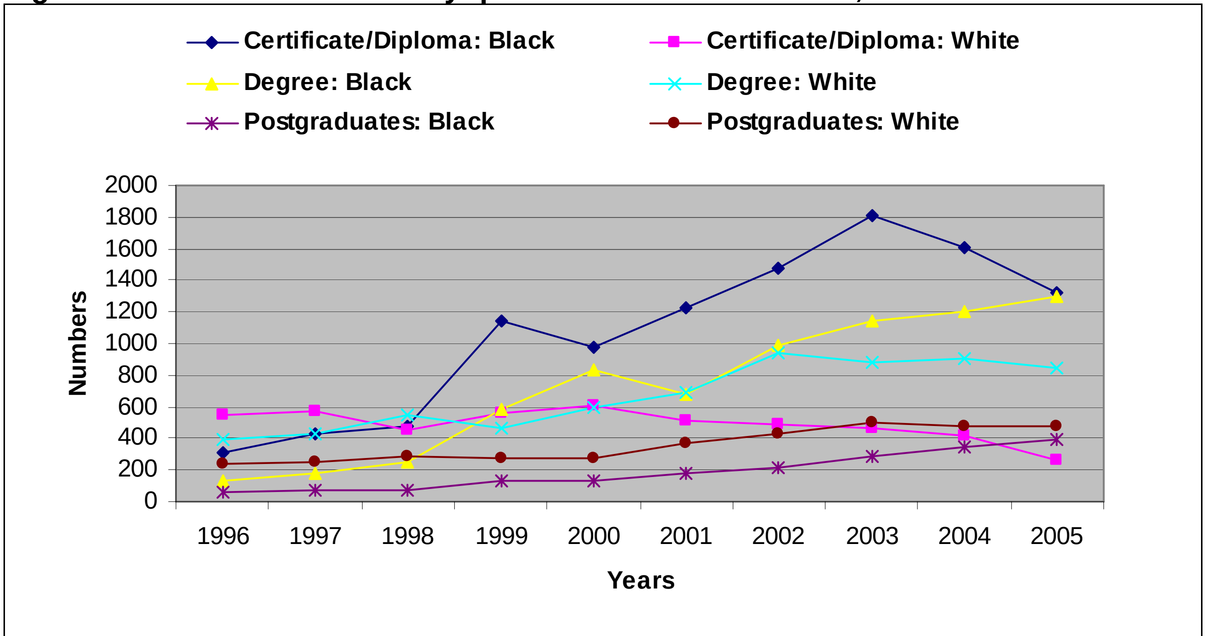
First in terms of the share of graduates by race, in 1996 white graduates held the majority share of graduates at all three qualification levels in computer science and data processing, as shown in Table 35 and in Figure 24. By 2005 this situation had shifted considerably. Black graduates increased their share of certificate/diploma qualifications by more than ten percent and their share of degree qualifications by more than twenty percent in the decade. As a result black graduates were in the majority at the certificate/diploma level and at the degree level, while at the postgraduate level in 2005, white graduates proportions were still a slim majority.

Second, in the same period changes occurred in the overall distribution of graduates between qualification levels. Between 1996 and 2005, graduates holding certificates and diplomas as a proportion of all graduates declined from 51 per cent to 34.5 per cent while the share of graduates with degrees increased from 30.8 per cent to 46.6 per cent. Postgraduates as a share of all graduates held the same proportion. This means that there was an increase in the overall qualification levels per cohort over the period that could be available to the labour market.

Table 35: Proportionate share of graduate numbers by qualification level and race, 1996 and 2005				
	1996		2005	
	n	%	n	%
Certificate/Diploma: Black	310	18.5	1324	28.9
Certificate/Diploma: White	544	32.5	256	5.6
Degree: Black	127	7.6	1293	28.2
Degree: White	389	23.2	846	18.4
Postgraduates: Black	65	3.9	398	8.7
Postgraduates: White	239	14.3	472	10.3
	1674		4589	

Source: DoE (1996 – 2005)

Figure 24: Graduation trends by qualification level and race, 1996 to 2005



Qualification by race	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Average annual growth (1996-2005)
Certificate/Diploma: Black	310	427	472	1142	977	1224	1480	1807	1613	1324	17.5
Certificate/Diploma: White	544	576	458	563	612	506	493	459	415	256	-8.0
Degree: Black	127	183	249	583	832	674	985	1139	1198	1293	29.4
Degree: White	389	434	545	469	601	694	945	878	900	846	9.0
Postgraduates: Black	65	68	70	129	133	179	218	291	346	398	22.3
Postgraduates: White	239	252	290	268	276	374	425	505	479	472	7.8

Source: DoE (1996 – 2005)

Graduates by gender

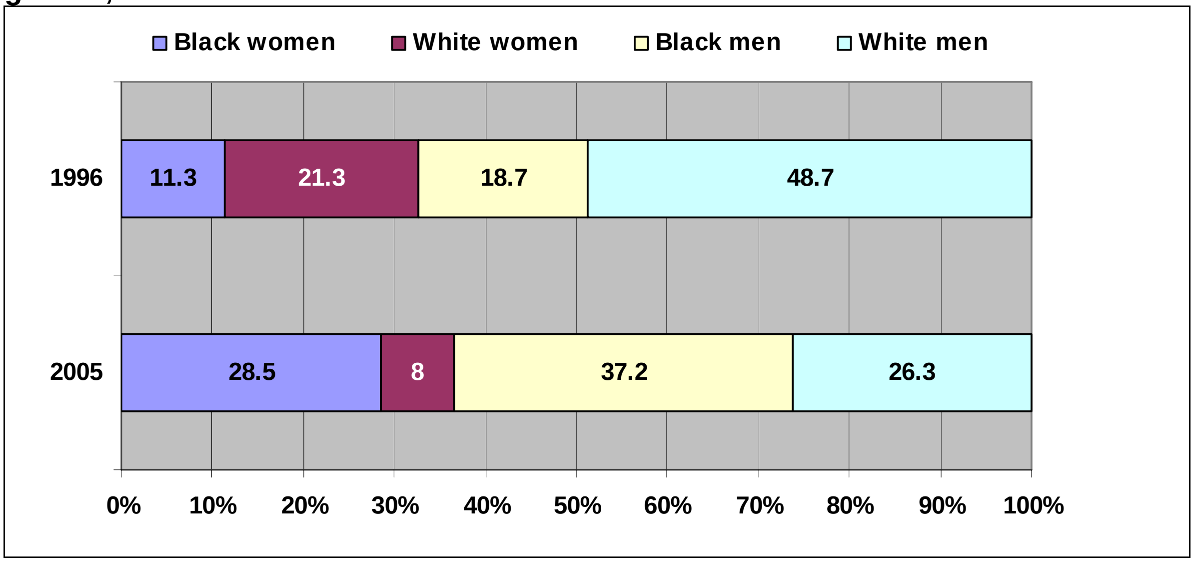
The ratio of computer science and data processing graduates by gender marginally increased in favour of females from 32.5 to 36.5 per cent between 1996 and 2005. This means that the gender make-up of computer graduates hardly shifted in the decade (Figure 25).

However, the same cannot be said of the race share within male graduates and within female graduates. Black males and females increased their share of graduates considerably.

Black female graduates increased at an average annual growth of 24.0 per cent, whereas their white contemporaries experienced an average annual growth of 0.3 per cent. Similarly, black male graduates increased at an average annual growth of 20.7 per cent whereas white male graduates increased at an average annual growth of 4.5 per cent.

As a consequence of these changes, by 2005 the number of black female graduates with computer science and data processing across all qualification levels was greater than the number of white male graduates.

Figure 25: Graduates in computer science and data processing by race and gender, 1996 and 2005



Source: DoE (1996 – 2005)

Graduates by qualification level and gender

We reported that the female share of computer science and data processing graduates increased slightly over the period 1996 to 2005. The average annual number of female graduates increased slightly more than the number of male graduates at all three qualification levels: 13.2 per cent against 12.1 per cent at the postgraduate level 18.1 per cent against 16.7 per cent at the undergraduate degree qualifications, and 9.8 per cent against 5.3 per cent at the certificate/diploma level.

It is noticeable that the proportion of male holders of certificate/diplomas declined significantly in relation to all other qualifications between 1996 and 2005 whereas this was not as evident for females. This proportion must be monitored lest increases in the number of female graduates become concentrated among lower qualification levels (Table 36).

Table 36: Proportionate share of graduate numbers by qualification level and gender, 1996 and 2005					
	1996		2005		Average annual growth (1996-2005)
	n	%	n	%	
Certificate/Diploma: Women	296	17.7	688	15.0	9.8
Certificate/Diploma: Men	558	33.3	891	19.4	5.3
Degree: Women	162	9.7	725	15.8	18.1
Degree: Men	354	21.1	1421	30.9	16.7
Postgraduates: Women	86	5.1	262	5.7	13.2
Postgraduates: Men	218	13.0	610	13.3	12.1
Total	1675	100	4598	100	11.9

Source: DoE (1996 and 2005)

Share of graduates between sub-fields of computer science and data processing, 1999 and 2005

In this section we explore changes in graduate production across the computer science and data processing sub-fields in two ways. First we examine changes in the share of graduate production across sub-fields between 1999 and 2005. Thereafter, we compare the various sub-fields according their average annual growth over the same period.[14]

A snapshot of graduate numbers per sub-field in 2005 reveals that only a few fields are responsible for a major share of graduate production (Table 37). The major four contributors are: information and database systems (36. 0 per cent), applications in computer science and data processing (21 per cent), computer operations and operations control (9.2 per cent) and programming languages (8.8 per cent). Together these study fields contribute 75 per cent of all graduates in the computer science and data processing fields.

Yet only two, 'Information and database systems' and 'computer operations and operations control' increased their share of graduates between 1999 and 2005, the former increased by a sizeable margin of just over ten percent. In contrast, two of the top four fields suffered declining output: applications in computer science and data processing (-4.2 per cent) and programming languages (-3.9 per cent).

The questions that arise here are: Why these patterns emerged? To what extent the shifts in graduate numbers between the sub-fields resolves or aggravates labour market demand? To what extent these shifts constrain or facilitate innovation in product or service markets?

[14] 'Computer Science and data processing' is the broad category that refers to a number of sub-study field categories. In HEMIS the CESM (0600) for computer science and data processing refers to the aggregation of applications in computer science and data processing (0601); computer operations and operations control (0602); computer hardware systems (0603); computer hardware (0604); information and data base systems (0605); numerical computations (0606); programming languages (0607); programming systems (0608); software methodology (0609); theory of computation (0610); education, societal and cultural considerations (0611); and other computer science and data processing (0699).

Before 1999 enrolment and graduate numbers were not disaggregated into the various sub-study fields of computer science and data processing (CESM 0600). Only since 1999 were enrolment and graduate numbers given according to the various sub-study fields (CESM 0601 – 0611).

Table 37: Share of graduate production among fields of specialisation in computer science and data processing, 1999 and 2005

	1999		2005	
	n	%	n	%
Computer Hardware Systems	60	1.8	179	3.9
Programming Systems	115	3.5	296	6.4
Computer Ops & Operations Control	196	6.0	422	9.2
Information & Data Base Systems	845	25.8	1656	36.0
Applications in Computer Sc & Data Processing	825	25.2	967	21.0
Education, Societal & Cultural Considerations	63	1.9	67	1.5
Programming Languages	417	12.7	404	8.8
Other Computer Science & Data Processing	577	17.6	554	12.1
Software Methodology	49	1.5	45	1.0
Computer Hardware	15	0.5	1	0.0
Theory of Computation	26	0.8	2	0.0
Numerical Computations	83	2.5	4	0.1
Total	3271	100	4597	100

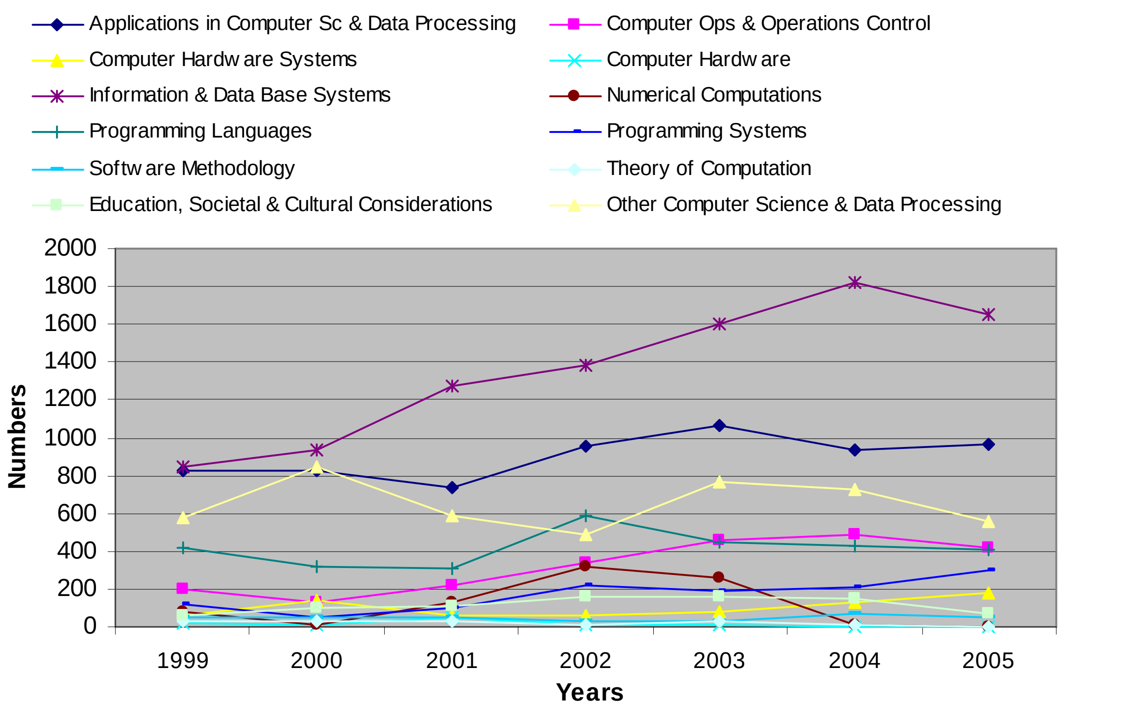
Source: DoE (1996 and 2005)

Average annual growth in computer science and data processing sub-fields

To obtain an overview of changes in graduate output, annual average growth was calculated for all of the sub fields over the period (Figure 26). It is interesting that three of the smaller sub fields showed strongest growth: computer hardware systems, programming systems and computer operations and operations control which reflected average annual growth in graduate output of 20.0 per cent, 17.1 per cent, and 13.7 per cent respectively. Notwithstanding its already large share, annual average growth of information and data base systems graduates increased 11.9 per cent.

The number of graduates in programming languages, other computer science and data processing, software methodology, computer hardware, theory of computation, and numerical computations showed negative growth over the seven years. Further research into the factors driving these processes is worth pursuit.

Figure 26: Graduates in various computer science and data processing fields of specialisation, 2005



Fields of specialisation in computer science and data processing	1999	2000	2001	2002	2003	2004	2005	Average annual growth (1999-2005)
Computer Hardware Systems	60	142	56	58	79	130	179	20
Programming Systems	115	48	98	214	185	209	296	17.1
Computer Ops & Operations Control	196	127	215	343	459	486	422	13.7
Information & Data Base Systems	845	933	1271	1379	1602	1823	1656	11.9
Applications in Computer Sc & Data Processing	825	821	741	956	1063	936	967	2.7
Education, Societal & Cultural Considerations	63	99	114	164	162	150	67	1.2
Programming Languages	417	321	313	588	445	428	404	-0.5
Other Computer Science & Data Processing	577	850	586	484	765	727	554	-0.7
Software Methodology	49	51	51	27	26	68	45	-1.3
Computer Hardware	15	12	48	5	7	0	1	-36
Theory of Computation	26	27	29	7	30	12	2	-37.7
Numerical Computations	83	6	134	321	256	7	4	-39.9

Source: DoE (1999 – 2005)

Electrical engineering and technology

Enrolment in electrical engineering and technology

Enrolments at universities and universities of technology in the study field of electrical engineering and technology rose strongly over the period 1996 to 2005. The main impetus was attributable to an average annual increase of 12 per cent in certificate/diploma enrolments and 8.5 per cent in degree enrolments (Table 38). By comparison, a 1.6 per cent increase in postgraduate enrolments, showed low propensity to take post-graduate studies beyond the graduate level.

Turning to each qualification level in turn, the numbers of candidates enrolling for certificate or diploma qualifications in the field of electrical engineering and technology as measured in annual average growth increased at variable rates. Substantial increases were experienced in black female enrolment (19.3 per cent) and black male enrolment (12.2 per cent) over the period, whereas there was negligible growth in the enrolment of white males (0.8 per cent) and females (1.9 per cent).

A more stark pattern was evident for degree courses in the electrical engineering and technology field where the average annual growth of enrolments among black men (15.9 per cent) and women (28.3 per cent) rose quite sharply. By contrast, enrolments of white males (-2.3 per cent) declined and white female enrolment (4.5 per cent) increased slowly. The annual average rates mask the fact that enrolment for degree courses peaked midway through the period and then subsided.

Postgraduate enrolments grew off a small base. Measured in annual average growth, there was a rise and in black female (7.0 per cent) and male (3.0 per cent) postgraduate enrolments respectively, while white female enrolments rose (4.6 per cent) over the period, and white male enrolment declined (-1.8 per cent). The proportion of electrical engineering and technology students enrolled for post-graduate work was much smaller than the proportion of computer science and data processing students who enrolled for post-graduate work.

Table 38: Enrolment in electrical engineering and technology (for ICT output) by race group and gender, 1999-2005										
Qualification	**Race**	**Gender**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**Average annual growth (1999-2005)**
Certificate/ Diploma	Black	Men	423	504	333	523	603	746	846	12.2
		Women	104	156	87	144	204	249	299	19.3
	White	Men	108	74	60	86	83	113	113	0.8
		Women	4	3	2	3	3	10	5	1.9
	Other	Men	1	1	1	0	0	0	0	-20.6
		Women	1	0	0	0	0	0	0	
		Other	0	0	0	0	0	0	0	
	Total		641	736	484	756	893	1118	1264	12.0
Degree	Black	Men	49	248	375	329	244	110	119	15.9
		Women	7	46	105	85	76	35	33	28.3
	White	Men	77	141	192	189	158	107	67	-2.3
		Women	6	11	18	15	14	10	8	4.5
	Other	Men	0	0	0	0	0	0	1	
		Women	0	0	0	0	0	0	0	
	Total		140	445	690	618	492	263	228	8.5
Post-graduates	Black	Men	25	32	28	40	42	35	29	3.0
		Women	4	4	3	4	3	4	6	7.0
	White	Men	26	19	41	33	29	27	23	-1.8
		Women	1	2	7	6	5	3	3	12.2
	Other	Men	0	0	0	0	0	0	0	
		Women	0	0	0	0	0	0	0	
	Total		56	56	79	82	79	70	62	1.6
Total	Black	Men	496	783	736	892	889	891	994	12.3
		Women	116	205	196	232	283	288	339	19.6
	White	Men	211	233	294	308	269	247	204	-0.6
		Women	12	15	26	25	22	23	16	4.6
	Other	Men	1	1	1	0	1	1	1	-4.7
		Women	1	0	0	0	0	0	0	
		Other	0	0	0	0	0	0	0	
	Total		837	1238	1253	1457	1464	1450	1554	10.9

Source: DoE (1999 – 2005)
NOTE: The enrolment and graduation numbers provided in all of the tables in this discussion of the study field of electrical engineering and technology are less than the actual totals obtained from the Department of Education's HEMIS databases. The numbers given in the tables in this report reflect 35 per cent of the total enrolment and graduates from the electrical engineering and technology study field. The data is presented in this way because only a proportion of graduates with qualifications in this field take up employment in the ICT sector. It has been estimated that only 35 per cent of graduates enter the ICT environment.[15]

Enrolment share by race and gender, 2005

The recent 2005 patterns of enrolment by race group (Table 39) at different qualification levels, reveals that: black candidates dominated enrolment at diploma/certificate level on a nine to one ratio, whereas at the degree level the ratio is close to a two-to-one ratio and this is reduced further to three-to-two among post-graduates. A similar pattern exhibited in the computer science and data processing study field has been discussed in some detail earlier in this document.

[15] Interview with Prof F.W. Leuschner Head of the Department of Electrical, Electronic and Computer Engineering, University of Pretoria (2002)

Table 39: Proportionate share of in electrical engineering and technology enrolment by qualification level, race and gender, 2005

Race	Gender	Certificates and Diplomas		Degrees		Post-graduates	
		n	%	n	%	n	%
Black	Men	846	66.9	119	52.2	29	47.4
	Women	299	23.7	33	14.6	6	10.2
White	Men	113	9.0	67	29.4	23	37.9
	Women	5	0.4	8	3.5	3	4.5
Other	Men	0	0.0	1	0.3	0	0
	Women	0	0	0	0	0	0
Total		1264	100	228	100	62	100

Source: DoE (1996 – 2005)

Note: Numbers in this table are 35 per cent of enrolment in the electrical engineering and technology study field.

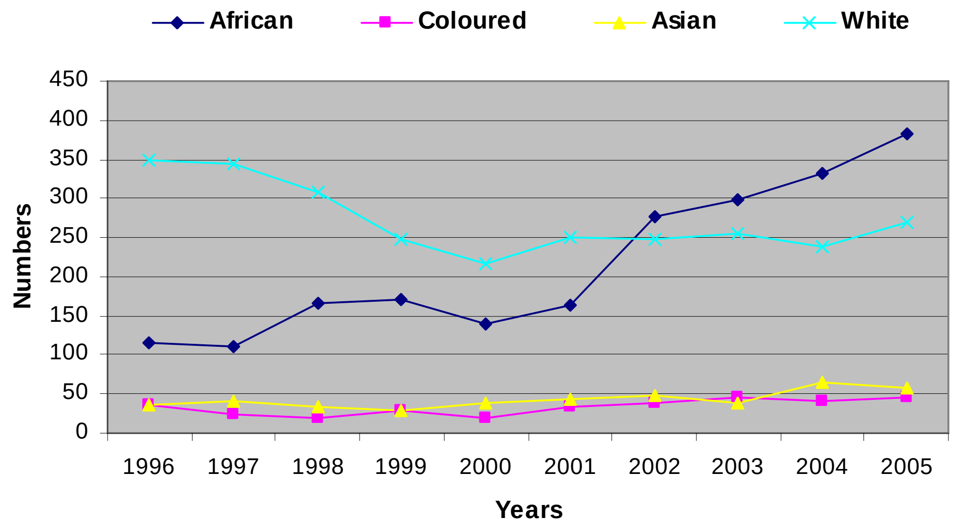
Graduates at HE institutions in electrical engineering and technology by race, 1996 to 2005

Over the period 1996 to 2005 the number of electrical engineering and technology graduates grew at an annual average rate of 3.8 per cent (Figure 27) which is much slower than for the field of computer science and data systems which showed an 11.7 per cent increase over the period.

Within this overall increase, growth in graduate output by race group was uneven. The highest growth rate was visible for African graduates with an average annual growth of 14.1 per cent. Coloured and Indian graduate production in electrical engineering and technology obtained average annual growth of 2.3 and 5.2 per cent respectively. White graduates declined (-2.9 per cent per annum).

As with the computer science and data systems study field, the main locus of growth was with African graduates whose numbers exceeded white graduates for the first time in 2002. Unlike computer science and data systems where graduate outputs of all the race groups increased over the period - though at different rates - white graduate production declined in electrical engineering and technology.

Figure 27: Graduates at HE institutions in in electrical engineering and technology by race, 1996 to 2005



Race	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Average annual growth (1996-2005)
African	117	112	166	172	139	164	278	298	331	382	14.1
Coloured	37	25	20	29	20	34	40	46	41	45	2.3
Asian	37	41	33	28	39	43	49	39	65	58	5.2
White	350	345	308	247	215	250	248	256	238	269	-2.9
Total	540	522	528	476	413	491	614	639	675	755	3.8

Source: DoE (1996 – 2005)
Note: Numbers in this table are 35 per cent of enrolment in the electrical engineering and technology study field.

Graduates by qualification level and race

Looking at proportions of graduate numbers by qualification level and race, between the 1996 and 2005 years, it is clear that shifts took place in both dimensions.

In the first instance, the proportion of graduates with certificates and diplomas increased from 48.1 per cent in 1996 to 54.7 per cent of all graduates in 2005. The question is why graduates with diplomas and certificates increased against graduates? Also remarkable is that from an equal share of certificates and diplomas among black and white graduates in 1996, black students became the overwhelming majority of this graduate type in 2005 with an 80 per cent share. The increase in these numbers took place very swiftly from 2000 onwards (Table 40, Figure 28).

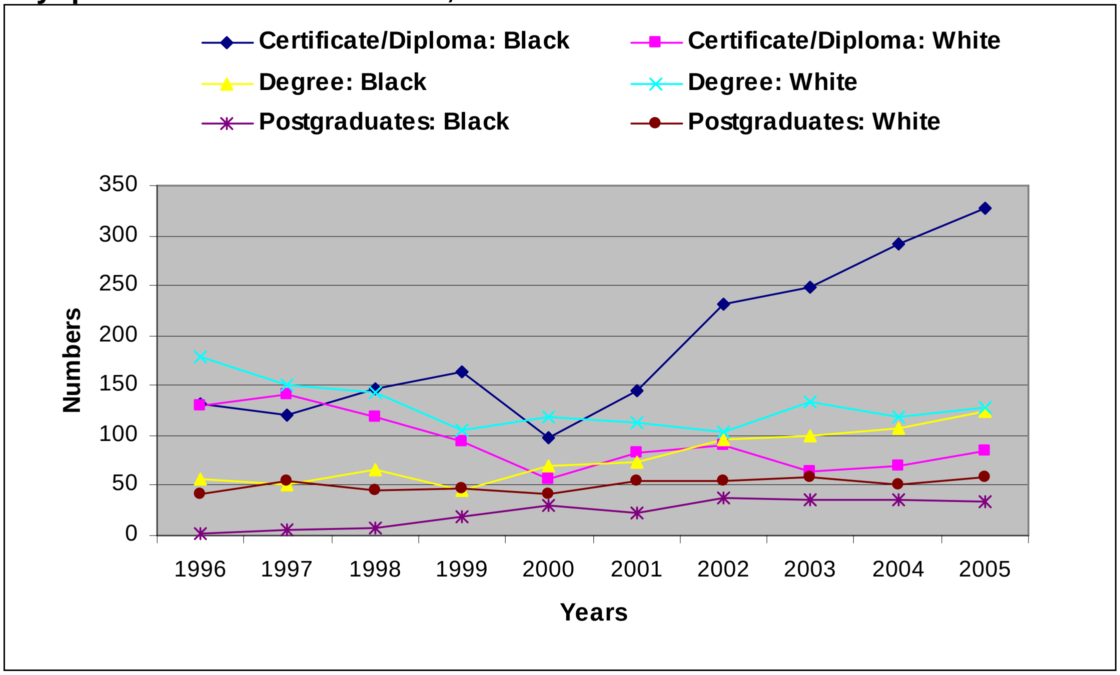
Table 40: Proportionate share of graduate numbers electrical engineering and technology by qualification level and race, 1996 and 2005

Qualification by race	1996		2005	
	n	%	n	%
Certificate/Diploma: Black	131	24.2	328	43.5
Certificate/Diploma: White	129	23.9	84	11.2
Degree: Black	56	10.4	124	16.4
Degree: White	180	33.3	127	16.9
Postgraduates: Black	3	0.5	33	4.4
Postgraduates: White	41	7.7	58	7.7
Total	540	100	755	100

Source: DoE (1996 and 2005)
Note: Numbers in this table are 35 per cent of enrolment in the electrical engineering and technology study field.

At the same time, graduates with degrees as a proportion of all graduates declined from 43.7 per cent to 33.3 per cent between 1996 and 2005. This means that there was a decrease in the overall qualification levels per of electrical engineering and technology graduate cohorts that became available to the labour market over the period. The race share of this diminishing graduate group shifted in favour of black graduates from one-in-four to an equal share.
By 2005, postgraduate level graduates increased their share of all graduates from 8.2 per cent to 12.1 percent, and within this group, white graduates were still the majority.

Figure 28: Graduates at HE institutions in electrical engineering and technology by qualification level and race, 1996 to 2005



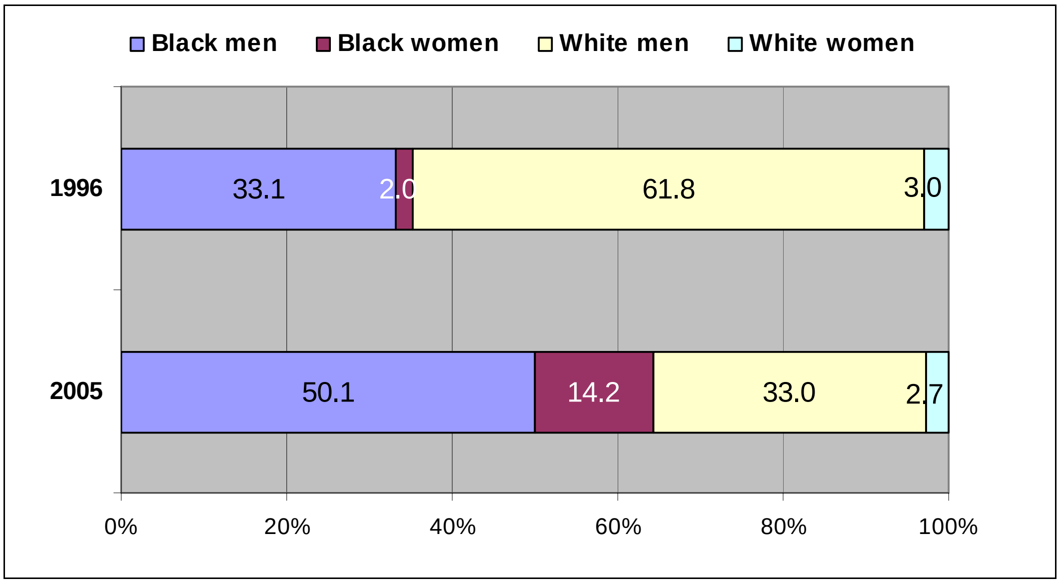
Source: DoE (1996 – 2005)
Note: Numbers in this table are 35 per cent of enrolment in the electrical engineering and technology study field.

Gender race and qualification levels

The proportion of female graduates with an electrical engineering and technology qualification increased from 5.0 per cent to 16.0 per cent between 1996 and 2005 (Figure 29). Though this was a substantial increase, the study field is clearly still dominated by males. The increase was driven mainly through improvements in the representation of black females.

Among males, black graduates increased their share from 33.1 per cent to 50.1 per cent, while the share of white males decreased from 61.8 per cent to 33.0 per cent, thus producing an inversion of the race balance within the overall male dominance of this study field from 1996 to 2005.

Figure 29: Graduates at HE institutions in electrical engineering and technology by race and gender, 1996 and 2005



Source: DoE (1996 and 2005)
Note: Numbers in this table are 35 per cent of enrolment in the electrical engineering and technology study field.

Given the slight overall participation of females in this study field, significant improvements in the female share of graduates at the different qualifications levels cannot be expected. In 2005, female graduates were outnumbered four to one at the certificate/diploma and degree levels and by nine to one at the post-graduate level (Table 41).

Table 41: Proportionate share of graduates by qualification level and gender, 1996 and 2005

Qualification	1996		2005		Average annual Growth (1996-2005)
	n	%	n	%	
Certificate/Diploma: Women	12	2.2	78	10.4	23.3
Certificate/Diploma: Men	248	45.9	334	44.3	3.4
Degree: Women	11	2.1	41	5.4	15.6
Degree: Men	225	41.7	210	27.8	-0.8
Postgraduates: Women	4	0.8	8	1.1	7.6
Postgraduates: Men	40	7.4	83	10.9	8.4
Total	540	100	755	100	3.8

Source: DoE (1996 and 2005)
Note: Numbers in this table are 35 per cent of enrolment in the electrical engineering and technology study field.

PART THREE: SUPPLY AND DEMAND

CHAPTER 11: SUPPLY OF AND DEMAND FOR ICT GRADUATES

Introduction

In the first part of our analysis, we paid considerable attention to the features of the ICT sector workforce and the ICT workforce – the so-called 'demand side' of the supply-demand relationship. In the course of the analysis we were able to make inferences about possible shortages of computer professionals. Some of these aspects will be revisited in the conclusion of this paper.

In the second part of the analysis, we presented an analytic overview of graduate production from higher education in the fields of study which are considered to be the main source of qualified computer professionals outside of the private ICT training industry. Analysis of the contribution of private training was not within the brief of this work.

So far we have not explicitly addressed the interaction between demand for computer professionals in the labour market and supply of qualified graduates in computer science. In this section of the analysis we attempt to add value to the debate in three ways.

First, we attempt to bring together the data that we have assembled and analysed in the first two parts of this paper. In doing this, we will attempt to *bring the demand and supply sides together so to speak to make a projection*. We use historical data on the size and other dimensions of the occupational labour markets of computer professionals and electronic engineering professionals to generate assumptions about future behaviour of the market for those occupations. We then create a model that projects possible demand into the future. A similar approach is applied on the supply side which involves generating a predicted graduate output curve into the future. The curves of demand and supply are then juxtaposed so that a putative shortage/oversupply figure is produced.

Typically, projections of labour market demand and supply are deficient if used in isolation. For this reason, we have obtained information from the labour market itself in order to enrich our analysis of the question of demand and supply of ICT professionals.

In the first instance we apply standard economic theory to an analysis of *data on the remuneration* of professionals and of computer professionals in South Africa. In so doing we observe that changes in remuneration of computer professionals is evidence of a labour shortage in these occupations.

Then, we use *data from a recent survey of vacancies* conducted by the HSRC to draw some tentative hypotheses about labour shortages in the computer professional occupational fields.

We then conclude this section with a discussion on the relative contribution of the results from each approach for understanding the demand-supply conundrum.

Projection of future demand and supply

It should be acknowledged that this is a very simple methodology and does not incorporate applied non-linear dynamic models of labour forecasting (eg: econometric models such as the general equilibrium model or other complex input-output models) which depend on harvesting rich national datasets. Also, the methodology derives estimates for demand and supply separately, when in reality demographic trends and participation rates are interdependent.

We apply the same method to the four occupational categories that have been analysed in some detail in the demand section of this report. This is because these four occupational categories absorb the majority share of high skilled ICT graduates from higher education.

First we will apply the method to computer professionals and associate professionals' (CPAP). Then we apply the method to electronic and telecommunications engineers and technicians (ETET).

Computer professionals and associate professionals (CPAP)

Assumptions: Demand side

A number of assumptions are made in order to calculate the demand for CPAPs over the period 2006 to 2015. These assumptions refer to key factors that impact on the size of the CPAP workforce in the future. The assumptions are based on historical trends:

1. the average annual growth of 0.4 per cent in the number of CPAPs over the period 1996 to 2005 will continue over the period 2006 to 2015. In reality the annual average increase may prove to be considerably higher. This is because the 0.4 per cent average over the decade covers the period when the dot.com bubble burst and where the ICT industry globally lost ground and shed labour;
2. the ratio of ICT managers to CPAPs calculated for 1996-2005 at about one-in-four will be maintained in the years to follow;
3. the ratio of CPAPs and ICT managers aged 60 years and older to the rest of the ICT workforce calculated for 1996-2005 will be maintained in the years to follow. In reality the ratio of workers aged 60 years and older will fluctuate, over time in relation to the overall computer population. Also, the racial composition of this group will contribute to the shape of demand for skills on the basis of equity;
4. CPAPs and ICT managers who turn 60 years old will retire. In reality, numbers of these workers may continue to work after official retirement as contractors. This may slightly lessen demand for certain skills;
5. the average annual growth of 14.9 per cent in the number of deaths among science, engineering and technology (SET) human resources over the period 1997 to 2002 will continue over the period 2006 to 2015;
6. the same ratio between ICT-trained persons emigrating and numbers of ICT-trained who were employed in 2001 in South Africa will remain constant. In reality this may not be the case. There is increasing global competition for skilled workers. The rate at which skilled South African ICT workers emigrate may increase.

Two scenarios: including and excluding ICT managers

Based on the above assumptions, we build two scenarios which provide a slightly different perspective on the demand – supply equation. That is we include the occupational category of ICT managers in our model. We do so for two reasons. First, because industry players claim there is a shortage of ICT managers, and secondly because we assume that ICT managers will be frequently sourced from the CPAP occupations. In other words we suggest that CPAP professionals will frequently be promoted to ICT management positions. There is a loss of CPAPS once they are appointed or promoted into management positions. In effect this represents a further source of demand on the CPAP workforce.

We expect that including ICT managers as a source of demand could significantly affect the outcome of this exercise. We therefore proceed as follows.

In Scenario 1, we compute the demand for CPAPs and include another source of demand which is ICT managers assuming that ICT managers are largely drawn from the ranks of CPAPs. We have therefore included this factor in our Scenario 1.

Scenario 1: Demand for CPAPs *and* ICT managers: Data was obtained from different sources in order to populate Table 42 based on the factors identified above:

i. The number of CPAPs employed was obtained from LFS data for the 2005 base year. In 2005 there were 49 688 CPAPs;
ii. CPAPs had an average annual growth of 0.4 percent over the period 1996 to 2005. This was applied as a percentage in the following years;
iii. The number of ICT managers from LFS data was calculated by selecting those that had studied an ICT related field of study and were employed as managers (in manufacturing or business services or computing services, or communication etc.). In 2005 there were 12 700 ICT managers. The ratio of 25.6 per cent ICT managers to CPAPs was applied over the following years;
iv. According to the 2005 LFS, 8.6 per cent of employed CPAPs were aged 60 years and older. It is assumed that this 8.6 per cent will retire every year;
v. A mortality figure was calculated by using mortality figures for SET workers, from Kahn et al. (2004). The average annual growth of 14.9 per cent in the mortality of SET human resources over the period 1997 to 2002 was calculated and applied over the period 2006 to 2015;
vi. A United Nations Development Programme case study on South Africa in 2001 (UNDP 2001b) indicated that around 3 000 ICT-skilled workers leave the country each year and this was around 3.35 per cent of the ICT-skilled workforce employed in 2001. We applied this ratio to the number of ICT workers employed each year to generate a projected emigration number.

We simply calculate the following:
CPAP+ ICT managers – retirement – mortality – emigration = annual demand[16]
Table 42 reflects the outcome of the above calculation for each year. The total requirement of new CPAP and managers by 2015 to cover losses due to retirement, mortality, emigration, and new demand, is estimated to be 93 452.

[16] CPAPs (0.4 per cent average annual growth) + ICT managers (25.6 per cent of CPAPs) – retirement (8.6 per cent of ICT workforce) – mortality (14.9 per cent average annual growth) - emigration (3.35 per cent of ICT workers) = annual demand.

Table 42: Projection of demand for computer professionals, computer associate professionals and ICT managers, 2005-2015								
Year	**CPACs**	**ICT managers**	**CPAPs plus managers**	**New Demand**	**Aged 60 and older (8.6% of ICT workforce)**	**Mortality (14.9% average annual growth**	**Demand arising from emigration**	**Total**
	n		**n**	**n**	**n**	**n**	**n**	**n**
Base year 2005	49688	12700	62388	n/a	n/a	n/a	n/a	n/a
2006	49877	12748	62625	237	5386	737	2098	8458
2007	50068	12797	62865	240	5406	847	2106	8599
2008	50259	12846	63105	240	5427	973	2114	8754
2009	50451	12895	63346	241	5448	1118	2122	8929
2010	50644	12944	63588	242	5469	1285	2130	9126
2011	50837	12994	63831	242	5489	1476	2138	9346
2012	51031	13043	64074	244	5510	1696	2146	9596
2013	51226	13093	64319	245	5531	1949	2155	9880
2014	51422	13143	64565	246	5553	2239	2163	10201
2015	51618	13193	64811	246	5574	2573	2171	10564
Total				**2423**	**54793**	**14892**	**21344**	**93452**

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)
Kahn, 2004 (data on mortality); UNDP, 2001b (data on emigration)

Scenario 2: We estimate demand for CPAPs *without reference to ICT managers* as a source of demand from the CPAP workforce. Consequently, we use the same assumptions as described in detail for Scenario 1 with one exception. We do not include factor (iii) in our calculations. Our formula is simply:

CPAPs – retirement – mortality – emigration = annual demand[17]

Table 43 reflects the outcome of the following calculation for a particular year. The total requirement of new CPAPs by 2015 to cover losses due to retirement, mortality, emigration, and new demand, is 74 103.

[17] CPAPs (0.4 per cent average annual growth) – retirement (8.6 per cent of CPAPs) – mortality (14.9 per cent average annual growth) – emigration (3.35 per cent of CPAPs) = annual demand

Table 43: Projection of demand for Computer Professionals and Associate Professionals, 2005-2015

Year	CPAPs	New demand	Aged 60 and older	Mortality	Demand arising from emigration	Total
	n	n	n		n	n
Base year 2005	49688	n/a	n/a	n/a	n/a	n/a
2006	49877	190	4289	571	1671	6721
2007	50068	190	4306	656	1677	6829
2008	50259	191	4322	754	1684	6951
2009	50451	192	4339	866	1690	7087
2010	50644	193	4355	995	1697	7240
2011	50837	193	4372	1143	1703	7411
2012	51031	194	4389	1314	1710	7607
2013	51226	195	4405	1509	1716	7825
2014	51422	196	4422	1734	1723	8075
2015	51618	196	4439	1993	1729	8357
Total		**1930**	**43638**	**11535**	**17000**	**74103**

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)
Kahn, 2004 (data on mortality); UNDP, 2001b (data on emigration)

Having built and applied a model to project demand, we now move on to develop a simple projection for supply of ICT skills from higher education institutions.

Supply side: Projecting graduate output between 2005 and 2015

By using the graduate production data from the higher education system (universities and universities of technology) as discussed above in this report it is possible to calculate a projected output figure for computer science and data processing graduates by 2015.

The first step in this simple procedure is to calculate the historical growth of graduate output from higher education in the earlier period 1996 to 2005. The growth in output of computer science and data processing graduates at higher education (HE) institutions over the period 1996 to 2005 was 11.9 per cent. This percentage is then used as a multiplier against the actual output of computer science and data processing graduates in 2005 (4 598). According to this method, the total number of computer science and data processing graduates from HE institutions, entering the labour market between 2006 and 2015, may be 89 729.

We do not simply take the total number of graduates on face value. Rather we give recognition to a major factor affecting the accuracy of supply-side calculations. That is: the number of graduates from a particular field do not necessarily practice professionally in that field. For this reason we cannot presume a simple direct relationship between graduate output and entrants into a particular professional field.

This is because, our study on demand showed that 26.4 per cent of those who obtained a high skill qualification in an ICT related field of study, do not work in an ICT field (Appendix D). This is an important factor that must impact on supply side calculations.

Not all persons who qualify in a field can be counted on to practice in that field once employed. Therefore, we deducted this percentage against the output for each year.

A similar principle must be applied to the ICT management occupational category. Persons who studied ICT and are managers may not necessarily be managers in an ICT environment. Therefore this group constitutes an additional – though slight – decrease in the total number of graduates entering the field and becoming eligible for positions as computer professionals and associate professionals. Based on the 2000-2005 labour market data, averaged over the period, 20 927 managers had studied in an ICT related field of study, and 18 845 worked as ICT managers. A certain proportion who trained in the ICT field did not become ICT managers (ie: 20 927 managers who had a higher education ICT training/qualification minus 18 845 who became ICT managers = 2082 who had a higher education ICT training/qualification but who worked as *non ICT managers*) This number, 2082 constituted 1.8 per cent of of all managers with an ICT related field of study who were employed (112 690). Therefore we subtract 1.8 per cent (managers qualified with ICT related qualifications, but work in other than ICT management) from ICT graduates, each year on the assumption that a similar proportion, though ICT trained/qualified will not work in ICT management, but other management.

By inserting these elements in the calculation of graduate output from higher education we are attempting, however simply, to take into account labour market and individual choice effects that impact on the balance between demand and supply.

Based on the factors discussed, the total number of CPAPs from HE institutions, entering the labour market between 2006 and 2015, is estimated to be 64 425 (Table 44).

Table 44: Projected graduate output between 2005 and 2015

Year	HE output: Computer Science and Data Processing	Average annual growth (1996 - 2005) %	Graduates who will not work in an ICT field (26.4%)	Graduates who will work as other managers (1.8 %)	Total: Other work	Graduates that will work in an ICT field
Baseline 2005	4598	11.9	1214	83	1297	
2006	5144	11.9	1358	93	1451	
2007	5755	11.9	1519	104	1623	
2008	6438	11.9	1700	116	1816	
2009	7203	11.9	1902	130	2031	
2010	8058	11.9	2127	145	2272	
2011	9015	11.9	2380	162	2542	
2012	10086	11.9	2663	182	2844	
2013	11284	11.9	2979	203	3182	
2014	12623	11.9	3332	227	3560	
2015	14123	11.9	3728	254	3983	
Total: 2006 to 2015	**89729**		**23688**	**1615**	**25304**	**64425**

Source: Authors' calculations based on HEMIS data over the period 1996 – 2005 (DoE, 1997-2006)

This calculation of supply has, some limitations. Firstly, graduates in other fields of study also form part of the supply of ICT workers thereby lowering the total potential demand. Without an empirical base from which to estimate the size of this group, we merely note this factor.

Secondly, internationalization is an increasing trend in higher education and in 2000 and 2004, international students represented eight per cent and seven per cent respectively of the total enrolment at South African higher education institutions (Sehoole 2006). It is not known what percentage of foreign students enroll for ICT related fields of study and return to their home country to practice. Counting this group in the total graduates inflates the real number likely to practice in South Africa. Taking this group into account would force us to revise our graduate output estimates downwards.

Thirdly, a small percentage of people who obtain qualifications from private ICT training institutions that are equivalent to higher education study at NQF 5 & 6 are not included in the calculations because we do not have access to robust enough data on this phenomenon.

The above factors could not be taken into account in our model.

Supply and demand: computer professionals and associate professionals

We proceed to a comparison between the demand and supply according to the calculations made above.

In Table 45 the higher education computer science and data processing graduate supply is compared to the demand for CPAPs and ICT managers arising from new demand over the period 2005 to 2015.

If *ICT managers* are included (Scenario 1), a shortage of 29 027 CPAPs by 2015 is predicted by the model, assuming no changes to the assumptions.

If ICT managers are *excluded (Scenario 2)*, a shortage of 9 679 CPAPs is predicted by the model for 2015, assuming no changes in the assumptions

Table 45: Output of new graduates needed to address demand for CPAPs, 2005-2015

	Scenario 1 (including manager demand)	**Year**	**N**
A	ICT workers including managers[1]	2005	62388
B	ICT workers including managers[2]	2015	64811
C (B-A)	Growth in demand for ICT workers		2423
D	Demand arising from death and retirement[3]		69685
E	Demand arising from emigration[4]		21344
F (C+D+E)	Total number of positions that need filling		93452
	Total number of new graduates[5]		64425
	Shortage		**29027**
	Scenario 2 (only CPAP demand)	**Year**	**N**
A	ICT workers (excluding managers)[6]	2005	49688
B	ICT workers (excluding managers)[7]	2015	51618
C (B-A)	Growth in demand for ICT workers		1930
D	Demand arising from death and retirement[8]		55174
E	Demand arising from emigration[9]		16999
F (C+D+E)	Total number of positions that need filling		74103
	Total number of new graduates[10]		64425
	Shortage		**9679**

Source: [1]drawn from Table 21, [2]drawn from Table 21, [3]drawn from Table 21, [4]drawn from Table 21, [5]drawn from Table 23; and [6]drawn from Table 22, [7]drawn from Table 22, [8]from Table 22, [9]from Table 22, [10]from Table 23

We now proceed to apply the same approach above to calculating the demand and supply of electronic and telecommunication engineers and technicians (ETET) in the ICT industry.

Projection of future demand for electronic and telecommunication engineers and technicians (ETET) in the ICT industry.

Demand side Assumptions

A number of assumptions were made in order to calculate the demand for electronic and telecommunication engineers and technicians (ETET) over the period 2005 to 2015. These assumptions which refer to key factors that impact on the size of the ETET workforce are:

1. the average annual growth of 4.6 per cent in the number of ETETs over the period 1996 to 2005 will continue over the period 2006 to 2015;
2. the ratio of 35 per cent of electronic and telecommunication engineers who worked in the ICT environment to those who worked in other industries in 2003 (Interview 2003) will remain the same for the following years;
3. the ratio of electronic and telecommunication managers to ETETs calculated for 1996-2005 will be maintained in the years to follow;
4. the ratio of ETETs plus managers aged 60 years and older to the rest of the ICT workforce calculated for 2000-2005 will be maintained in the years to follow;
5. ETETs and managers who turn 60 years old will retire;
6. The ratio of electronic and telecommunication engineers to science, engineering and technology (SET) human resources for 2005 will stay the same over the years to follow;
7. the average annual growth of 14.9 per cent in the number of deaths among science, engineering and technology (SET) human resources over the period 1997 to 2002 will continue over the period 2006 to 2015;
8. the average annual growth of 8.3 per cent in the number of SET human resources that emigrated over the period 1997 to 2002, will stay the same over the period 2003 to 2015.

Based on the above assumptions, we have built two scenarios. In Scenario 1, we compute the demand for ETETs, including the additional source of demand from electronic engineering managers. Scenario 2 does not factor in the additional demand of electronics and telecommunication engineering managers.

Two scenarios: including and excluding ETET managers

Scenario 1: Demand for ETETs *and* electronic and telecommunication engineering managers: Data was obtained from different sources in order to populate Table 46 based on the factors identified above:

i. The number of ETETs employed was obtained from LFS data for the 2005 base year. In 2005 there were 20 914 ETETs in the ICT industry (that is 35 per cent of all 59 754 ETETs in the labour market);

ii. ETETs had an average annual growth of 4.6 percent over the period 1996 to 2005. This was applied as a percentage in the following years;

iii. The number of electronic and telecommunication managers were obtained from LFS data. According to HE supply data from 1996 to 2005 (HEMIS), 31.7 per cent of all engineering students studied electrical engineering and 35 per cent of electrical engineers studies in an ICT related field. The number of electronic and telecommunication managers was thus calculated by obtaining 31.7 per cent of technical managers who have studied engineering and 35 per cent of these who were part of the ICT industry. In 2005 there were 1624 electronic and telecommunication managers. The ratio of 7.8 electronic and telecommunication managers to ETETs in 2005 was maintained over the following years;

iv. According to the 2000 to 2005 LFS data, one per cent of employed ETETs were aged 60 years and older. It is assumed that this one per cent will retire every year;

v. A mortality figure was calculated by using mortality figures for SET workers over the period 1997 to 2002 from Kahn et al. (2004). The ratio of 6.2 per cent electrical engineers to SET workers was calculated according to the ratio of electrical engineering graduates to SET graduates in 2005. The ratio of 35 per cent ICT engineers to electrical engineers was calculated for the given SET mortality figures. An average annual growth of 14.9 per cent in the mortality of SET human resources over the period 1997 to 2002 was calculated and applied over the period 2006 to 2015;

vi. Demand arising from emigration was calculated by using emigration figures for SET workers over the period 1997 to 2002 from Kahn et al. (2004). The average annual growth of 8.3 per cent in emigration figures over the period 1997 to 2002 was applied over the period 2006 to 2015.

We calculated the following:

ETETs+ ETET managers – retirement – mortality – emigration = annual demand[18]

Table 46 reflects the outcome of the above calculation for each year. The total requirement of new ETETs and managers by 2015 to cover losses due to retirement, mortality, emigration, and new demand, is estimated to be 38 130.

[18] EEPAPs (4.6 per cent average annual growth) + EEPAP managers (31.7 per cent of engineering graduates and 35 per cent of electrical engineering graduates) – retirement (one per cent of EEPAPs) – mortality (14.9 per cent average annual growth) - emigration (8.3 per cent of EEPAPs) = annual demand.

Table 46: Projection of demand for electronic and telecommuniations engineers and technicians and managers, 2005-2015

Year	ETETs	ETET Managers	ETETs plus managers	New Demand	Aged 60 and older	Mortality	Demand arising from emigration	Total
	n	n	n	n	n	n	n	n
Base year 2005	20914	1624	22538	n/a	n/a	n/a	n/a	n/a
2006	21876	1699	23575	1037	236	928	250	2450
2007	22882	1777	24659	1084	247	1066	271	2668
2008	23935	1859	25794	1134	258	1225	294	2910
2009	25036	1944	26980	1187	270	1407	318	3181
2010	26188	2034	28221	1241	282	1617	344	3484
2011	27392	2127	29519	1298	295	1858	373	3824
2012	28652	2225	30877	1358	309	2134	404	4205
2013	29970	2327	32298	1420	323	2452	438	4633
2014	31349	2434	33783	1486	338	2818	474	5115
2015	32791	2546	35337	1554	353	3238	513	5658
Total				**12799**	**2910**	**18741**	**3679**	**38130**

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)
Kahn, 2004 (data on mortality and emigration)

Scenario 2: We estimate demand for ETETs without reference to electronic and telecommunication managers as a source of demand from the ETET workforce.

Consequently, we use the same assumptions as described in detail for Scenario 1 with one exception. We do not include factor (iii) in our calculations. Our formula is:

ETETs – retirement – mortality – emigration = annual demand[19]

Table 47 reflects the outcome of the following calculation for a particular year. The total requirement of new ETETs by 2015 to cover losses due to retirement, mortality, emigration, and new demand, is 36 998.

[19] EEPAPs (4.6 per cent average annual growth) – retirement (one per cent of EEPAPs) – mortality (14.9 per cent average annual growth) - emigration (8.3 per cent of EEPAPs) = annual demand.

Table 47: Projection of demand for electronic and telecommuniations engineers and technicians 2005-2015

Year	ETETs	New Demand	Aged 60 and older	Mortality	Demand arising from emigration	Total
	n	n	n	n	n	n
Base year 2005	20914	n/a	n/a	n/a	n/a	n/a
2006	21876	962	219	928	250	2359
2007	22882	1006	229	1066	271	2572
2008	23935	1053	239	1225	294	2810
2009	25036	1101	250	1407	318	3076
2010	26188	1152	262	1617	344	3375
2011	27392	1205	274	1858	373	3709
2012	28652	1260	287	2134	404	4085
2013	29970	1318	300	2452	438	4508
2014	31349	1379	313	2818	474	4984
2015	32791	1442	328	3238	513	5521
Total		**11877**	**2701**	**18741**	**3679**	**36998**

Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)
Kahn, 2004 (data on mortality and emigration)

Having built and applied a model to project demand, we now move on to develop a simple projection for supply of ETETs skills from higher education institutions.

Supply side: Projecting graduate output between 2005 and 2015

By using the graduate production data from the higher education system (universities and universities of technology) as discussed above in this report it is possible to calculate a projected output figure for electronic engineers and technology graduates by 2015.

The first step in this procedure was to calculate the historical growth of graduate output from higher education in the earlier period 1996 to 2005. The growth in output of electronic engineering and technology graduates at higher education (HE) institutions over the period 1996 to 2005 was 3.8 per cent. This percentage was then used as a multiplier against the actual output of electrical engineering and technology graduates in 2005 (2 156). According to this method, the total number of electronic engineering and technology graduates from HE institutions, entering the labour market between 2006 and 2015, may be 26 607. However, only 35 per cent of electrical engineering and technology graduates will work in the ICT field (Interview 2003). This percentage was then used to calculate the actual output of electronic engineering and technology graduates into the ICT industry. On this basis we calculate that the number of electronic engineers and technology graduates from HE institutions, entering the *ICT labour market* between 2006 and 2015, may be 9 312 (Table 48).

Table 48: Projected Electronic Engineering and Technology graduate output between 2005 and 2015			
Year	**HE output: Electronic Engineering and Technology**	**Average annual growth (1996 - 2005)**	**Around 35 % of Electrical Engineering graduates will go into ICT**
	n	**%**	**n**
Baseline 2005	2156	n/a	n/a
2006	2238	3.8	783
2007	2323	3.8	813
2008	2411	3.8	844
2009	2502	3.8	876
2010	2597	3.8	909
2011	2695	3.8	943
2012	2797	3.8	979
2013	2903	3.8	1016
2014	3013	3.8	1055
2015	3127	3.8	1095
Total: 2006 to 2015	**26607**	**3.8**	**9312**

Source: Authors' calculations based on HEMIS data over the period 1996 – 2005 (DoE, 1997-2006)

This calculation of supply has limitations as noted above in the discussion of CPAPs above.

Supply and demand: Electronic and telecommunications engineers and technicians

We proceed to our comparison between demand and supply.

In Table 49 the higher education electronic engineering and technology graduate supply is compared to the demand for ETETs and managers arising from new demand over the period 2005 to 2015.

If *ETET managers* are included (Scenario 1), a shortage of 28 817 ETETs is predicted by the model by 2015 assuming that conditions remain the same.

If ETET managers are *excluded (Scenario 2)*, a shortage of 27 685 ETETs is predicted by the model by 2015 assuming conditions remain the same.

Table 49: Output of new graduates needed to address demand for ETETs, 2005-2015

	Scenario 1	Year	N
A	ETETs including managers[1]	2005	22538
B	ETETs including managers[2]	2015	35337
C (B-A)	Growth in demand for ETETs workers		12799
D	Demand arising from death and retirement[3]		21651
E	Demand arising from emigration[4]		3679
F (C+D+E)	Total number of positions that need filling		38130
	Total number of new graduates[5]		9312
	Shortage		**28817**
	Scenario 2	**Year**	**N**
A	ETETs (excluding managers)[6]	2005	20914
B	ETETs (excluding managers)[7]	2015	32791
C (B-A)	Growth in demand for ETETs workers		11877
D	Demand arising from death and retirement[8]		21442
E	Demand arising from emigration[9]		3679
F (C+D+E)	Total number of positions that need filling		36998
	Total number of new graduates[10]		9312
	Shortage		**27685**

Source: [1]drawn from Table x, [2]drawn from Table x, [3]drawn from Table x, [4]drawn from Table x, [5]drawn from Table x2; and [6]drawn from Table x3, [7]drawn from Table x3, [8]from Table x3, [9]from Table x3, [10]from Table x2

Conclusion: The projections

The projections suggest that by 2015 there will be a shortage of:

- 29 027 graduates qualified for employment as a computer professional or computer associate professionals. This number takes into account the demand arising from the ICT manager occupation OR
- 9679 graduates qualified for employment as a computer professional or computer associate professionals.
- 28817 graduates qualified for employment as electronic and telecommunications engineers or technicians. This number takes into account the demand arising from the electronic and telecommunication engineering manager occupation OR
- 27685 graduates qualified for employment as a electronic and telecommunications engineers or technicians.

The method applied above covers a decade, which is not as wide an expanse of time as addressed by Kibuuka and van Aardt (1999) of more than 25 years. Nevertheless, in a relatively unstable market environment and in a sector which tends to respond sharply to technological innovations and to financial market trends, even a shorter 'error term' of ten years will impact on reliability. Finally, the model applied is based heavily on the extrapolation of past trends that may change as conditions change.

Notwithstanding the caveats, these projections contribute to a picture which must admit to the likelihood of growth in the future demand in the two fields of computer science and electronic and telecommunications technology at both professional and associate professional/technician levels.

The most important element to bear in mind is that the labour market environment is highly complex and there is no simple and direct interaction between supply and demand. We acknowledge that each method is used to obtain a sense of how the labour market is behaving is limited and should be considered in the light of other data and interpretations.

Would evidence from another perspective back up the projections? One such source of corroborative evidence lies in the analysis of remuneration of computer professionals and computer associate professionals.

Remuneration and occupational demand

Dramatic growth in employment in a particular occupation over time is likely to reflect a significant rise in demand for candidates in the labour market with the requisite skills. Likewise, rapidly rising relative remuneration in a particular occupation may imply that the demand for workers exceeds the supply (Veneri 1999). When demand exceeds supply in a particular occupation, compensation tends to rise relative to compensation in other occupations that require similar education, effort, and conditions (United States National Research Council 2002).

Remuneration is one important incentive to attract and retain workers, in a competitive labour market for specific skills. Remuneration trends can give an indication of changing demand for specific skills relative to supply. Growth in the remuneration of Computer Professionals and Associate Professionals (CPAP) compared to growth in the remuneration of all professionals and associate professionals in the economy can be an indication of demand exceeding supply for ICT professional skills.

Remuneration data can fluctuate widely from one year to another which makes it difficult to determine a trend over a period of time. Therefore remuneration of professionals and associate professionals was calculated by averaging over two year intervals.

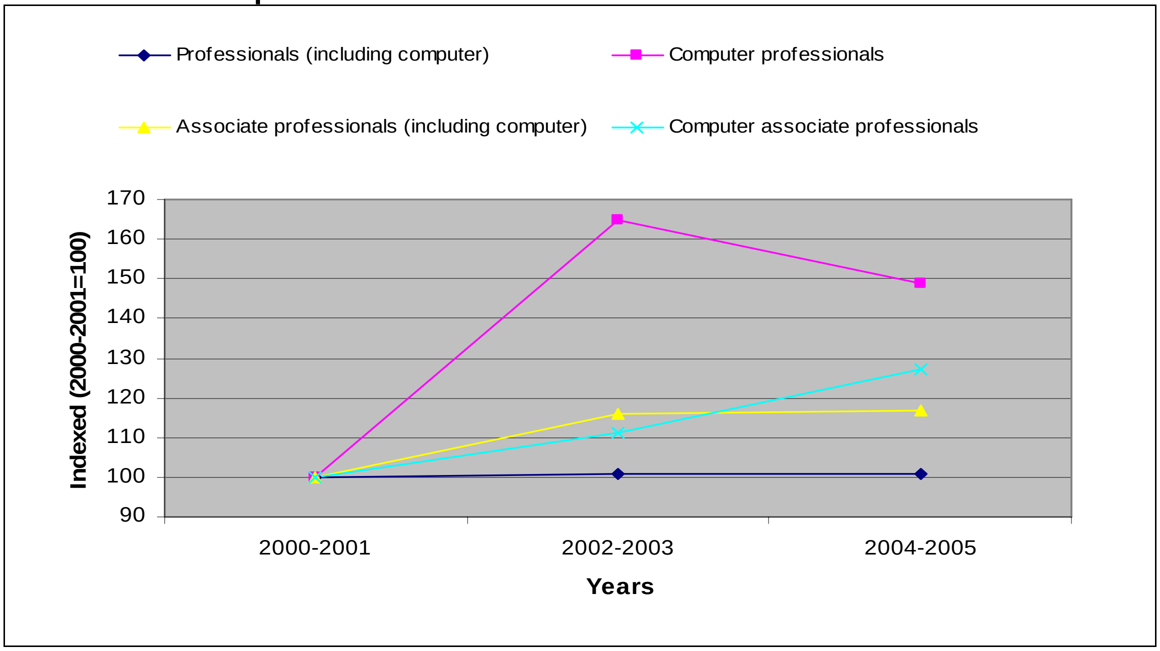
There has been a growth in the remuneration of all professionals and associate professionals over the period 2000 to 2005, as shown in Figure 30. Importantly, the remuneration of CPAPs increased faster than the remuneration of all professionals and all associate professionals.

The remuneration of all professionals grew at 0.9 per cent per annum; while the remuneration of *computer* professionals grew at a rate of 7.4 per cent per annum over the period 2000 to 2005.

The remuneration of all associate professionals grew at 2.9 per cent, while the remuneration of *computer* associate professionals grew 10.8 per cent per annum over the same period.

This is a strong indication of increasing scarcity/demand for CPAP relative to demand for other professionals. We may hypothesise that increasing information intensity in business processes and buoyant economic growth in the period 2000 to 2005 drove the demand for computer science and data processing qualifications.

Figure 30: A comparison of changes in remuneration between all professionals and all associate professionals and CPAPs 2000 to 2005



Source: Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

The remuneration evidence accumulated so far suggests that there has in the recent past been a shortage of computer professionals and associate professionals. But these are very broad categories. Could other forms of data also corroborate the above analysis and add value through more specific identification of occupations where such shortages may be manifested? The next section makes use of available survey and interview data to address these questions.

Study of vacancies advertised in ICT occupations

Research indicates that employment data such as counts of vacancies per occupational category can be evaluated to assess the existence of, or the potential for, a skills shortage (Lopez-Bassols 2002). Such information is not available from the LFS or the OHS. Research must be conducted to elicit vacancy information from employers, labour brokers or other service businesses in the recruitment field. An alternative approach is to monitor the media which carry job advertisements.

The vacancy data on ICT professionals that is reported on below was drawn from a national weekly Sunday newspaper (Sunday Times) over three years between April 2004 and March 2007. The key information about each job advertised was coded occupationally and entered into a database created by the Department of Labour (named the 'Job Opportunity Index database) which was then analysed by the HSRC (Erasmus 2007). This data gathering was undertaken in order to generate a sense of skills shortages across the economy and was not specifically focused on the ICT sector.

Before undertaking the analysis, some reservations about the data must be recorded. Employers advertise vacant posts in different media (eg: the ICT industry advertises vacant posts quite extensively through the internet) so the data recorded does not provide a full picture of all advertising. The data also does not account for other channels of recruitment such as head hunting. Therefore, this information will not necessarily reflect the full extent of vacancies in the ICT sector.

Vacancy data analysis

From vacancy data captured across the period, 2 499 vacancies were classified as belonging to the sub-major occupational group '26: ICT (Information and Communication Technology) Professionals' using the South African Department of Labour's Organising Framework for Occupations (OFO) classification system.

Based on this information, in South Africa, vacancies for ICT Professionals accounted for 4.4 per cent of all vacancies for professionals over the three years under review (Table 50). In this period, we calculated that 5.1 per cent of all professionals are ICT professionals. A situation where computer professional's share of employment (5.1 per cent) is higher than computer professional's share of vacancies (4.4 per cent) suggests that on aggregate there is not a shortage of these professionals.

Table 50: Share of vacancies for ICT Professionals by OFO Occupational Group , and by year in percentages

OFO Occupational Group	Share of vacancies			
	04/05	**05/06**	**06/07**	**3 year average**
ICT Professional vacancies as a share of total vacancies recorded[1]	3.69	4.74	4.53	4.4
% share within ICT professinoals	**04/05**	**05/06**	**06/07**	**3 year average**
261 Business and Systems Analysts and Programmers	57.4	60.2	64.8	61.5
262 Database and Systems Administrators, and ICT Security Specialists	16.1	14.5	15.5	15.3
263 ICT Network and Support Professionals	26.5	25.2	19.7	23.2
	100.0	100.0	100.0	100.0

[1] The 'total' number of advertised job vacancies relates to the total number appearing in the OFO recoded database, rather the total number of advertisements placed every year in the Sunday Times.

However, it is quite possible that aggregate numbers can hide the existence of shortages. This requires disaggregation of the broad ICT professionals group of occupations into particular occupational categories. This procedure reveals quite wide differences in vacancy rates between the following occupations.

Computer associate professionals: The vacancy survey suggests that vacancies for computer associate professionals constitute 9.7 per cent of all vacancies in the broad category of associate professionals. According to current employment data, only 1.2 per cent of all associate professionals are computer associate professionals. The vacancy rate (share of vacancies) for computer associate professionals is much higher than their share of current employment among associate professionals. This data suggests that a significant shortage of computer associate professionals was apparent in the period of the vacancy survey.

ICT managers: According to data from the vacancy survey, there does not seem to be a high demand for ICT managers. While 14.3 per cent of all persons employed as managers are categorized as ICT managers, Only 1.2 per cent of all managerial vacancies was for ICT management vacancies. The data suggests that vacancies for ICT managers are very low in relation to the population of ICT managers. This finding appears counter-intuitive, because anecdotal evidence from industry suggests the opposite.

We now return to ICT professionals in order to disaggregate this category according to specific occupations.

ICT Professionals: Over a three year period, the largest share of ICT professional job vacancy adverts were placed in search of Business and Systems Analysts and Programmers (61.5 per cent), followed by vacancies for ICT Network and Support Professionals (23.2 per cent). Database and Systems Administrators, and ICT Security Specialists accounted for 15.3 per cent of all ICT Professional vacancies (Table 50).

Table 51 shows the number of advertised vacancies and percentage change for each minor group of ICT Professionals across the three year period. In year three, the vacancies recorded was 98.7 per cent more than the number of vacancies recorded in year one.

The business and systems analysts and programmers group recorded the largest per increase over the three years followed by the Database and Systems Administrators, and ICT Security Specialists. There was a strong indication that this upward trend may continue (i.e. an r-squared value near/above the 95 per cent confidence level).

The number of advertised vacancies for Network and Support Professionals increased by 72.5 per cent from Year 1 to Year 2, but slowed very quickly in Year 3. This suggests that demand for this group has tapered off (r^2 value of <0.5). Nevertheless, 47.8 per cent more vacancies were advertised for Network and support Professionals in Year 3 than in Year 1.

Table 51: Total job vacancies for ICT Professionals (OFO Occupational Group), by year and minor group

Occupations	% change			Trend line	
	Year 1-Year 2	Year 2-Year 3	Year 1-Year 3 2004 - 2006	shape	r^2-value
26 ICT Professionals	81.0	9.8	98.7	↗↗	0.8792
261 Business and Systems Analysts and Programmers	90.0	18.1	124.4	↗↗	0.9378
262 Database and Systems Administrators, and Security Specialists	63.1	16.8	90.5	↗↗	0.9506
263 ICT Network and Support Professionals	72.5	-14.3	47.8	↗→	0.4212

This kind of analysis is potentially valuable because it gives some indication of the occupational groups in which there appears to be more pressure from employers to hire workers.

The fluctuations in demand from year to year –as recorded by vacancies – are as important to take note of as the proportionate shifts recorded in demand for different occupational groups. This suggests that the ICT work environment is relatively volatile and that trends can quite quickly shift direction.

Survey of employers who advertised vacancies for ICT professionals

Based on the vacancy data discussed above, a survey of the employers that posted vacancies was conducted between July and September 2007. The number of interviews conducted with employers of ICT professionals was proportionate to the number of ICT professional vacancies advertised.

A total of 33 employers were interviewed in connection with 121 vacancies across the ICT minor occupational groups (Table 52). Of these vacancies, 100 (82.6 per cent) were reportedly filled.

It is important to observe here that the fill-rate obtained in this sample is quite high, averaging 83 per cent for all ICT minor professions. Nevertheless, this figure would need to be 100 per cent to rule out evidence of a skills shortage. At the same time we must recognize that even in an occupational labour market with a surplus of skills the fill rate on a first round of interviews will not always be 100 per cent.

Further insight into the state of the labour market for ICT professionals is provided from the data on applicants. Clearly, the quality of the short-listed applicants is affected by the general suitability of all applicants. In this respect, relatively low proportions of the total numbers of applicants were considered suitable by the employers. This can be an indication of the general low suitability of candidates in the labour market and at the same time it can simply be a measure of the levels of desperation of unemployed people who may apply for posts outside of there are of expertise.

Table 52: Survey results for ICT professional vacancies by OFO occupational group

Occupation	Vacancies			Applicants		
	Vacancies	Filled	Fill Rate %	Appli-cants	Suitable applicants	% suitable
26 ICT Professionals	121	100	82.6	2220	263	11.9
261 Business and Systems Analysts and Programmers	105	85	81	1371	195	14.2
262 Database and Systems Administrators, and ICT Security Specialists	8	7	87.5	689	32	4.6
263 ICT Network and Support Professionals	8	8	100	160	36	45.8

Although we have some idea of the success rate of filling posts, there are other relevant questions for future consideration. How long did it take to fill vacancies? Which jobs were subject to higher turnover of incumbents? How did employer initiated career pathing and promotions influenced the appearance of vacancies? This would have required a time consuming and expensive follow-up with all employers.

Vacancies – Summary

To conclude – the dataset did not have enough depth to make detailed claims regarding skills shortages with sufficient confidence at the minor occupational level. What the analysis suggests is that vacancies in the sector fluctuate quite sharply over short periods of time. This means that data about existing shortages is quickly outdated. How such data could inform training interventions before being overtaken by events must be carefully considered. In addition, the cost-benefit of obtaining such data depends on the use to which it is put.

Noting these reservations, the most prominent features of the data from the period 2005-2007 suggests that:

- vacancies among ICT professionals are likely to continue rising
- there was a relative shortage of ICT associate professionals that may still be evident. We should bear in mind that ICT associate professionals work in a large variety of ICT environments and many hold qualifications suited to specific ICT

operating and software environments. A more precise specification of skills would be necessary to initiate training interventions to particular types of shortage.

- the most prominent demand among specific occupational categories was for business and systems analysts and programmers. However, the systems development functions that ‘systems analysts’ and ‘programmers’ perform are quite different. Certainly ‘programmers’ is a very wide category that covers different skills levels and domains of software expertise. The data source does not allow separation of these occupational types.
- The data suggests that within the ICT professions, vacancies in certain occupations are harder to fill, and the quality of the pool of candidates and the selection options is weaker than employers might desire. The latter observation is sobering. It reflects the existence of sizeable populations of workseekers who – as employers see it - do not possess the requisite qualifications to begin to compete.

Conclusion: The question of supply and demand

We have remuneration data that points to a shortage of computer professionals and associate professionals in the labour market between 2000 and 2005. We have a projection that points to a shortfall in graduate production from higher education between 2005 and 2015 in the study fields of Computer Science and Electrical Engineering and Technology. Both studies point towards a general trend of relative skills scarcity in computing occupations – as long as current conditions persist unchanged.

In the first instance, the information is useful in drawing attention to occupational categories (such as computer professionals and associate professionals) where demand recently exceeded supply. In the second instance the information is also valuable because it points out that graduate production in study fields that traditionally serve these occupations may not meet projected needs in the next decade.

However, neither of the above forms of evidence provide disaggregated information that takes account of the variegated nature of ICT skilling at the professional (high skills) and associate professional (intermediate skills) levels. Put differently, it is necessary to obtain more detailed information that should inform specific planning of appropriate interventions to resolve the shortages observed.

Although available information from a recent HSRC study begins to provide some direction with respect to which particular occupations are affected by vacancies, and which kinds of skills are needed, it does not go far enough. This is largely because the data obtained is not sufficiently focused to realise sufficient detail at the level of individual occupations. A targeted study with a larger sample may be worthwhile, but the cost-benefits of such a study – and who this study might benefit most - should be carefully considered.

CHAPTER 12: IMPLICATIONS FOR ICT SECTOR DEVELOPMENT AND SKILLS NEEDS

ICT sector, job creation and job destruction

The question of skills shortages – in terms of scarce or critical skills – is part of a broader question which is to ask: what are the broad trends in ICT sector activity that are likely to be labour replacing or labour shedding? It is appropriate to first examine the macro level trends between the ICT sub-sectors before considering fluctuation in occupational demand for skilled workers.

Historical performance of the three sectors reveals the following. The ICT Manufacturing sub-sector produces a minor share of ICT sector GDP with a low growth trajectory. Its employment share is three times larger than its GDP share. This means that its GDP per worker ratio is not as favourable as the other two sectors. Employment is in slow decline.

Summary of ICT sub-sector growth and employment trajectories				
	GDP		Employment	
ICT sub- sector	Share in %	Growth	Share in %	Growth
ICT Manufacturing	Small	Low	Moderate	Low negative
Communication	Large	Strong	Moderate	Strong negative
ICT Services	Large	Medium	Moderate	Positive

The Communication sub-sector produces a large share of ICT sector GDP with a strong growth path. It has a moderate labour market size but suffered significant job losses. These characteristics appear to be consistent with job-shedding capital intensive technology sector development.

The ICT Services sub-sector generates a large share of GDP with good growth though lower than communication. It sustained the fastest growing share of employment through the period 1996-2005.

Turning now to employment patterns in economic activities below the sub-sector level, which was based on LFS and OHS data, we have observed that telecommunications, suffered a declining share of ICT employment. This sub-sector is not disaggregated.

In the IT services sub-sector which increased its share of employment the industry sub-group 'software consultancy and supply' was a strong employer (46 per cent). This is consistent with the importance of software to business processes in the widest possible array of organisational environments. When industry sub-groups such as 'hardware consultancy', 'wholesale trade in equipment', 'maintenance and repair services and equipment rental' are grouped together as businesses active in servicing general hardware and network needs, their combined share of total employment (35.9 per cent) begins to approach the magnitude the software consultancy sub-group. One would have expected the former to grow faster in this recovery period after 2000.

The smallest sub-sector, manufacturing, enterprises in the manufacture of 'computing machinery' and of 'insulated wire and cable' together employed four in every ten ICT manufacturing workers. Big employment increases were reflected among enterprises producing insulated wire and cable. The third biggest group, 'electronics', showed a substantial decline in employment, whereas enterprises engaged in manufacture of 'medical and other instrumentation and appliances' increased their employment share by the same magnitude.

Based on this analysis of the period 1996 to 2005, the ICT sector as a whole is unlikely to absorb labour. The manufacturing and telecommunications sectors will in all likelihood continue to shed labour. They exhibit signs of skill biased technology change.

Growth and employment prospects seem most likely to be achieved in the ICT services sub-sector. However, much will depend on the specificity of the sub-activity concerned because the skill intensity and combination of skills required of services sector activities can vary quite considerably.

In terms of skills, the data shows that between the two periods, the proportions of low-skill workers declined in all sub-sectors, but especially in telecommunications. Although the evidence points to a general increase in skill levels, there were different patterns in each of the three sub-sectors.

In ICT manufacturing, there was no increase in the proportion of high skill workers. The shift transpired between the low and intermediate skill levels in favour of higher proportions of workers with intermediate skills. In IT services the increase in skill levels was apparent in a decrease in low skills together with an increase in high skills proportions, while the proportion of intermediate skills was virtually unchanged. In the telecommunications sub-sector a sharp decrease in low skills workers occurred simultaneously with increased shares among both intermediate and high skill workers.

Skills biased technology change

In the period of study, the pattern of employment by skills level in the ICT sector has shifted away from low skills towards high skills. This presents the opportunity to ask whether general theory of skills biased technology change (SBTC) is applicable to the ICT sector, or at very least for the telecommunications and services sector?

SBTC holds that in the general labour market, there is a tendency for technology driven change to generate relatively stronger demand for higher than for lower skills. The theory of SBTC seems to explain why in developed countries and in some developing countries, under the influence of technology, the requirement for high skills increases faster than demand for lower skills. This may be reflected in for example employers employing computing professionals rather than administrative workers. The example is chosen to suggest that technology innovations can displace the need for physical administrative labour through recourse to digital means. More broadly, proponents of SBTC argue that the increased informationisation of the workplace itself creates a demand for more workers other than computing professionals such as business strategists and statisticians who are adept at managing and interpreting information to generate enterprise competitive advantage. (Bresnahan and Greenstein, 1999; Bresnahan, Brynjolfsson and Hitt, 2002; Forth, Mason & O'Mahoney, 2002,12). The SBTC research and theoretical base may contribute some value in understanding ongoing skills shifts in the South African ICT industry sub-sectors.

Occupational level analysis

Identifying ICT occupations is not a simple matter, as the nature of work and the shape of organizations evolve in the presence of technology and market forces. This study focused on four occupational categories which can be viewed as the core occupations associated with the broader ICT sector. Cumulatively this group constitute about two thirds of total ICT workforce employment.

Employment of ICT related professionals and associate professionals, 1996 to 2005						
ICT occupations	Average employed per annum					
	1996-1999	%	2000-2005	%	1996-2005	%
Computer professionals	27651	21.8	29833	19.3	28960	20.2
Computer associate professionals	27652	21.8	32154	20.8	30353	21.1
Electronics & telecommunication engineers	3074	2.4	2386	1.5	2661	1.9
Electronics & telecommunication engineering technicians	27441	21.6	45408	29.3	38221	26.6
Other	41061	32.3	45161	29.2	43521	30.3
Total	126880	100	154941	100	143716	100

The distribution of ICT professionals by sector, by spatial location and by private-public sector is also relevant to the likelihood of skills shortages.

These occupational groups may be employed across any economic sector. However, to take computer professionals for example: the biggest employers of computer professionals in the 2004-2005 period were Finance (74.3 per cent) and Manufacturing (11.8 per cent). A similar proportion was evident in the sectoral employment of computer associate professionals where the biggest sectoral employers were Finance (70.6%) and Manufacturing (12.7 per cent). As the largest sectoral employers of ICT computer professionals and associate professionals, it would be important to investigate sectoral determinants of future employment growth.

The spatial dimension is crucial. Looking at provincial distribution is immediately apparent that practically nine in every ten computer professionals is located in one of three provinces: Gauteng (55.2 per cent), Western Cape (23.0 per cent) and KwaZulu-Natal (10.7 per cent). In each of the other six provinces the share of computer professionals is below 2 per cent. The future analysis of skills shortages would be enhanced if location – rural and urban, and metropolitan - were taken into account.

Supply of high skill ICT workers

Ordinary schools, especially high schools and FET Colleges so far have played a relatively small part in the development of cohorts of high skill ICT graduates. The private sector plays a major role in skilling of ICT workers, especially in proprietory software environments. Much of the training opportunities are vendor driven, modular and generally have a low theory component. The overwhelming majority of such training opportunities offering certification are based on global vendor defined skills levels. As such there is minimal alignment with national qualification systems. This said, it is estimated that a very small percentage – in the single digits – of vendor courseware is equivalent to higher education qualifications.

The table below provides a picture of the average share of graduate output from key ICT cognate fields of study between 1996 and 2005 as well as average annual growth rate in graduate output for the same period. Clearly, the largest contributors are

‘Computer Science and data Processing’ and ‘Electrical Engineering’ though in the latter case we must note that only a proportion of such graduates would work in ICT related occupations. It is noteworthy that two fields with relative low graduate outputs, namely ‘Computer Engineering and Technology’ and ‘Business Data Systems’ share high average annual growth rates along with Computer Science.

ICT related fields of study in higher education	**Average share**	**Average annual growth (1996-2005)**
Administrative & Office Services	7.3	7
Business Data Systems	2.1	12.6
Computer Science & Data Processing	47.4	11.9
Computer Engineering & Technology	1	14.3
Electrical Engineering	21.8	3.8
Graphic Arts & Technology	1.3	0.4
Other	19	7.3
Total	100	

We must take the analysis further to consider which fields of specialization within ‘Computer Science and Data Processing’ generate the most graduates. In 2005, four fields generated nearly 66 per cent of all graduates: Information & Data Base Systems (36.0 per cent), Applications in Computer Sc & Data Processing (21.0 per cent), and Programming Languages (8.8 per cent). The fields in which graduates specialize in and the unevenness of graduate share must also be taken into account in considering the match between demand and supply.

Share of graduate production among fields of specialisation within the computer science and data processing field of study, 1999 and 2005

	1999 %	**2005 %**
Computer Hardware Systems	1.8	3.9
Programming Systems	3.5	6.4
Computer Ops & Operations Control	6	9.2
Information & Data Base Systems	25.8	36
Applications in Computer Sc & Data Processing	25.2	21
Education, Societal & Cultural Considerations	1.9	1.5
Programming Languages	12.7	8.8
Other Computer Science & Data Processing	17.6	12.1
Software Methodology	1.5	1
Computer Hardware	0.5	0
Theory of Computation	0.8	0
Numerical Computations	2.5	0.1
Total	100	100

Features of demand and possible shortage

The most prominent features of the data from the period 2005-2007 suggests that:

- vacancies among ICT professionals are likely to continue rising
- there was a relative shortage of ICT associate professionals that may still be evident (We should bear in mind that ICT associate professionals work in a large variety of ICT environments and many hold qualifications suited to specific ICT operating and software environments. A more precise specification of skills would be necessary to initiate training interventions.)
- the most prominent demand among minor occupational categories was for business and systems analysts and programmers. However, the systems development functions that 'systems analysts' and 'programmers' perform are quite different. Certainly 'programmers' is a very wide category that covers different skills levels and domains of software expertise.
- The data suggests that within the ICT professions, vacancies in certain occupations are harder to fill, and the quality of the pool of candidates and the selection options is weaker than employers might desire. The latter observation is sobering. It reflects the existence of sizeable populations of work seekers who – as employers see it - do not possess the requisite qualifications to begin to compete.

Making sense of supply and demand information

We have remuneration data that points to a shortage of computer professionals and associate professionals in the labour market between 2000 and 2005. We have a projection that points to a shortfall in graduate production from higher education between 2005 and 2015 in the study fields of Computer Science and Electrical Engineering and Technology. Both studies point towards a general trend of relative skills scarcity in computing occupations – as long as current conditions persist unchanged.

In the first instance, the information is useful in drawing attention to occupational categories (such as computer professionals and associate professionals) where demand recently exceeded supply. In the second instance the information is also valuable because it points out that graduate production in study fields that traditionally serve these occupations may not meet projected needs in the next decade.

However, neither of the above forms of evidence provide disaggregated information that takes account of the variegated nature of ICT skilling at the professional (high skills) and associate professional (intermediate skills) levels. Put differently, it is necessary to obtain more information that could inform planning of appropriate interventions to resolve the shortages observed.

Although available information from a recent HSRC study begins to provide some direction with respect to which particular occupations are affected by vacancies, and which kinds of skills are needed, it does not go far enough. This is largely because the data obtained is not sufficiently focused to sustain reliable interpretation at the level of individual occupations. A targeted study with a larger sample may be worthwhile, but the cost-benefits of such a study – and who this study might benefit most - should be carefully considered.

ICT policy development and implications for skills development

Since 1994, economic growth and employment creation have remained the fundamental challenges facing government's economic programs. The relationship between growth and employment and how to create economic conditions propitious for both to occur remain a contested empirical and policy terrain (Lowitt and Altman,2008; Altman, 2003). We briefly consider how economic policy interventions after 2000 have envisioned a role for ICT in this environment.

Government launched a series of policy initiatives which included: the expansion of fiscal policy, the Integrated Economic Action Plan (IEAP), the Microeconomic Reform Strategy (MERS) and the Integrated Manufacturing Strategy (IMS) between 2001 and 2003, followed by the Accelerated and Shared Growth Initiative of South Africa (ASGISA) and its related Joint Initiative for Priority Skills Acquisition (JIPSA) in 2006. Soon thereafter, the National Industrial Policy Framework (NIPF) was launched in 2007. Based on the vision articulated for the ICT what were the implications for employment and at what level of skills could workers take advantage of such employment opportunities?

At first, according to Lowitt and Altman (2008) the IEAP and MERS reflected the position of the Department of Trade and Industry (DTI) on the set of fundamentals necessary for the economy to be competitive.

These policy documents recognized that high tariffs in the telecommunications sub-sector substantially raised the costs of doing business. Second they acknowledged the contribution of ICT to generating efficiencies in business processes and value chains. In effect their emphasis was on ICT as a contributor to the general conditions for national economic development rather than the ICT sector itself as a source of growth and employment.

ASGISA and JIPSA and the growth of BPO

The Accelerated and Shared Growth Initiative of South Africa (ASGISA) of January 2006 sought to promote sustainable economic growth and labour absorbtion. Particular economic sectors were targeted for interventions which in the short term including tourism, business process outsourcing (BPO), and biofuels.[20] (Mail and Guardian, 7-12 April 2006).

In March 2006, government established the Joint Initiative on Priority Skills Acquisition (JIPSA), tasked to address the question of constraints and inefficiencies in the existing legislative and regulatory frameworks and institutional arrangements for the delivery of skills. ICT and related skills were incorporated in this initial agenda in two ways. The need for skills in the broad communications industry (see (a) above) was informed by the desire of government to increase access to public good infrastructure. The inclusion of telecommunications along with transport and other 'network industries' make it clear that JIPSA was primarily interested in ICT skills to service public good infrastructure.

[20] Other sectors targeted in the medium term included: creative industries, mineral beneficiation, chemicals, agriculture and forestry

Initially JIPSA saw skilling as supportive of ICT in a general way. The question of how skills development as an input into specific sub-sectoral development driven by a development plan was not recognized.

The only instance from JIPSA which demonstrates a clear and direct link between planning to enter a particular market and an assessment of the skills needs to support such an initiative in the ICT related field is the case of South Africa's entry into the burgeoning global market for Business Process Outsourcing (BPO) service providers. BPO is a relatively straight-forward service sector area to work in because the technologies are known and because the skills requirements are relatively well defined. The challenge is to either find similar sectors where entry to the market is relatively easy because the path has already been beaten and where labour absorbtion potential remains positive though not assured in terms of global competition between labour markets.

As far as the ASGISA and JIPSA phase is concerned – apart from BPO – it does not seem that further initiatives to identify an ICT sub-sector for diversification and to formulate a set of strategies including skills development to suit such a challenge have been undertaken.

National Industrial Policy Framework: Platform for sharpening strategic focus

In January 2007, government published its National industrial policy framework (NIPF). which aims to "set out a vision for the industrial economy within the short-medium and medium-long term." (DTI,2007,13,14,15)

The NIPF identifies five broad sectoral groupings "where it is apparent that much of our sectoral diversification potential lies (DTI,2007,37).

- Natural resource based sectors
- Medium technology sectors (including downstream mineral beneficiation)
- Advanced manufacturing sectors
- Labour intensive sectors
- Tradeable services sectors

The NIPF document adopts a more holistic approach to the challenges of generating a programme of sustainable industrialization than its predecessors. It recognizes that hitherto, South African efforts to achieve a more diversified and labour absorbing industrialization trajectory have been lacking in several dimensions. (DTI,2007,26,29,51)

Importantly, the NIPF document highlights the importance of a "much closer alignment between industrial policy and skills and educational development, particularly with respect to sector strategies." (DTI,2007,47). The IPAP proposes 'sectoral actions' for immediate implementation (DTI,2007b,4). ICT – in terms of services and products[21] - is one of four sectors that are identified as those "for which substantial sector strategy development and perspectives is further required" [22] (DTI,2007b, 33). The NIPF also

[21] In a detailed table on p.34, reference is made to the need to "undertake research to identify opportunities within ICT services to support local content development.' This aspect is not reflected in the main text, but is noted here.

[22] The other sectors are: mining and mineral beneficiation, agriculture/agro-processing and creative industries.

refers to ICT services as a form of non-traditional tradeable activities into which South Africa could diversify its economic activities (DTI,2007a,24,34). [23]

What has hitherto been lacking in order to make coherent plans regarding sector support measures such as skills development strategies is a properly researched decision to target particular ICT economic activities. Without such a specification, 'realistic' skills supply and demand analysis could not be undertaken. Meanwhile higher education institutions have been taking criticism for not supplying the needs of the ICT sector, a challenge higher education could not address without a clear indication from government and the business sector as to what specific ICT economic growth opportunities would be taken forward.

Triangulation with ISETT SETA analyses

A key feature of this report is that it mainly utilizes data from the Labour Force Survey (LFS) and October Household Survey (OHS). These surveys were conducted by Statistics South Africa (StatsSA) the national statistics agency for the period under investigation, 1996-2005. The analysis that is presented here therefore offers an important perspective on the state of skills and skills development in the ICT sector in South Africa. This is because the StatsSA data provides an independent source of data from that employed by the sector education and training agency (SETA) mandated to facilitate and coordinate skills development in the ICT sector, that is the ISETT (Information Systems Electronics and Telecommunication Technologies) SETA.

The ISETT SETA analysis of the sector as published in its Sector Skills Plan, Annual Training Reports and Annual Report is based on its own management information system which in turn is based on returns from the enterprises that are members of the SETA. This is important because the population of enterprises that forms the basis of the ISETT SETA reporting does not include all enterprises. The Department of Labour set a financial threshold below which enterprises were not considered liable for payment of the Skills Levy. In 2003 this threshold was a R250 000 per annum payroll, and later in 2007 this threshold was shifted upwards to R500 000 per annum. This was to relieve the administration burden on small enterprises and on the SETAs. What this means is that all workers employed in enterprises falling below this threshold are excluded in addition to a not insubstantial proportion of enterprises which do not necessarily comply with SETA requests for reporting.

It can therefore be expected that the data discussed in this report will differ from reports based on ISETT SETA data submitted by enterprises. This presents an important opportunity in the form of triangulation between ISETT reporting and analysis and the analysis presented here.

[23] This raises the question of innovation in ICT services through R&D.We do not refer to ICT R&D skills in this project. See: Paterson (2006a) (2006b).

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APPENDICES:

A **Demarcation of the ICT sector**

B **Datasets used for the purpose of analysis in this report**

C **Numbers of students in FET Colleges who enrolled and passed ICT-related course offerings, 1996-2005**

D **Sectoral employment of graduates with a qualification in computer science and data processing**

APPENDIX A: DEMARCATION OF THE ICT SECTOR

The ISETT SETA is the Sector and Training Authority (SETA) established for the Information Systems, Electronics and Telecommunications Technologies Sector. SETAs were established in terms of Section 9 (1) of the Skills Development Act, Act 97 of 1998 as intermediate institutions to facilitate skills development in particular economic sectors and sub-sectors.

The South African ICT sector is the responsibility of the ISETT SETA and is defined to comprises three distinct but interlinked sub-sectors: the information technology (IT), telecommunications and electronics subsectors (Department of Trade and Industry, 2005: p141):

_ *Information Technology (IT)* – a field that deals with computer systems design and integrated solutions, programming, hardware and software engineering;

_ *Telecommunications* - a field that deals with wired telecommunication, cellular and other wireless telecommunication, paging, television and radio network signal distribution and satellite telecommunications;

_ *Electronics* - a field that deals with Electronics equipment. Excluded are electronics manufacturing which belongs to the manufacturing SETA (MERSETA).

The ISETT SETA adopted a definition used by the Organisation for Economic Co-operation and Development (OECD), which defines the ICT sector as: "…a combination of manufacturing and services industries that capture, transmit and display data and information electronically" (OECD, 2002: p18; SAITIS, 2000: p3).

For **manufacturing** industries, the products of a candidate industry must:

- be intended to fulfil the function of information processing and communication, including transmission and display; or
- use electronic processing to detect, measure and/or record physical phenomena, or to control a physical process.

Components primarily intended for use in the above products are also included.

For **service** industries, the products of a candidate industry must:

- be intended to enable the function of information processing and communication by electronic means.

Ongoing demarcation process

The definition of the ICT industry is a complex process which is ongoing as technology influences the economic processes and work processes according to which products and services are produced.

Internationally a Panel considers the options for sector demarcation. In the view of the members of the Panel, the 'information economy' consists of the economic activities of those industries that produce content, and of the ICT industries that move and display the content. These economic activities include the use of information and of ICT products by both people and business. The ‘information society’ includes the social impact of the information economy. These "working definitions" were seen as a means to promote discussion of the definitions of the constituent parts and of their boundaries. They could not be seen as final until agreement had been reached on the parts.

The next steps in building indicators for the information society is agreement on a definition of the content industries which, when added to the ICT definition, will provide a working definition of the information economy. At the same time, the Panel will develop a classification of ICT products which will permit the gathering of statistics on the ICT output of industries not included in the definition.

After some deliberation, the Panel excluded the Reproduction of Recorded Media industry (ISIC 2230) as it was felt to belong to the content industries in ISIC Division 22, Publishing, Printing and Reproduction of Recorded Media. Retail sale of household appliances, articles and equipment (ISIC 5233) was excluded because the classification was felt to be inaccurate for the purpose intended. The same argument applied to wholesale trade, but it was possible there, using NACE, to offer guidelines for more precise reporting. This reflected the view that, although no part classes would be included in the definition, exceptions could be considered when the complete exclusion of an industry would mean the exclusion of a significant number of businesses which are producing ICT goods and services.

The proposed definition of ICT includes the following International Standard Industry Classifications (ISIC Rev.3) industries:

Manufacturing

359 Manufacture of office, accounting and computing machinery

363 Manufacture of insulated wire and cable

371 Manufacture of electronic valves and tubes and other electronic components

372 Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy

373 Manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods

374 Manufacture of medical appliances and instruments and appliances for measuring, checking, testing, navigating and for other purposes, except optical instruments

Note: SICCODE 374 is supposed to only include sub-codes:

- 3742 Manufacture instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment; and
- 3743 Manufacture of industrial process control equipment

Services - goods related

615 Wholesale of machinery, equipment and supplies

852 Renting of other machinery and equipment

Services – intangible

752 Telecommunications
860-869 Computer and Related Activities
- 860 Computer and Related Activities
- 861 Hardware consultancy
- 862 Software consultancy and supply
- 863 Data processing
- 864 Data base activities
- 865 Maintenance and repair of office, accounting and computing machinery
- 869 Other computer related activities

South African application of the SIC Codes

However, the codes used by Statistics South Africa (OHS and LFS) are only to three digits and data is thus provided for the whole 374 SICCODE and includes also other activities such as the manufacture of medical instruments which is not related to the ICT sector.

The same applies to SICCODE 852 which should only include sub-code 8523 (Renting of office machinery and equipment, including computer), but there is only data on the whole 852 SICCODE which also includes renting of any machinery and equipment.

According to the definition of the ICT industry published in the South African Government Gazette (March 2005), SICCODE 871 (Research and experimental development on natural sciences and engineering), SICCODE 961 (Motion picture, radio, television and other entertainment) and SICCODE 357 (Manufacture of special purpose machinery) should also be included, however:

- the OECD definition excludes **SICCODE 871** (Research and experimental development on natural sciences and engineering), as this code not only includes ICT research and development of electronic equipment and systems, but also agricultural and livestock research, medical and veterinary research, fuel research and other research and development;
- the OECD definition excludes **SICCODE 961**, because this code does not only include the *provision of radio and television transmission signals*, but in addition also *circus productions, ballroom activities, amusement park attractions and other activities* which is not ICT related;
- **SICCODE 357** (Manufacture of special purpose machinery) includes the *manufacture of agricultural and forestry machinery, weapons and ammunition, machinery for textile, apparel and leather production and other* non ICT activities and not only the *manufacture of alarm systems* which is activities related to the ICT sector.

In this study

The SIC codes used to compile sub-sectoral GDP data from Quantec data differ from the South African standard set of SIC codes. The GDP data is based on a broader range of SIC codes and therefore can be seen as indicative but not definitive of the growth in the ICT sector. The SIC codes used are as follows: Manufacturing (SICCODES 359-366; 370-376), ICT services (SICCODES 61-63; 84-88) and Communications (SICCODE: 75).

Employment according to different definitions of the ICT sector

Given the differences between the South African and the OECD definitions of the ICT sector, it is logical to assume that each format will produce different estimates of employment. Table 1 below reveals that this is indeed so. It is therefore important to use one framework consistently if possible. Furthermore, we note that depending on which framework a researchers uses this may limit comparability or at least create difficulties in reconciling the numbers obtained via the other framework.

Table 1: Comparison of employment figures generated by the OECD and Government Gazette definitions of the ICT sector

Activities	Average employed p.a.	
	1996-1999	2000-2005
ICT sector activities according to the Government Gazette definition of the ICT sector		
357 Manufacture of special purpose machinery	13391	32901
752 Telecommunication	83677	71297
860-869 IT services	58581	76298
871 Research & development in natural science & engineering – (manufacture of electronic valves & tubes-electronics manufacturing)	6245	20799
961 Motion picture, radio, television & other entertainment	38785	16758
Total	200679	218053
ICT sector activities according to the OECD definition		
359 Manufacture of office, accounting & computing machinery	7574	8516
363 Manufacture of insulated wire and cable	5044	10126
371-374 Electronics equipment	16197	36046
371 Manufacture of electronic valves & tubes	6245	20799
372 Manufacture of television & radio transmitters	2693	3734
373 Manufacture of television and radio receivers	3774	3297
374 Manufacture of appliances for measuring and checking	3484	8216
752 Telecommunication	64919	71297
IT services (615, 852, 860-869)	58581	76298
615 Wholesale trade in machinery, equipment & supplies	10897	6143
852 Renting of other machinery & equipment	1598	4469
860 Computer & related activities	20945	252
861 Hardware consultancy	4908	10438
862 Software consultancy & supply	12412	35404
863 Data processing	797	1818
864 Data base activities	1281	3879
865 Maintenance: Office, accounting & computing machinery	2289	6858
869 Other computer related activities	3453	7037
Total	152315	202283

Sources: Government Gazette (March 2005) and Quantec, 2007 (StatsSA OHS data for 1996 – 1999; StatsSA LFS data for 2000 – 2005)

Further analyses are based only on the OECD definition of the ICT sector

APPENDIX B: DATASETS USED FOR THE PURPOSE OF ANALYSIS IN THIS REPORT

Chapter 3

For the analysis in Chapter 3, we drew data on sectoral and sub-sectoral GDP and employment from the Quantec database, as is acknowledged in each table or figure.

We used the Quantec database for the above analysis because Quantec was the only source of GDP data disaggregated on a sub-sectoral basis to the third digit Standard Industrial Classification (SIC) level. The Quantec data did have its own limitations. Data was not provided separately for each and every SIC code at the third level. In some instances GDP values were given for groups SIC codes. This meant that in these cases it was not possible to separate the GDP data for certain industrial activities from each other.

As a consequence of this bundling of codes together in the Quantec data, the Quantec GDP and employment data actually represent a wider group of activities than those given in the OECD definition for the ICT sector.

For example, the analysis above is based on a definition of 'communication' which includes Telecommunication (SIC752) as well as Post & Telecommunication (SIC750) and Postal & related courier activities (SIC 751)[24]. In other words, we used GDP data and employment data for a wider set of industrial activities than just Telecommunications. A summary of the SIC groups included in the discussion above is given in column (a) below. Given that telecommunications is by far the largest of the three sub-groups and will dominate the figures we considered this to be an acceptable compromise to meet the purpose of interrogating the link between economic growth and employment growth. For each ICT sub-sector, the SIC codes and thereby the range of economic activities for which Quantec GDP and employment data was available was broader than the SIC codes applied to an OECD definition of the ICT sector (Column b below). The use of this proxy data was necessary in order to consider the employment – growth relationships in the sector.

SIC codes used for employment and GDP in the ICT sector

Subdivision	(a) SIC codes applied to GDP and employment data from Quantec	(b) SIC codes applied to LFS and OHS data according to OECD definition of ICT sector
Manufacture of electrical machinery & apparatus	359	359
	360-362	-
	363	363
	364-366	-
Manufacture of radio, TV, instruments, watches & clocks	370	-
	371-374	371-374
	375-376	-
Communication	750	-
	751	-
	752	752
IT services	615, 852, 860-869	615, 852, 860-869

[24] See Appendices for detailed breakdown of SIC codes for each part of the analysis.

Chapter 4 and subsequent chapters

The analysis of labour force data presented in Chapter 4 and subsequent chapters, is based on data drawn from the OHS and LFS by the authors. It was possible to draw data precisely according to the OECD definition of the ICT sector. The use of OHS and LFS data was necessary because we wanted data that accurately reflected the OECD definition of ICT, rather than the Quantec data applied in the discussion above as a proxy for ICT employment. Furthermore, the OHS and LFS employment data provides the opportunity for deeper level disaggregation which is important considering that the main focus of this report is the size and characteristics of the ICT labour force.

It must be noted that there is some discontinuity between the two data sources. There are two reasons for this. First, as we have noted above, the Quantec employment and GDP data is based on a broader set of SIC codes than the LFS and OHS data that will be used in the analysis in following chapters. This means that annual employment counts will differ between the two datasets, such in Manufacturing employment.

Secondly, the value of the Quantec data is that it consists of a standardized time series over a long period. However, the data modeling techniques undertaken produce values that may differ to some degree from the values in the original OHS and LFS datasets that we use.

Therefore, differences between the datasets can be expected, as seen in the Table below which compares the values derived for 'average annual employment' and 'average annual employment growth' for the two datasets. The 'services' and Communications/Telecommunications' sub-sector values for employment size and for average annual growth are comparable. However, the values for Manufacturing sub-sector employment differ by about 30 000 and there is also a substantial difference in the estimates of average annual growth.

The difference in employment size figures has been explained above. The larger employment size recorded from the Quantec data contains a wider set of economic activities – and will therefore reflect a larger workforce – than the OECD SIC codes applied to the OHS and LFS data. We argue that once the presence of these groups is removed, the size of the labour force is more correct. Secondly we argue that the removal of the other groups reveals that ICT manufacturing has a higher annual employment growth rate than the broader set included in Quantec.

Key data sources for analysis					
Analysis of GDP and employment Chapter 3			**In depth analysis of employment Chapters 4 to 9**		
Source: Quantec OHS and LFS data adjusted			**Source: StatsSA OHS and LFS data**		
	Annual average employment	**Average annual growth**		**Annual average employment**	**Average annual growth**
Manufacturing	63495	-3.5	Manufacturing	34494	5.7
Communication	76359	-5.2	Telecommunication	83445	-2.6
Services	69211	3.4	Services	72796	2.7
	209065	-1.7		190735	0.02

On the basis of the discussion above, we propose that it is reasonable to pursue in-depth discussion of employment in the ICT sector based on LFS and OHS datasets.

SIC codes for the ICT sector according to the OECD definition of the sector

SICCODES used for the ICT sector (OECD definition)		
Subdivision	**SICCODE**	**Activity**
ICT manufacturing	**359**	**Manufacture of office, accounting & computing machinery**
	363	**Manufacture of insulated wire and cable**
	371-374	**Electronics**
	371	Manufacture of electronic valves & tubes
	372	Manufacture of television & radio transmitters
	373	Manufacture of television and radio receivers
	374	Manufacture of appliances for measuring and checking
Telecommunication	**752**	**Telecommunication**
IT services	**615, 852, 860-869**	**IT services**
	615	Wholesale trade in machinery, equipment & supplies
	852	Renting of other machinery & equipment
	860	Computer & related activities
	861	Hardware consultancy
	862	Software consultancy & supply
	863	Data processing
	864	Data base activities
	865	Maintenance: Office, accounting & computing machinery
	869	Other computer related activities

SIC codes for the ICT sector according to which Quantec supplied GDP data

SICCODES used for GDP in the ICT sector		
Subdivision	**SICCODE**	**Activity**
Manufacturing	**359-366**	**Manufacture of electrical machinery & apparatus**
	359	Manufacture of office, accounting & computing machinery
	360	Manufacture of electrical machinery & apparatus
	361	Manufacture of electric motors, generators & transformers
	362	Manufacture of electricity distribution & control apparatus
	363	Manufacture of insulated wire & cable
	364	Manufacture of accumulators, primary cells & primary batteries
	365	Manufacture of electric lamps & lighting equipment
	366	Manufacture of other electrical equipment
	370-376	**Radio, TV, instruments, watches & clocks**
	370	Manufacture of radio, TV & communication equipment & apparatus of medical, precision & optical instruments, watches & clocks
	371	Manufacture of electrical valves & tubes & other electronic components
	372	Manufacture of TV & radio transmitters & apparatus for line telephony & line telegraphy
	373	Manufacture of TV & radio receivers, sound or video recording or reproducing apparatus & associated goods
	374	Manufacture of medical appliances & instruments & appliances for measuring, checking, testing, navigating & for other purposes, except optical instruments
	375	Manufacture of optical instruments & photographic equipment
	376	Manufacture of watches & clocks
Communication	**75**	
	750	Post & Telecommunication
	751	Postal & related courier activities
	752	Telecommunication
Services	**61-63**	Wholesale & commission trade, except of motor & motor cycles
	84-88	Business services

APPENDIX C: NUMBERS OF STUDENTS IN FET COLLEGES WHO ENROLLED AND PASSED ICT-RELATED COURSE OFFERINGS, 1996-2005

Numbers of students in FET Colleges who enrolled and passed ICT-related course offerings, 1996-2005

Study offerings	level	Status	Years									
			1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Computer Studies	2	Entered	4730	4538	7767	8176	9297	9079	8565	8813	8358	8410
		Passed	3140	2847	4376	4176	5318	4853	4694	4769	4594	4589
	3	Entered	12927	14095	13593	13827	17389	21252	22615	22583	24382	24821
		Passed	7105	7782	8023	8426	9402	11549	12171	11536	11974	11985
	4	Entered	8557	9733	10003	9573	8736	7355	6615	6301	6169	6800
		Passed	26387	30797	31958	30328	27661	25127	23375	23316	23277	27387
	5	Entered	10667	18508	20056	22062	22979	18748	17261	16695	16303	17671
		Passed	7691	13366	14106	11822	12965	12587	11617	12142	11116	12006
	6	Entered	3139	7675	9801	10027	9602	9921	9155	9276	9185	8847
		Passed	1897	4451	5796	5832	5927	5682	5451	5848	5905	5694
	OBE	Entered	0	0	66	440	390	9	2	39	66	174
		Passed	0	0	46	329	313	4	1	0	26	11
Electronics and Telecommunications Trades	1	Entered	8105	10939	16333	20438	21726	22144	24312	23546	23407	26109
		Passed	5135	6891	8645	10975	11360	11411	11401	12750	13296	11489
	2	Entered	17841	19354	21051	22397	23122	23843	24247	22654	23086	23185
		Passed	8973	9267	10710	11397	12114	12183	11964	11358	12426	10756
	3	Entered	18331	22059	25028	25153	26470	29342	33936	36090	39886	38890
		Passed	9512	11646	12476	15196	15445	14936	15271	14983	14885	16080
	4	Entered	19346	22394	24850	25530	27763	27950	27332	27350	28055	29254
		Passed	9978	11344	12416	14394	15757	15896	14909	15010	14583	13354
	5	Entered	11461	13040	15060	16312	19895	18593	20032	19863	18160	17847
		Passed	5735	5900	7531	8291	9517	9644	10651	9785	9070	9588
	6	Entered	7010	8588	9110	10213	11480	12972	13254	14025	14077	12704
		Passed	3057	3748	3906	4716	5645	6562	6802	6428	6760	5383
ICT and Telecommunications	4	Entered	810	1027	1159	1000	805	801	790	597	538	334
		Passed	517	504	475	521	418	413	391	324	296	194
	5	Entered	379	525	525	473	516	452	448	355	337	253
		Passed	199	263	279	281	247	234	245	186	169	131
	6	Entered	168	284	301	358	386	353	308	337	262	182
		Passed	66	125	117	152	159	167	134	155	133	75
Telecommunications Trades	1	Entered	1413	1875	2756	3324	4546	4511	4527	3265	2755	2205
		Passed	506	560	985	1298	1758	1815	1789	1276	1183	1013
	2	Entered	3563	4107	4903	6087	6822	7243	7138	6070	5407	4407
		Passed	2247	2605	3213	4230	4555	4607	4255	3675	3084	2412
	3	Entered	16	7	11	39	14	0	0	0	0	0
		Passed	2095	2604	2989	3757	4238	4367	4570	3643	3228	2511
	4	Entered	709	901	821	772	817	788	819	713	770	686
		Passed	1033	1236	1306	1507	1697	1846	1879	1686	1288	1163
	5	Entered	1040	1481	1463	1758	2063	2078	2507	2215	1738	1360
		Passed	531	837	752	965	1110	1104	1316	1190	929	611
	6	Entered	531	745	932	1036	1242	1387	1428	1460	1442	1071
		Passed	362	493	509	704	787	825	864	834	836	591

Source: DoE (1996 to 2005)

APPENDIX D: EMPLOYMENT OF GRADUATES WITH A QUALIFICATION IN COMPUTER SCIENCE AND DATA PROCESSING

As part of an overview of the supply and demand situation for workers to fill 'computer professional' and 'computer associate professional' posts it is appropriate to look who has a qualification in the field of ICT and where these people are employed or are not employed.

Over the period 2000 to 2005, one per cent (112 690 annual average) of all employed (11727 903 annual average) workers held qualifications in *ICT related fields of study.*

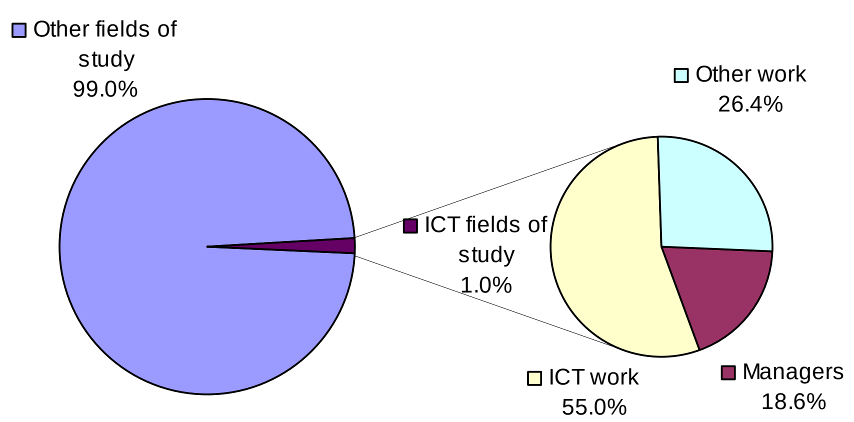
It should be noted that the 'ICT related fields of study' category in the LFS dataset is not 'pure', and will necessarily include workers who will have studied other physical, mathematical, and life science fields as well as computer related subjects.

What we are particularly interested in is the work status of persons who claim to have qualifications in an ICT related field of study, since this number is central to understanding the supply of qualified people into the labour market.

It is interesting to note that of those who reported having studied for a qualification in an *ICT related field of study,* 55.0 per cent worked as Computer professionals and associate professionals, 26.4 per cent did other work and 18.6 per cent were in managerial positions not necessarily related to ICT management(Figure A).

What this data is tells us is that a significant number of persons who graduated with a qualification from a higher education institution in an ICT related study and who were employed in the period 2000-2005 did not work as computer professionals or associate professionals. One in four graduates was employed in work other than as ICT professionals or associate professionals.

Figure A: Type of employment among workers with a qualification in an ICT related field of study, 2000-2005



Source: LFS (2000 – 2005) (StatsSA, 2001 -2006)