5

An Assessment of Skill Needs in Information and Communication Technology

NATIONAL TRAINING ORGANISATIONS

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Any views expressed in this report are those of the authors and not necessarily those of the DfES, the NTOs or any other organisation involved in the Dialogue.

Contents

Foreword

As the representative National Training Organisations (NTOs) for the Information & Communication Technology (ICT) sector, we welcomed the commitment of the National Skills Task Force to the importance of a sectoral dimension in understanding skills issues.

This report has been developed as a result of a partnership between NTOs, their employers and Government, and has involved consultation with a wide range of partners, including some of the funding and planning bodies who will benefit from this information. It has brought together a wide range of information, including key findings from each of our Skills Foresight programmes and latest research evidence from a major employer survey of ICT professionals commissioned by the ICT NTOs, and supported by the DfES and the DTI 'IT and Communications Professionals in the UK'. That project, and especially the analyses of skills issues within each sector will be crucial for identifying further areas for action on the part of respective NTOs.

The result is a detailed and thorough assessment of the current and projected skill needs in ICT, which will be an invaluable source of information for education, training and careers planners. The key messages that have emerged present a clear challenge to the sector in the future. These challenges will require innovative and flexible solutions to be found by the industry, training providers, colleges and the development agencies that support them - across the whole of the UK.

We look forward to working with the Learning and Skills Council (LSC), Regional Development Agencies (RDAs), Careers Services and to strengthening valued partnerships with key organisations in England, Scotland, Wales and Northern Ireland in order to address these challenges.

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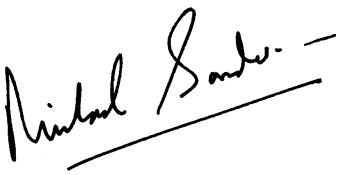

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Chief Executive
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Skills Dialogues - General Introduction

Skills Dialogues constitute a series of consultations with all major industrial and business sectors, leading to the production of high quality authoritative skills assessments for each of these broad sectors. Dialogues developed from recommendations in the 2nd Report of the Skills Task Force, Delivering skills for all, as a means of providing better quality information on changes in skills supply and demand at a sectoral level. They draw on research undertaken by National Training Organisations (NTOs) through Skills Foresight and other projects as well as a wide range of national research on current and future skills needs. Recognising the UK remit of NTOs the dialogue reports reflect the UK perspective as far as possible, although not all the available evidence which underpins the Dialogues is UK wide. Typically, the reports do not provide a region by region analysis but they do attempt to illustrate any major regional differences. The Skills Dialogues operate as a rolling biennial programme with the first four reports already published and the rest of the series due to appear by Spring 2002.

The purpose of the dialogues is to improve the quality of skills information available at a sector level, and to provide an effective voice for NTOs and employers in their sectors in the planning and implementation of education and training provision and in informing careers advice and guidance. They will ensure that industry sector views are well articulated and represented to major stakeholders, such as the Learning and Skills Council (LSC) and its local arms, Regional Development Agencies (RDAs) and careers services. The dialogues are designed to draw on the work of individual NTOs but to cover broader industrial groupings, so as to aid strategic planning and make the information base more manageable.

The assessments produced through the dialogues should also directly contribute to Sector Workforce Development Plans, as the evidence on skill needs will underpin proposed action and influence the nature of relationships with key partners.

Each report results from a process of consultation with the main organisations in the sector to identify the key issues, and a wide ranging analysis of existing material on skills supply and demand, and factors influencing skill trends. The evidence includes sector specific analysis from the recent national research conducted on behalf of the National Skills Task Force including the Employer Skills Survey (ESS) and Projections of Employment and Qualifications by the Institute for Employment Research as well as the NTOs' own Skills Foresight research. The material is brought together into a draft discussion document for a national seminar, which involves all the key interests in the sector, such as employers, NTOs, Further and Higher Education planning, funding and qualifications' bodies, trade unions, professional associations and government departments.

The final report takes on board the comments from all those involved in the Dialogue and provides a comprehensive analysis of the skill needs and an authoritative statement about skills trends in the sector. We hope they will be useful to policy makers and planners in other parts of the United Kingdom. For example, a series of skills monitoring and forecasting exercises are being undertaken in Northern Ireland and the work on this and other Dialogues will inform the Northern Ireland research.

Executive Summary

This is the report of the Information and Communication Technology (ICT) Skills Dialogue undertaken by the Department for Education and Skills (DfES), the Department for Trade and Industry (DTI) and the sector National Training Organisations (e-skills NTO[1], EMTA and Skillset).

It has been written by the Institute for Employment Studies (IES) and the Science Policy Research Unit (SPRU). The aim of the exercise has been to provide an authoritative statement of the skill needs of the ICT sector.

The five main points to emerge are that:

- **demand for professional ICT skills continues to expand** - for both fundamental operating systems and programming languages and new Internet-related skills;
- **supply is starting to respond** as university output increases and other channels open up;
- **skill deficits still persist** - through external recruitment shortages and internal skill gaps;
- **however the worst of the recent skill shortage crisis appears to have passed** as demand slows down and supply catches up; and
- **concern is switching from inadequacies in the quantity to quality of skills supply**.

The other main findings are summarised below.

One million employees and rising

Taking all the evidence into account, there are likely to be over a million people employed in a job which is largely dependent on their technical skills in information and communication technologies - ie ICT professionals.

Personnel in ICT occupations have been growing considerably faster (by around half in the last five years) than the UK workforce as a whole (seven per cent), especially in supply and service organisations in the ICT dedicated sector (92 per cent growth). The largest group of ICT personnel are found in the computer services industry (around one-third of the total). The non-ICT dedicated sector, of businesses which use rather than service or supply ICT, accounts for just over half of the total ICT population, a proportion that has been shrinking in recent years. The largest share of employment in the non-ICT dedicated sector is in financial and business services.

Software engineers represent the fastest growing ICT occupational group (more than doubled in size in last five years). They are more likely to be found in computer services than other sectors. Slower growing occupations are at lower skill levels, such as computer operators.

1. nto tele.com was originally a partner in the dialogue process, but is now merged into e-skills NTO.

Importance of small firms

The ICT dedicated sector, and especially computer services and new media, is, like most sectors dominated by small firms, though most of the ICT workforce is in the larger companies. The non-ICT dedicated employers are likely to be larger ones. Self-employment in ICT is slightly higher than the average for the workforce as a whole. It is much higher in some ICT occupations (such as software engineers).

Young(ish) workforce

ICT personnel are only slightly younger than the average for all employees, but this overall figure masks differences by occupation and sector. New areas of ICT employment, such as web design, have some of the youngest workforces.

Employment clusters

There is strong regional and local clustering of ICT work in and around London and the Home Counties. The rest of ICT personnel are spread across other UK regions and countries. The profiles of ICT employment by occupation and sector vary considerably by geographical region and country.

Male dominated

Women are under-represented in ICT employment, and especially in jobs at higher skill levels. Little progress appears to have been made in increasing the participation of women in ICT in recent years.

Technical skills in demand

The top ranking technical skills sought by employers are those associated with the **Windows/NT** operating system. Other key areas include **Microsoft** applications (eg **Access**, **Office** and **Publisher**) the **Unix** operating system and, to a lesser extent, the **C and C++** programming languages.

Demand is growing, but still at a relatively low level, for people skilled in newer languages and operating systems such as **Java**, **Perl**, **XML** and **Linux** and the Internet-related areas of **HTML** and **JavaScript**.

Importance of generic skills

While ICT professionals need advanced technical skills, they also need to be able to apply them by working with others, in a flexible way and understanding their customers' requirements and business environment. They therefore also need high levels of generic skills such as problem solving, communications, team working and numeracy skills.

Diversity of supply

The ICT workforce is better qualified than the workforce as a whole, and ICT employers have a tradition of recruiting graduates. Higher education appears to be the main direct route into ICT jobs from the education system. The supply of graduates in ICT subjects has been growing much faster than all graduates (up by about 25 per cent in last five years).

Broad HE intake

ICT students tend to come from broader backgrounds than all higher education students, in terms of age and entry qualifications, but women are still considerably under-represented. Employers recruit as many graduates from non-IT as from IT subjects, mainly for their personal skills, aptitude and intelligence. The proportion of non-IT graduates entering ICT occupations is even higher in the non-ICT dedicated sector. There are widespread concerns about the quality of some IT graduates both in terms of their work 'readiness' and underlying technical competence, and a number of initiatives aim to address this.

Vocational routes

A range of ICT qualifications and courses are offered in further education. Though large numbers are studying ICT in colleges, many do so at basic levels to enable them to make better use of ICT in their jobs and not as entry qualifications to ICT specialist occupations. Another route into ICT is via Advanced Modern Apprenticeships (AMAs), but numbers here are also quite low. An unknown number of people with ICT qualifications at intermediate level enter ICT-related jobs.

School qualifications, at GCSE and 'A' level, in ICT have also been growing, and an increasing number of schools make widespread use of ICT in the curriculum.

Work-based training

Most large firms, and the majority of all firms, provide training to their ICT staff, often using commercial providers. Proprietary qualifications are very popular.

About one in three of ICT personnel received job-related training (in a three month period), a slightly higher proportion than in the workforce as a whole - as tends to be the case in graduate professions. Those in technical functions were more likely to get training.

Skills, shortages and gaps

Skills shortages falling, but still exist

A range of evidence suggests that skill shortages are widespread but are not as severe as in previous years. The latest available data suggest that the number of hard-to-fill vacancies appears to have fallen in recent months. The main areas of recruitment problems appear to be among software development professionals and technicians especially in the ICT dedicated sector, sales professionals and operations managers.

Most of the shortages appear to be skill-related. The skills in short supply are those in greatest demand - particularly a generic understanding of IT and of Windows-based operating systems. The main problem is an insufficient number of applicants with the required skills.

Skills gaps persist

The vast majority of ICT professionals are thought to be fully proficient at their job. The technical skills gaps identified by the ICT Skills Survey include microsoft applications, Window/NT and networking skills.

Generic skills gaps are also important, particularly general business knowledge in the larger establishments and general IT user skills in the non-dedicated sector. Problem-solving, oral communication and customer handling skills were the other main areas of concern.

The consequences of skills deficits

Skill deficits - caused either through external labour market shortages or internal skills gaps - can result in companies failing to provide desired levels of customer service. They can also lead to delays in developing new products, difficulties in introducing technological changes and new working practices and a loss of business.

Remedial action

Companies try to get round the problems caused by skill deficits by improving training or recruitment, greater use of contract staff or outsourcing, changing working practices or living with sub-optimal levels of performance.

The future for skills

Demand continues to rise?

There is a range of influences on the demand for ICT professionals including: those related to economic growth; the development of e-business and the structure of the ICT sector; the rate and nature of technological development; and the structure of governance over the sector including regulation and the development of standards.

The two available sector-wide forecasts for UK demand predict annual growth rates of between four per cent (Institute for Employment Research, IER) and 7.5 per cent (European Information Technology Observatory, EITO). Other forecasts which focus on elements of the sector predict higher growth rates, particularly for the IT services sector and for people working in Internet-related areas.

Synthesising the available information for this review, we have developed three scenarios for discussion:

- The High Road - a fast growth rate scenario with employment rising by eight per cent a year.
- The Middle Road - a medium scenario based around two to three per cent annual growth.
- The Low Road - where employment is at best static and possibly declines by one per cent a year.

Will supply keep pace?

On the supply side a further range of influences apply including: the ability of the vocational educational and training systems to adapt to changes in demand; the perceived attractiveness of ICT careers; the efficacy of new e-learning training techniques; and Government policy on immigration and taxation.

The only available forecast on supply (from EITO) predicts a six per cent annual growth rate, although the basis of the forecast has been questioned. The supply of ICT graduates from UK higher education is expected to increase slightly.

Three possible supply scenarios have been developed for this review:

- Full flow - with the potential recruitment pool increasing at a rate of six to seven per cent a year.
- Medium flow - with the supply pool increasing at around three per cent a year.
- Steady flow - with supply trends remaining constant if not actually declining.

Implications

- Our view considering the evidence is that the medium road/full flow combination of demand and supply scenarios is the most likely, which suggests that there should be fewer, rather than greater, problems meeting the expansion of demand over the next few years. However there is still a large volume of 'replacement demand' to meet and further changes in technology and business organisation could lead to continual skill gaps.
- Therefore skill gaps and the lack of crucial generic skills, shortages in areas of rapidly changing technology, the quality of all technical skills and the ability to apply them in a business context, are all likely to remain issues of concern over the coming years.

Agenda for action

In the Dialogue discussions a number of suggestions were made about what could be done to tackle the prevailing trends. Proposed actions tended to centre on a number of key issues:

- building a consensus about the sector and a common language to discuss skill issues and monitor trends;
- widening the recruitment pool;
- improving the quality and responsiveness of the education and training system;
- monitoring progress and emerging issues.

One underlying theme that also emerged was the need to concentrate effort on relatively few areas and ensure that they were met with concerted and long-term action with all the funding agencies, policy bodies and stakeholders pursuing the same (few) goals.

1. Introduction

This is the report of the Information and Communication Technology (ICT) Skills Dialogue, one of a series of 16 dialogues being undertaken at a sectoral level, by DfES, DTI and other sponsor departments in partnership with National Training Organisations (NTOs). In this dialogue group, there are three NTO partners: e-skills NTO[1], EMTA and Skillset.

In this chapter we discuss the scope of the dialogue and the approach we have adopted and the structure of the report.

1.1 Background to skills dialogues

Skills dialogues came from a recommendation in the National Skills Task Force (STF) report *'Delivering Skills for All'* that more attention should be given to skill needs at a sector level. The dialogues comprise consultations with major industrial and business sectors leading to an authoritative skills assessment report for each of a number of broad sectors. They should improve the quality of skill information available at a sector level, by building on the work of individual NTOs. Their aim is to draw out key messages to help inform Government, NTOs, employers, training providers and agencies such as RDAs and Learning and Skills Councils (LSCs) in the planning and implementation of education and training provision and careers guidance.

This report contains an assessment of trends in employment and skill needs and supply in the ICT sector and ICT occupations. It is based on statistics and information obtained from a wide ranging data gathering and consultation exercise and represents a comprehensive attempt to synthesise all the available evidence.

This report is about the ICT sector in the UK. As such it nominally excludes electronics manufacture (which in turn is included in the more widely defined Information Technology, Electronics and Communication (ITEC) sector). We focus on the narrower ICT sector, unless the only available data sources take a broader perspective. Where appropriate we have indicated the scope of the relevant data.

1.2 Setting the scene - ICT, jobs and skills

The ITEC sector, ie including the computing, telecommunications and electronics industries (see Section 1.3.1 below), is one of the fastest growing areas of the UK economy, and central to the emergence of the new Information Society with all its accompanying social and commercial challenges.

- ITEC industries contribute just over eight per cent of the UK's Gross Domestic Product (GDP), up from 6.5 per cent in 1993, accounting for one-third of the UK's GDP growth in the last few years (DTI/OST, 2000).
- Almost 15 per cent of total trade for the UK is in ITEC products and services, although the overall trade balance is in slight deficit (OECD, 2001).

1. nto tele.com was originally a partner in the dialogue process, but is now merged into e-skills NTO.

- Total exports in ITEC products and services are around £30 billion, of which electronics accounts for about £26.7 billion. Imports of £32.6 billion are similarly dominated by electronics (1998 figures, in DTI/OST, 2000).
- The ICT market (hardware, software and services) in the UK increased by over 22 per cent in the 1997-99 period, a similar growth to the EU countries average (Eurostat, 2001). In 1999, it represented 45.6 billion ECUs, the second largest country market in Europe, and 22 per cent of the total EU total.
- Companies producing ICT based products and services account for over one-third of the total market capitalisation of the FTSE-100 companies index (DTI, 2001a). (nb This was before a number of dot.com companies joined the index and the market value slumped).

Furthermore, there has been rapid growth in the use of ICT by people at home and at work. As the number of personal computers (PCs) in the UK increases (estimated at over ten per cent a year) more people are now routinely using ICT. By September 2000, 48 per cent of adults claimed to be using a PC and 37 per cent the Internet (DfEE, 2001a); and there is at least one mobile phone for every three inhabitants of the UK (Eurostat, 2001).

On the whole, UK companies are more advanced in their use of ICT, especially networking and communications technologies, compared to other countries (DTI, 2000a). One-third of UK businesses have more than three-quarters of their employees using PCs; over 70 per cent of businesses use external e-mail; and over 86 per cent use mobile phones. The whole process of trade is being changed radically by the use of the Internet - by 1999, half of all UK companies had an Internet presence and ten per cent offered products online and these proportions are rising (see Tackey *et al.*, 2000 based on Spectrum Strategy Consultants, 1999).

Expansion in the take-up and applications of ICT products in all their various forms has been fuelled by innovation and falling costs/increasing power of equipment (an estimated doubling of this ratio every 18-24 months). It has helped to generate a 50 per cent rise in ICT employment over the last five years. Some industries are more ICT intensive than others (eg finance) but ICT is pervasive throughout the economy, and has transformed some established industries (eg insurance, travel booking, publishing). Its effects on employment have been highly differentiated, but substantial, especially on work patterns and work locations (eg call centres, homeworking, teleworking) and the nature of some jobs, including the creation of new jobs (eg 'web masters') and the demise or transformation of more traditional ones (eg telephone engineers). The impact of ICT on recent productivity improvements in the UK economy is harder to see as yet, but this is expected to become more evident in the years ahead (Harris, 2001).

ICT occupations range widely from those requiring very specific, in-depth technical knowledge and expertise (eg on Internetworking technology, PC operating systems) to others where a broader technical ability is needed alongside good interpersonal skills or expertise in specific applications areas (eg e-commerce, financial services, healthcare). ICT skills are needed both in the development and/or delivery of ICT products and services and in their application in a range of different workplaces. This has led to a complex pattern of ICT skills across a range of sectors. ICT skill shortages

are prevalent and widely talked about, and have been for many years. But there is no consensus either here in the UK, or more widely in Europe and the US, about the scale of the shortages or future trends. This is partly due to the dynamic and sometimes volatile nature of the sector, but also a lack of agreement over common terminology for occupations and different interpretation of data (Millar *et al.*, 2001).

Although in recent months there has been an apparent slowdown in the growth trends of the ICT sector, especially in the telecommunications market, ICT jobs are still in high demand and account for a growing share of total UK employment.

1.3 Scope of this dialogue

This dialogue is concerned with the ICT sector in a broad sense. This is in line with the broad sector groupings developed for the Skills Dialogue process which have been designed to be manageable and also combine similar industries in terms of skill requirements. These groupings are based on the existing Standard Industrial Classification (SIC92).

In the case of ICT, however, use of the SIC immediately causes difficulties in the meaningful analysis and interpretation of employment data, because:

- ICT is a rapidly developing sector, with constantly changing sector boundaries;
- the basic ITEC segments, as defined by the SIC - computing, communications and electronics - are converging, which means that an increasing array of electronics or telecomms products have software embedded in them. Boundaries between the ITEC sub-sectors are blurring, although skill sets themselves may not be merging. For instance, the concept of a software engineer working with embedded software in the electronics industry is different from that of a software engineer designing systems for e-commerce (eg NIERC, 2000);
- ICT occupations are found across the economy, not only in companies whose core business is ITEC products - *'ITEC is everything'*, (OST, 1996). Their coverage is therefore wider than the ITEC SIC categories.

Furthermore, much of the available occupational information is based on the Standard Occupational Classification (SOC), eg the Labour Force Survey, which is often not sensitive enough to pick up on ICT skills issues within the various sub-sectors or specific ICT jobs.

Because of the pervasive nature of ICT across the economy, and the difficulties outlined above relating to the SIC and SOC, we have adopted a scope for this dialogue which has both an industry and occupation dimension. This has been done in order to provide an assessment of ICT skills and employment trends that we hope is both comprehensive and meaningful to all involved in the sector.

1.3.1 ICT industry dimension

The overall aim of the dialogue was to build upon the 'Stevens' report (DfEE, 1999b) which took as a working definition of the industry:

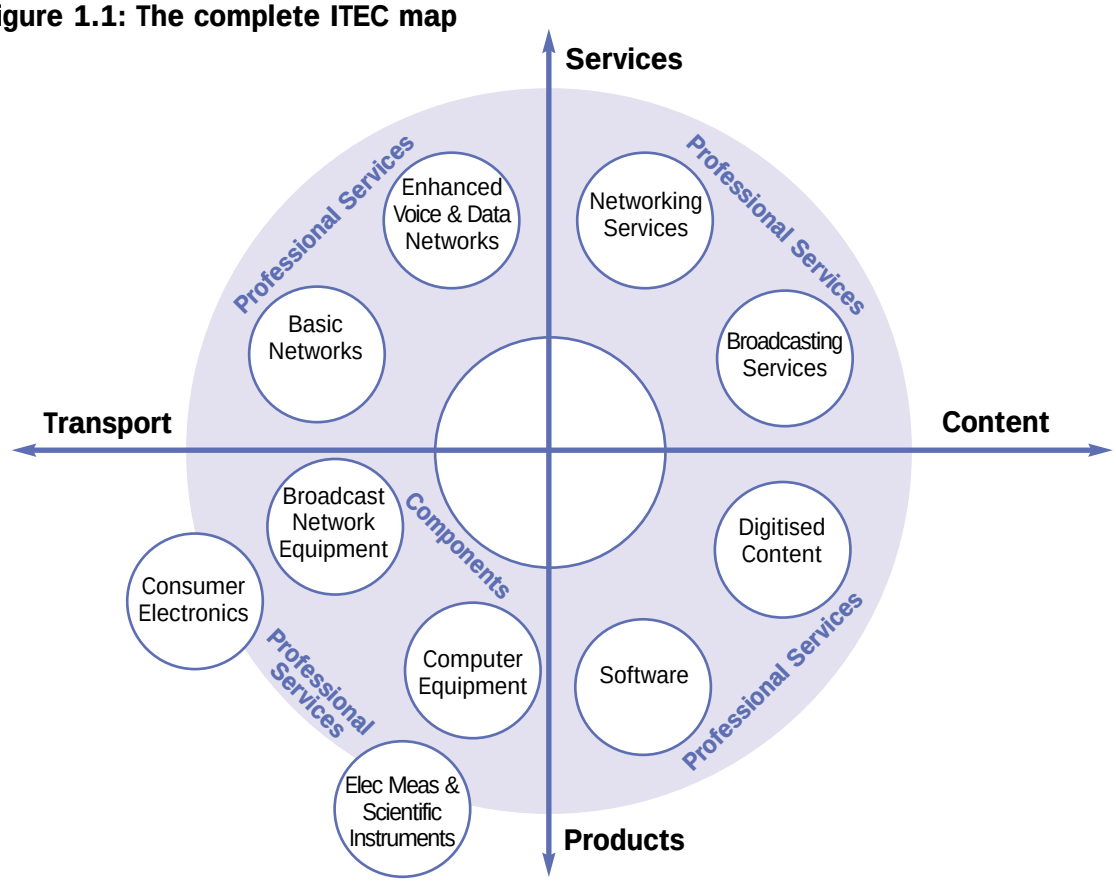
'Informatisation = the progressive application of information and communication technologies to the input, storage, processing, distribution and presentation of information.'

This definition is taken from a framework developed by Hawkins, Mansell and Steinmuller (1997) in a paper on mapping and measuring the ITEC sector, and chosen by them because:

'ICT is a social as well as a technological process, requiring management processes, organisations and skills as well as tools employed in the production of goods and services.'

They went on to identify eight broad ITEC sectors, which are shown in Figure 1.1.

Figure 1.1: The complete ITEC map



Source: Hawkins et al., SPRU, 1997

This map helps to set out a broad definition of the ITEC industries for our purposes. It includes both hardware and software activities, depicts the process of technological convergence, and also makes a distinction between ICT services/delivery and ICT product/content with their differing skill needs. However, it does not fully cover ICT employment nor the full scope of the ICT group of NTOs, as it deals only with the ICT provider or ICT dedicated industries. It also includes much of the electronics manufacturing sector (the E in ITEC) and the media industries which have been covered already to an extent by other dialogues[1]. In the case of electronics, the focus in this dialogue is primarily the servicing and delivery aspects of electronics equipment

1. The Skills Dialogue Report *An assessment of Skill Needs in Engineering* published in February 2001 contains a considerable amount of information about the electronics sector.

(eg computers, peripherals, VCRs and telephones) rather than the manufacturing activity. For the media industries we have aimed where possible to identify the most relevant parts of the new media industries (within the limitations of the available data).

The sectoral map (Figure 1.1) has been translated into a SIC-based definition for the dialogue as follows:

SIC 30, 32, 33.3	Manufacture: office/machinery/computers; electronic components, etc. TV/radio transmitters, instruments/control systems
SIC 36.5	Manufacture: Electronic/video games and toys
SIC 64.2	Telecommunications
SIC 72.1-6	IT consultancy/supply; maintenance repair office machinery; data processing and other computer related activities
SIC 92.1, 92.2 (part)	Motion picture and video activities; radio and TV broadcasting services
SIC 22.3 (part)	Sound/video recording (digitised content).

But as mentioned above the SIC has limitations when applied to ICT, in particular in analysing available data for these sectors, and these need to be borne in mind when reading this report. For consistency, much of the analysis and forecasting data on ITEC industries is based on larger (2-digit) SIC groupings: 30 & 32, 64 and 72.

1.3.2 ICT occupation dimension

Most reports about ICT people and skills tend to focus on employment in ICT industries (ie as defined above). These are often referred to collectively as the ICT provider or ICT dedicated sector. Much of the wider ICT community ie the 'ICT user' or non-ICT dedicated sector, is often omitted. This includes most of the rest of the SICs.

This report has adopted an occupational definition that focuses on ICT practitioners ie ICT relevant occupations which can be found across a range of industries, both in the ICT dedicated and non-ICT dedicated sectors. They include people who have a high level of knowledge, experience or understanding of ICT (design, development, installing, maintaining, managing and supporting computer systems, telecommunications networks, software applications and/or hardware capabilities) rather than people with primarily ICT user skill needs (eg users of MS Office and the Internet; or PC sales staff with basic support skills). The latter are included in other Dialogue reports, in particular the one on the financial services sector which will be published in late autumn 2001. We recognise though that there can be some difficulty defining ICT relevant occupations, especially as increasingly some people are combining a high level of ICT skills with other specialist skills in their jobs (eg in publishing and operational management), and ICT skills reports have various occupational coverages. Also, as the number of ICT users increases, there will be an effect on the skill requirements of ICT practitioners and how employers resource their needs for them (via the user community).

Figure 1.2: SFIA skills framework

Category	Sub-category	Skill
Strategy and planning	Information management	Information resource management
	Advice and guidance	Consultancy, technical specialism
	Business/IS Strategy and planning	Business process improvement, IS strategy and planning, business risk management
	Technical strategy and planning	Systems architecture, Change control, Business continuity planning, Emerging technology monitoring, Methods & tools, Network planning
Management and Administration	Supply management	Contract management, Procurement
	Project management	Programme management, project management, Project office
	Quality management	Quality assurance, Quality management, compliance
	Resource management	Asset management, Systems development management, IS co-ordination, ICT management, Service delivery management
Sales and marketing	Sales and marketing	Account management, Marketing, Selling, Sales support
Development and implementation	System development	Business analysis, Systems design, Database design, Data analysis, Programming/software development, Technical authority, Systems testing
	Human factors	Systems ergonomics, Media creation
	Installation and integration	Systems integration, systems installation/decommissioning
Service Delivery	Education and training	Education & Training management, Development & training, Education & training delivery, Training materials creation
	Infrastructure	Configuration management, Network control, Capacity management, Security administration
	Operation	Application & system support, ICT operations, Database administration, Service level control
	User support	Network administration & support, User support
User	User	Business-IS alignment, information handling, use of ICT

Source: e-skills NTO (June, 2001)

The main functional ICT groups can be seen in the SFIA framework (Skills for the Information Age, a collaborative effort to develop a skills matrix, organised by e-skills NTO, see Figure 1.2.) The categories are similar to those used in the British Computer Society's Industry Structure model (ISM 3.2). (NB In this dialogue, the 'User' category shown in the SFIA framework was not included).

The SFIA framework is a commonly agreed classification of the jobs that exist in ICT or of the skills required to perform them. It is relatively new and so little occupational data are available based around it. Much of the analysis of ICT employment data which has been used in this report however has had to use the 1990 Standard Occupational Classification (SOC) system (and where available, the new 2000 SOCs). The main difficulty with the SOC90 is that it identifies traditional IT groups such as IT managers, software engineers, computer analyst/programmers, computer operatives, etc. who do not map easily onto the job groupings which many employers currently use to identify skill needs (and are included in SFIA). Nor does it deal adequately with the new occupations in the ICT industries, especially those in new (digital) media. The 2000 SOC codes are slightly better in this respect but there are little data currently available to analyse on this basis. The main exception is the occupational data from the recent national ICT Skills Survey of employers (undertaken by NOP, for the ICT group of NTOs, in early 2001) which used an occupational framework broadly based on SFIA to obtain information on the ICT workforce and employers' skill needs. The survey was structured around key ICT functions (eg. product development, external ICT customer services, internal ICT operations/services, ICT sales and marketing, strategy and planning). The main survey results are included in this Dialogue report (e-skills NTO, 2001c).

In reading this report, it is worth bearing in mind that, while the majority (but not all) of employees in the ICT dedicated sector are likely to be in ICT relevant occupations, their proportion varies in non-ICT dedicated businesses. Also, the ICT occupational pattern itself varies between and within the two broad sectors. Some individual ICT staff may not feel this distinction between ICT dedicated and non-ICT dedicated sectors is valid (as their careers may take them into both sectors) and boundaries are blurring as some non-dedicated companies integrate ICT more into their products and become more like ICT dedicated companies. But we feel it still an important distinction to make in assessing the nature of trends in ICT employment and skill needs in the economy, and also understanding the key 'drivers'.

1.3.3 Geographical coverage

One further point on scope is that the intention of all the dialogue reports is to provide a mainly UK-wide perspective on changing skill needs and supply, identifying where possible from the available data key regional or country differences. We have followed this principle here, though not all the data available cover all of the UK, and, where available, an international perspective on some issues is also included. ICT is increasingly a global business with companies outsourcing functions internationally and international flows of specialist staff to meet skill needs and so it does not make sense to focus exclusively on supply and demand within the UK labour market.

1.4 Approach

It was realised at the outset of this dialogue that the issues surrounding skill change and needs in ICT have been the subject of many labour market studies over the years, and that a great deal of information has been amassed. However, it was also

recognised that it is an ever changing picture and much of the available evidence on skills has been put together in a piecemeal way. As mentioned above (Section 1.2), there is no consensus as to the overall size of the ICT population nor the scale of current skill shortages, nor on skill forecasts. The approach taken by the dialogue has been to add value to the existing sum of knowledge by:

- being comprehensive and cumulative - aiming to build a clear consensus around the skill needs and how to address them for the whole sector, not just some of the constituent parts where various past studies have focused. These have used different definitions and bases, and there has been no mechanism for bringing them together to form a coherent assessment. As the importance of understanding related technological developments grows and ICT technologies converge, a pan-sector approach becomes more important;

- being inclusive - providing 'key players' in the sector, including employers, the opportunity to contribute views, experiences and information, and to respond to the findings and implications drawn. In particular, the draft findings including provisional future scenarios were presented at the recent Dialogue Seminar and views of participants included in this final report;

- being forward looking - capturing the dynamic nature of the sector and accurately presenting the changes taking place. Information on ICT gets out of date quickly and there has been little in the way of trying to anticipate future skill requirements in this fast moving sector where provision (in education and training) can often lag behind demand;

- being authoritative - basing the assessment of skill needs on the evidence available from a review of the data and literature and commenting on its robustness.

The main work undertaken to date has followed a broadly similar pattern to other dialogues. The key elements have been to:

- obtain the most up-to-date information which is held by a range of organisations on: skill needs, shortages, supply and other associated issues. This included reports, salary surveys, industry surveys and discussion papers;

- extract relevant information from Government statistical sources (eg Labour Force Survey);

- liaise with the consultants (NOP) and the NTOs involved in the recent skills survey of ICT employers in the UK (e-skills NTO, 2001c) and make use of relevant output data;

- consult with a range of people in employing organisations, trade bodies, professional bodies, RDAs, NTOs and other local and sector bodies with an interest in ICT skills issues (over 40 interviews have been undertaken);

- collate, analyse and review all the information obtained from the various sources to assess the current position and current trends;

- explore future demand trends through the development of a number of provisional scenarios and a forecast analysis;

- draft this final report.

1.5 Report contents

The report is organised into six further chapters:

Chapter 2 deals with ICT employment and skill demand. It defines the ICT population, assesses recent trends and discusses its distinguishing characteristics.

Chapter 3 discusses the supply of people and skills to the sector from the education system (particularly higher education), vocational training and employer-based training.

Chapter 4 focuses on skill problems. It presents evidence on the extent of shortages (ie external recruitment problems) and gaps (skill deficiencies in the existing workforce), their impact on businesses and the wider economy, and actions being taken to alleviate problems.

Chapter 5 then turns to the future. It discusses the main influences on the pattern of demand for, and supply of ICT skills and jobs and discusses the available future projections on demand. A range of scenarios are presented to help inform discussion of future trends.

Chapter 6 draws conclusions from the assessment of ICT skill needs and highlights the main messages to emerge from the review. It includes our recommendations for future action to improve the supply of skills and meet future demand.

A bibliography of all the material collated during the course of the dialogue is presented in an Appendix.

2. Employment and Skill Demand in ICT

This first main chapter of this ICT Dialogue report brings together the available evidence on the demand for people in the ICT sector and people in ICT relevant occupations (see Section 1.3).

It provides a quantitative assessment of the ICT population and employment trends, based on our investigations of the available data sources, and highlights the defining employment characteristics of the sector. In so doing, it draws attention to the uncertainties involved in making ICT population estimates, because of the inherent definitional difficulties and data deficiencies associated with ICT sectors and occupations, highlighted in the introductory chapter.

It also includes evidence on skill needs and changing employer requirements. ICT skill issues are further discussed in the two chapters which follow - Chapter 3 focusing on the supply of ICT skills and qualified personnel and Chapter 4 on skill shortage problems.

2.1 Key points

The main points made in this chapter are set out below.

- Taking all the evidence into account, there are likely to be a little over a million people employed in a job which is largely dependent on their technical skills in information and communication technologies and/or employed in workplaces where the business activity revolves around information and communication technologies.
- Personnel in ICT occupations have been growing considerably faster than the UK workforce as a whole, especially in the ICT dedicated sector.
- The largest cluster of ICT personnel are found in the computer services sub-sector within the ICT dedicated sector. The non-ICT dedicated sector accounts for around half of the total ICT population, a proportion that has been shrinking in recent years. Financial and business services make up the lion's share of ICT employment in the non-ICT dedicated sector.
- The SOC category described as 'software engineer' represents the fastest growing of the ICT occupational categories, and demand for this group is highest in the computer services sub-sector. Slower growing occupations are generally at lower skill levels.
- The ICT dedicated sector, and especially the computer services and new media sub-sectors, are dominated by small firms, though most of the ICT workforce is employed by larger companies. The non-ICT dedicated employers are likely to be larger ones.
- Self-employment in ICT is slightly higher than the average for the workforce as a whole. It is much higher in some ICT occupations (such as software engineers) and in the computer services sub-sector.
- ICT personnel are slightly younger than the average for all employees, but this overall figure masks differences by occupation and sector. New areas of ICT employment, such as web design, have some of the youngest workforces.

- There is strong regional clustering of ICT work in and around London and the Home Counties. The profiles of ICT employment by occupation and sector vary considerably by geographical region and country.

- Women remain under-represented in ICT employment, and especially in jobs at higher skill levels, and little change has taken place in female participation rates. A number of barriers to increasing the female employment share have been identified in education and employment.

- People in ICT occupations are likely to be better qualified than the average employee. In particular the proportion of graduate employees in ICT is high and growing. Almost half of employees in computer services are graduates.

- The most frequently mentioned technical skills sought by employers are those associated with the Windows/NT operating system. Other key areas include Microsoft applications (eg Access, Office and Publisher) and to a lesser extent the Unix operating system and the C and C++ programming languages.

- Demand is growing, but still at a comparatively low level, for people skilled in newer languages and operating systems such as Java, Perl, XML and Linux and the Internet-related areas of HTML and JavaScript.

- While many ICT professionals need advanced technical skills, they also need other generic or soft skills to be able to apply their technical expertise in a business environment and to work well with others. Problem solving, communications, team working, and numeracy skills are all emphasised by employers.

2.2 The two dimensions of the ICT population

As explained in the introductory chapter, the scope of this dialogue covers both people working on ICT business activities and people with ICT skills working in ICT dedicated and non-dedicated sectors. Thus, there are two main ways of estimating the ICT population ie sectorally and occupationally:

- First, in terms of employment in the **ICT sector**, or ICT dedicated organisations, this population comprises all people in the industrial coverage whether or not they are ICT skilled staff. In the UK, the ICT dedicated industries have been defined by reference to the 1992 Standard Industrial Classification (SIC92) scheme but, as discussed in Section 1.3, the SIC has limitations when applied to ICT. Difficulties can arise when only part of some SICs are relevant (eg the telecommunications sub-sector in the wider communications sector, or parts of broadcasting services) and data are not available to make this distinction clear.

- And secondly, in terms of employment of **ICT personnel**, this covers people in ICT occupations who can be found in any economic sector, both ICT dedicated and non-dedicated businesses. Here, the difficulty lies in classifying ICT relevant occupations (see Section 1.3.2). Different sources of data use different occupational definitions, and much of the relevant ICT occupational data is rather narrowly defined.

Estimates vary as to the total population of ICT staff that currently exists, depending on which base is used, and also where the sector or occupational boundaries are drawn. Below we review the main sources (which are summarised in Table 2.1).

2.2.1 ICT dedicated sector population

A recent OECD survey (2001) which aimed to measure the ICT sector in member countries, based on published national statistics suggests a total of **just over 1.1 million** for the UK in 1997, representing nine per cent of total OECD ICT sector employment. The UK ICT total accounts for approximately five per cent of the total UK business sector, compared with 3.6 per cent for the OECD average. The estimate for the 'ICT services' sub-sector only in the UK (including 'wholesaling of goods') was just over 800,000.

This survey took a definition based on industrial classes in the International Standard Industrial Classification (ISIC) that cover ICT services and manufacturing, and includes all employees in these industries. It corresponds broadly to the ICT dedicated sector shown in Section 1.3.1, which relate to the scope of this dialogue, but it excludes the parts of media and broadcasting services which the dialogue includes (see Section 1.3). Note that the OECD definition includes under IT services 'wholesaling of machinery, equipment and sales' which is broader than just ICT goods and not identified in Section 1.3.1 as being within the ICT Dialogue defined scope.

Table 2.1: Estimates of the size of the ICT population

Data source	Estimate (see text for the basis of each total)
ICT Sector	
OECD (1997)	1,100,000
AES (1997)	870,000
ABI (1999)	1,000,000
LFS (2000)	1,200,000
KPMG (2000)	1,200,000
ICT Service sub-sector	
OECD (1997)	810,000
ICT occupations	
LFS (2000)	938,000
ITNTO/AISS (1999) and LFS (2000)	1,100,000 to 1,300,000
ICT Skills Survey	900,000 to 1,230,000
EITO	1,900,000

Source: Various

A similar, though slightly smaller, estimate of the size of the ICT dedicated sector comes from the UK's Annual Employment Survey (AES, based on workplace data and excluding establishments with less than five employees) in 1997, the latest year available at this level of breakdown. This showed a total ICT population of just over one million, representing 4.4 per cent of the all-industries total. Like the OECD estimate, this ICT population estimate also includes the whole of the 'wholesaling' sub-sector (around 237,000) but not the relevant media/broadcasting sectors (around 100,000). Excluding all of 'wholesaling' but including the media sectors, brings the **ICT dedicated sector population estimate to 870,000** including 180,000 people in electronics manufacture. (NB there are other small differences between the AES and the OECD totals due to small variations in coverage of industry classes). Within that total, the computer services sector population is estimated at 356,000.

The AES has been replaced as the main source of employment data by the Annual Business Inquiry (ABI) Employee Analysis. The latest available data for 1999 (Table 2.4) suggests a total of one million (including 180,000 in electronics). The main difference from the AES is in the IT sub-sector where the population is over 500,000.

An even more up-to-date ICT dedicated sector population estimate, for the year 2000, can be derived from the quarterly Labour Force Survey (LFS), though this is on a different basis to the AES (the LFS is an individual-based sample survey where data relates to individual's reported place of work). This shows a total of **1.5 million people** in the ICT dedicated sector in the September 2000 quarter (Table 2.2). The coverage is slightly wider than the AES total as it includes self-employed people as well as employees in very small workplaces (with under five employees), and also the whole of the communications sector not just telecommunications (SIC 64). But it excludes the 'wholesaling' sector. Approximately two-thirds of the communications sub-sector are not in telecommunications services and so if they are subtracted from the total, then the population (employed in electronics, telecommunications and computer services industries combined) is estimated **at around one million**. However, this is likely to be an under-estimation of the total as it excludes all of those employed in the wholesaling of ICT goods and also in parts of the media/broadcasting sector which are likely to be relevant (see Section 1.3.1). If these were to be included, then the total ICT dedicated sector population in 2000 based on this wider coverage is likely to be **around the 1.2 million** mark. A recent report on the electronics industry (but which appears to cover IT services too) also suggests an employment total of 1.2 million, though the basis of this estimate is not clear (KPMG, 2000).

2.2.2 ICT personnel population

We can derive an ICT personnel population estimate based on the number of people employed in ICT relevant occupations (across all industries) by also using the Labour Force Survey (LFS). The occupational categories of the available LFS data are based on the 1990 Standard Occupational Classification system (SOC90) groups and it is possible to identify five groups of most relevance to ICT:

- IT/computer managers - who include computer operations managers, data processing managers and systems managers;

- software engineers - including project leaders and computing systems designers. It should be noted that software engineering skills employed on user software (*on* a machine) in IT can be very different to those required by software engineers, dealing with embedded software (ie *in* a machine) in electronics;
- programmers/analysts - including analysts programmers, applications programmers, computer programmers, systems analysts;
- computer engineers - including computer maintenance engineers, computer service engineers and computer service technicians; and
- computer operatives.

The total number employed in these five SOC groups was **938,000** in September 2000 (Table 2.3). However, this is certainly an underestimate. It does not include people in jobs which require a high level of ICT skills but come under other SOC90 categories, for example teaching, research, operational management, sales, marketing and other technical functions (eg electronics engineering), and also some of the new digital technology and creative media occupations (involving the creation, development, maintenance and exploitation of the Internet). The electronics manufacturing industry alone employs over 100,000 professional engineers, electronics/electrical technicians and assembly workers not included in this 938,000 estimate (EMTA, 2000), and there are at least an additional 20,000 people in digital media jobs (BIMA, 2000), 2,800 broadcast engineers and 3,500 'animators' (Skillset, 2000). A labour market study in 1999 (ITNTO/AISS, 1999) suggested that the LFS estimates of the ICT population, based on the five SOC categories above, underestimated the number of people in IT related jobs by 40 per cent. On this wider basis, and taking into consideration other ICT related occupations not included, it seems reasonable to suggest that the total ICT personnel population is likely to number at least **1.1 million and possibly up to 1.3 million**.

The new SOC2000 classification system is expected to provide a better basis on which to analyse occupational profiles in ICT areas but early indications are that it too does not adequately capture the range of ICT occupations. The only data available currently are from occupational analysis and projection work undertaken for the National Skills Task Force by the Institute of Employment Research (Wilson *et al.,* 2000). This indicates a total of 313,000 ICT professionals in 1998 (code 213) and 69,000 ICT associate professionals (described as IT service delivery occupations, code 312). Other ICT occupation groups are part of larger groups and not identified separately.

The recent ICT Skills Survey (e-skills NTO, 2001c), based on a large sample of employers, was used to try to give a population estimate of the number of ICT professionals. The results show a population of around 900,000 (subject to confirmation). However, the survey does not include self-employed or ICT staff in micro businesses (with under five employees), because of the difficulty of reliably surveying them (estimated by authors at round 230,000). Therefore, a more comprehensive estimate based on this source is likely to be well over one million.

Lastly, another estimate of ICT related jobs is given in the recent European IT Observatory Report (EITO, 2001). This uses a much wider definition of ICT related jobs (which includes ICT, e-business and call centres) and suggests a much larger ICT population, a total population in the UK of 2.7 million. This breaks down to approximately:

- 1.9 million ICT professionals (requiring skills in applications, Internet-working, distributed systems, *etc.*);
- 652,000 e-business professionals (which include Internet business strategists, web designers, marketing professionals, publishers, *etc.*); and
- 180,000 call centre staff (mainly customer service staff with relatively low level of ICT skills).

This wider population estimate is likely to include many of the new and growing ICT jobs for example in new media and web-based services companies and e-commerce, which are not covered adequately by the data above, based on the SOC system. However, the basis for making the estimate is not clear from the published material.

2.2.3 ICT industries/personnel matrix

Of the 940,000 personnel in the ICT core occupations (as defined by the SOC90 codes and provided by the LFS 2000 data), just under half (420,000) were employed in the ICT dedicated sector, and slightly more (520,000) were in the non-ICT dedicated sector. This represents a 45/55 per cent split. (*NB* Here and in the rest of the analysis of LFS data by ICT industries in this chapter, the media/broadcasting services sector is not included. If it were, then the proportion in the ICT dedicated sector would be higher, nearer 50 per cent).

The ICT Skills Survey, see above, provisionally suggests a similar split, with some 60 per cent of ICT professionals employed in the non-ICT dedicated sector and 40 per cent in the ICT dedicated sector, (e-skills NTO, 2001c).

Focusing on LFS (2000) again within the ICT dedicated sector, by far the largest share of the ICT personnel total are in the computer services sub-sector (339,000), and they represent one in three of all ICT personnel in all sectors (as defined by these SOC90 occupational groups). The ICT occupations account for 61 per cent of the total employment in computer services, but just 14 per cent in the electronics sector (where large numbers are in electronics occupations, as mentioned above) and six per cent in the communications sector. These proportions give some credence to the assertion above that the SOC categories are too narrow to capture the total employed in ICT related jobs.

Within the non-ICT dedicated sector, by far the largest employers of ICT personnel are financial services (123,000). Next comes other business activities (64,000) and public admin, defence and social security (57,000). Others with substantial numbers are education (35,000), retail trades (30,000) and printing, publishing etc. (23,000).

Table 2.2: Employment in ICT industries, 1995 to 2000 (UK)

ICT sector (SIC)	Employment in 1995 (000s)	Employment in 2000 (000s)	Percentage of total ICT (2000) (%)	Percentage change 1995-00 (%)
Communications (64)	515	645	43.0	+2.5
Computer services (72)	268	555	36.9	+106.7
Electronics (30,32)	298	302	20.1	+1.2
Total ITEC	*1,081*	*1,502*	*100.0*	*+38.9*
Total economy	25,900	27,800	-	+7.3

Source: Labour Force Survey (1995, 2000)

2.2.4 Size of the sector - summary

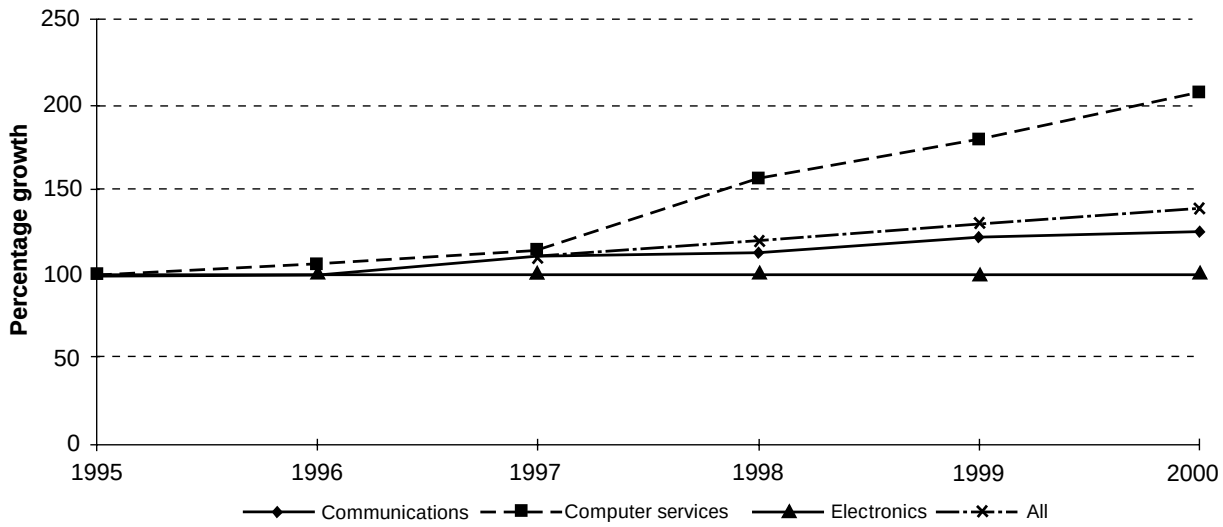
Taking all the evidence into account, and taking account of the reliability of the various sources, we estimate that there are slightly more than one million people employed in a job which is largely dependent on their technical skills in information and communication technologies.

2.3 ICT population trends

Between 1995 and 2000, total employment in the **ICT dedicated sector** increased by 39 per cent, that is an increase of nearly half a million people (based on LFS estimates, see Table 2.2 for sector coverage). The fastest growing of the ICT sub-sectors was computer services (which more than doubled) while the other two sectors grew only slightly. The data also clearly shows the much faster growth rate in computer services than in the economy as a whole over the period (only seven per cent growth). The telecommunications sub-sector (within communications) also grew at a faster pace (almost 40 per cent).

However, the trend has not been steadily upwards and growth has fluctuated over the period, as shown in Figure 2.1. For computer services, the annual growth peaked in 1997/98 at 30 per cent, and has since averaged around 15 per cent per annum.

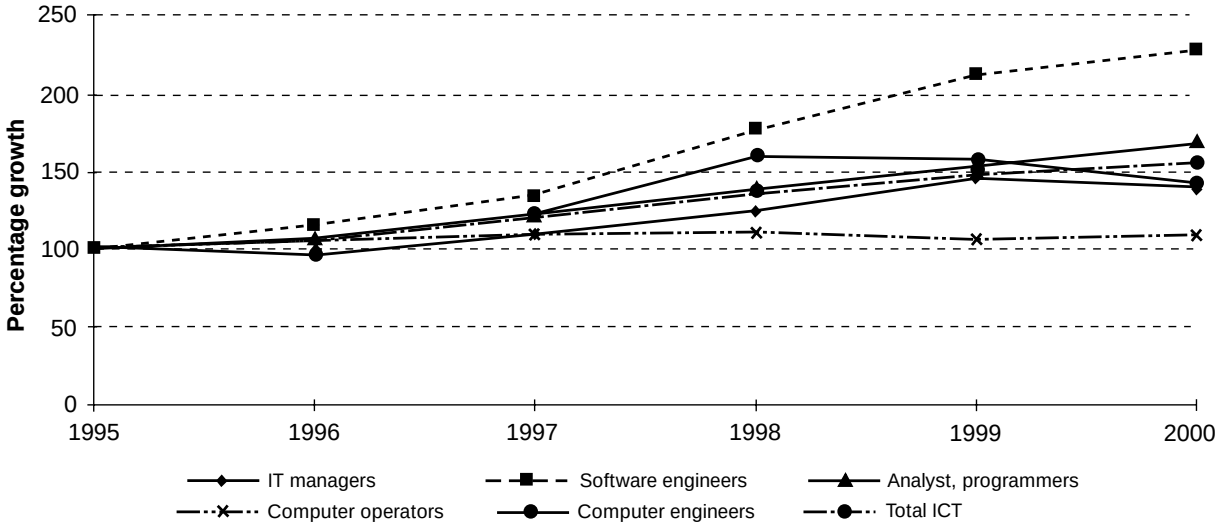
Figure 2.1: ICT Population trends, 1995- 2000



Note: 1995 = 100

Source: Labour Force Survey 1995-2000

Figure 2.2: ICT Population trends, 1995- 2000



Note: 1995 = 100

Source: Labour Force Survey 1995; 2000

Looking at the **ICT personnel** population (based on the identified ICT occupations as discussed above), the trend has also been one of substantial growth, especially in the late 1990s. Numbers increased by 56 per cent between 1995 and 2000, representing over 300,000 additional jobs (Table 2.3).

Annual growth rates for total ICT personnel peaked at over 15 per cent between 1998 and 1999, and have since dropped to just four per cent over the last year (Figure 2.2). It seems likely that the overall employment trend has been affected by a number of factors. These include: the overall economic trend pattern reflected in trends in corporate purchasing of IT products and services; the impact of the Year 2000 date change, which led to an acceleration in demand in 1999; and more recently the development of telecommunications and digital technology, e-commerce and the Internet. For reasons of occupation definition difficulties (discussed earlier), the true growth in demand for ICT staff produced by the recent rapid growth in the use of the Internet and digital media may be underestimated by these occupational trend figures (see Chapter 5 for further discussion of the influences on demand).

Table 2.3: Employment of ICT personnel, 1995 to 2000 (UK)

ICT occupation (SOC90)	Employment in 1995 (000s)	Employment in 2000 (000s)	Percentage of total ICT (2000)	Percentage change 1995-00
IT/computer managers(126)	133	185	19.7	+39.3
Software engineers (214)	87	200	21.3	+128.9
Comp analysts/programmers (320)	201	341	36.3	+69.3
Computer operators (490)	137	151	16.1	+9.9
Computer engineers (526)	43	61	6.5	+41.9
Total of above ICT occupations	602	938	100.0	+55.9
Total economy	25,900	27,800	-	+7.3

Source: Labour Force Survey, 1995; 2000

There has been much faster growth in demand for ICT personnel (as defined by these SOC groups) than in the ICT dedicated sector, up by 92 per cent since 1995, compared with the non-ICT dedicated sector (36 per cent). This has helped to shift the balance of ICT employment towards the ICT dedicated sector, from 36 per cent to 45 per cent of the total ICT personnel population in the last five years. There has also been a growth in outsourcing by non-ICT dedicated companies to more specialist firms, and changes to the structure of IT departments of large organisations. The latter includes declines in 'straight' programming and data inputting and increases in customer support (eg help desks, network development) and also increased demand for providing 'business solutions'. The ITNTO[1]/AISS 1999 report also showed a reduction from 78 to 69 per cent in the proportion of IT practitioners employed outside of computer services companies between 1994 and 1998. This shifting balance of employment also reflects differences in the occupational profiles of the two ICT sectors (see Figure 2.1) combined with the differential growth rates of ICT occupations over the period. The ICT dedicated sector has a higher demand for software engineers (see below), the fastest growing occupational group, and less need for computer operators, where growth in demand has been much smaller.

Within the non-ICT dedicated sector, faster growth in ICT personnel than the sector average has been recorded in printing and publishing (up by 71 per cent over the last five years); parts of the financial services sector (ie not pensions and insurance) (up by 92 per cent) and other business services (up by 96 per cent).

1. The ITNTO merged with the e-business NTO to form the e-skills NTO in July 2000.

Table 2.4: Distribution of employment and establishments in ICT sub-sectors, 1999 (Great Britain)

Subsector	Employment	Establishments	% of total employment	% of total establishments
Manufacture: office machinery/ computers (30)	51,400	1,870	5.1	1.2
Manufacture: electronic components etc. (32.1)	50,300	1,000	5.0	0.6
Manufacture: TV/radio transmitters/ receivers, etc. (32.2/3)	71,600	2,180	7.1	1.4
Manufacture: (electronic/video) games and toys (36.5)	9,300	820	0.9	0.5
Telecommunications (64.2)	221,000	8,260	21.9	5.2
IT consultancy and supply (72.1/2)	264,000	71,970	26.1	45.4
Maintenance/repair: office machinery, etc. (72.5)	27,800	2,280	2.8	1.4
Data processing, database activities and other comp related activities (72.3/4/6, 71.3)	210,800	60,160	20.9	38.0
Motion picture and video activities (92.1)	28,900	5,390	2.9	3.4
Radio and TV (broadcasting services) (92.2)	68,200	3,460	6.8	2.2
Sound, video recording (digitalised content)	6,900	1,100	0.7	0.7
Total of the above	*1,010,200*	*158,490*	*100.0*	*100.0*

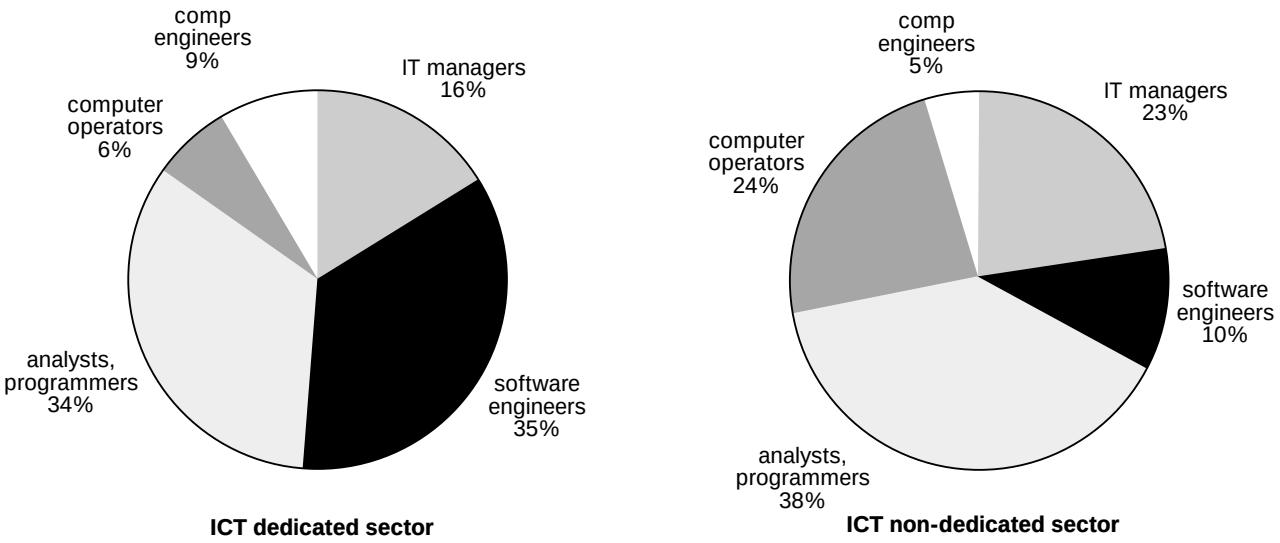
Source: Annual Business Inquiry (employee analysis) 1999

2.4 ICT occupation profiles

According to national employment (SOC based) data, the largest of the ICT occupational groups is computer programmers and analysts (36 per cent share of the total in 2000, LFS). Next in relative importance, sizewise, come software engineers and IT/computer systems managers, with 20 and 21 per cent respectively.

Figure 2.3 illustrates the marked difference in the occupational profiles of the ICT dedicated industries compared to the non-ICT dedicated ones. Software engineers comprise the largest group in the ICT industries (35 per cent), but just ten per cent in non-ICT dedicated, while computer operators comprise just six per cent in the ICT industries compared to 24 per cent of ICT employment in non-ICT dedicated businesses.

Figure: 2.3: Occupational profiles of ICT dedicated and non-ICT dedicated sectors



Source: Labour Force Survey, 2001

Looking at the ICT occupational profiles of the sub-sectors of the ICT dedicated sector (but excluding media/broadcasting industries as insufficient data available on this basis), there are also important differences. In particular, software engineers represent a higher proportion of the total ICT staff in computer services, while computer operators feature more in the communications sector.

Overall, across the economy, growth rates have been considerably faster for software engineers (more than doubled) than for computer engineers (just ten per cent over the period). Computer analysts/programmers remain the largest ICT occupational group and, although numbers have grown more slowly than for software engineers, its share of the total population has still grown (up from 33 to 36 per cent of the total). The lower level occupations, of computer engineer and operators, have been growing more slowly than the higher level, professional and manager ICT occupations.

An alternative way of grouping ICT skills and jobs is the new Skills Framework for the Information Age (SFIA) (see Figure 1.2). This aims to take more account of the diverse requirements of ICT employers than does the SOC system, and also actual ICT job groups found in the workplace, in particular the new ICT jobs. The ICT Skills Survey (e-skills NTO, 2001c) used this to develop a list of functions, and occupational roles within them, which could be used for collecting workforce data from employers. According to the survey, nearly 40 per cent of ICT professionals work in internal ICT operations roles and a quarter in a product development function. In the ICT dedicated sector most professionals work in product development (around a third) and external customer services. By contrast in the non-ICT dedicated sector ICT professionals mainly work in internal operations (over two fifths) and product development (around a quarter). The main occupational roles identified by the employers were:

- ICT software development professionals (product development);
- ICT systems support operators and administrators (internal operations);
- training professionals, eg training managers, executives and consultants (internal operations);
- helpdesk support operators and ICT support analysts (internal operations);
- ICT sales professionals and account managers (sales and marketing);
- customer systems support professionals (external customer services);
- ICT operations managers eg communications, IT, network or telecommunications managers (internal operations);
- technicians/engineers (product development);
- systems development professionals (product development);
- Internet/web professionals (product development).

These map onto some of the sub-categories and skill groups shown in Figure 1.2.

A recent NCC/Computer Weekly Tracking Survey in August 2000 (covering a large sample, around 2000 readers, though representing an unknown survey response rate), found that 69 per cent of them worked in software development to a 'significant extent' compared with 60 per cent in user support, 56 per cent in installation and integration and 51 per cent in project management. Most of the respondents had worked in at least one of the SFIA roles in their career to date, with the average number being five, indicating the diversity in many career paths.

An e-business NTO[1] survey of firms in 1999 showed that the IT services industry was divided fairly evenly into four occupation role groups: services development, services management, customer support and technical services (based on an earlier version of the SFIA framework).

Other data from market surveys, based on salary and job advertising surveys, have found higher growth in demand over the last year or so in PC support roles and also in management positions and Internet-related work (see for example Virgo, 2001).

1. E-Business NTO merged with the then ITNTO in July 2000 to form the e-skills NTO.

2.5 Characteristics of ICT employment

There are several important features of the characteristics of the jobs and people working in and with ICT:

- a lot of small firms and independent contractors/self-employed and some very large, dominant employers;
- regional clustering in South East England;
- youngish age profile;
- under-representation of women;
- comparatively high qualification profile.

2.5.1 Size breakdown

There is a high, and apparently growing, proportion of small companies in the ICT dedicated sector. Almost 90 per cent employ fewer than five people, and just one per cent employ 500 or more. The larger companies, however, account for the majority of the workforce - two-thirds of employees are in businesses with 50+ employees. By contrast, ICT staff in the non-ICT dedicated sector tend to be in larger organisations. For example, over half of the public sector organisations which subscribe to the CCTA Foundation (having ICT skill needs) employ over 500 staff (CCTA, 2000).

Looking more closely at ICT dedicated businesses, establishments in electronics and telecommunications are likely to be larger than those in computer services. Businesses in IT consultancy and supply, which comprise the largest sub-sector of the ICT dedicated sector, tend to be smaller on average than others. They account for a quarter of the total employment, but almost a half of all establishments in the ICT dedicated sector (Table 2.4). By contrast, telecommunications businesses are much larger on average: they have a 22 per cent share of total employment but just five per cent of total establishments. Data processing/database companies also tend to be relatively small businesses, and make up almost two-fifths of all ICT dedicated businesses, as do those in new media industries (averaging around 20 staff, though companies in new media and web design are more likely to be much smaller, micro-businesses, often new start-ups).

The ICT sector's size pattern was highlighted in the recent e-business NTO Foresight report (2000), which showed that 80 per cent of IT companies employed fewer than 20 people but account for only 25 per cent of the total workforce. Almost one-third of the workforce are in companies with over 250 employees. The ITNTO/AISS IT skills report (1999) showed a 25 per cent increase since 1994 in the proportion of IT personnel working in companies employing fewer than ten people (all industries).

2.5.2 Self-employment

Significant numbers of particular groups of ICT staff are self-employed or work as independent contractors. They can be working alongside a firm's employees in an IT department or from their own premises (often home-based) as, for example, trainers or consultants, though the stereotypical employee teleworker based solely at home is relatively rare (Huws *et al.*, 2001). An interesting pattern is emerging in the new media industries with small businesses comprising a mix of full-time staff, temporary contractors and freelancers.

According to the Labour Force survey 7.2 per cent of people in ICT occupations in 2000 were self-employed, a figure that has been increasing over the last five years (5.8 per cent in 1995). This is lower than the UK workforce average (11.4 per cent) which is perhaps somewhat surprising. However, in the ICT dedicated sector, the self-employed figure is much higher, at 13.5 per cent, and slightly exceeds the UK workforce average. It is likely that the LFS estimate of self-employment for ICT staff is an underestimate of the true situation as some people with ICT skills working as self-employed business or financial consultants will be classified elsewhere in the LFS.

The NCC/Computer Weekly tracking survey (August 2000) reported a self-employed figure similar to the ICT dedicated sector figure shown above: almost 14 per cent of survey respondents were either self-employment contractors, contractors employed by IT suppliers or had some other form of non-employee contract.

It is worth noting that self-employment is much higher in particular ICT occupations and sectors: for example, 21 per cent of software engineers are self-employed compared with just six per cent of analyst/programmers and virtually no IT/computer systems managers. While 12 per cent of people working in the computer services sector are self-employed, just three per cent in telecommunications services and just one per cent in electronics sectors work for themselves (LFS, 2000). Very few self-employed people working in ICT occupations outside of the ICT dedicated sector were recorded in the LFS, though many self-employed people are likely to be actually working as contractors in ICT functions inside non-ICT dedicated businesses.

A survey undertaken by the Association of Technology Staffing Companies (ATSCO) mainly covering large non-ICT dedicated firms in 1999, showed that almost half used some contract staff. This was more likely to occur among private than public sector organisations, in particular the privatised utilities and financial services, and among the larger companies. A number of employers were using 100 or more contract staff but much smaller numbers of contractors were more common. Numbers of contract staff being used had not changed much over the last 18 months in the majority of companies.

The 2000 CCTA survey of public sector organisations showed a continuing trend towards outsourcing or partnerships with the private sector. In the past, they were more likely to use outsourcing for provision of development work than operations, but the latter has now caught up with 72 per cent saying they used outsourcing for all or part of ICT development work as against 71 per cent for ICT operations. Over one-third of organisations surveyed had retained no in-house work compared with just eight per cent a year ago.

The e-working revolution has of course facilitated the potential for work to take place at a remote location (eg back offices located in other regions, teleworking). A recent European-wide survey of e-working found that half of all establishments were practising some form of eWork, and the largest proportion of this involved outsourcing (Huws and O'Regan, 2001). Interestingly, much of this outsourcing was carried out within the region in which the employer was based and relatively few crossed national boundaries. Despite the publicity given to the practice of relocating or outsourcing work to non-European destinations (eg India, Caribbean), the survey showed that this is strongly outweighed, in numerical terms, by work staying within Europe.

2.5.3 Regional clustering

London and South East England account for the largest segment of all the UK's ICT dedicated industries' establishments and employment total, and other regions each have relatively small percentages of the total. The LFS shows that England comprises 89 per cent of the total UK ICT personnel, with 43 per cent in London and the South East alone. The ICT Skills Survey (e-skills NTO, 2001c) shows a broadly similar, though slightly lower, concentration in South East England. Employment in the dedicated ICT sector is slightly more dispersed in and around London than ICT employment in the non-ICT dedicated sector. In the CCTA 2000 survey, London remains the dominant location of IT functions though several other regions (eg North West, North East and Scotland) are well represented in the total.

A recent analysis of e-working in Europe showed a strong clustering of ITEC occupations around the major European capital cities, including London, and also the densely populated parts of the Netherlands and Eastern European countries such as Poland and the Czech Republic (Huws *et al.*, 2001). Berkshire, Buckinghamshire and Oxfordshire together had the sixth highest ITEC occupational intensity of European regions, while Bedford/Hertfordshire and Inner London, the 11th and 12th highest (with 3.8 per cent and 3.1 per cent respectively of all workers in these localities). There are also clusters of e-work activities (defined in terms of ICT sectors), again mostly around major cities. The UK shows a slightly more dispersed pattern than many other countries in this respect reflecting the dispersal pattern of many large IT companies outside the immediate London vicinity down the M4 corridor to the South and West. The report's authors comment on how opportunities offered by the new Information Society Technologies are not resulting in an even geographical distribution but the development of specialist pools of labour in which 'like attracts like' and a danger of increasing regional polarisation.

The overall UK ICT employment figures mask differences between UK country and English regions in respect of their ICT occupational profiles. These undoubtedly reflect the variations in densities of different types of businesses and ICT activities in different localities. Northern Ireland has the highest proportion of software engineers (around a third of all ICT personnel compared to a UK average of 20 per cent), higher than in London and the South East (26 per cent), while the North of England regions have the lowest percentages. Computer analysts/programmers make up over half of total ICT employment in Wales and Northern Ireland but around a third in most other regions. (NB It is not possible to analyse regional patterns further using the LFS data because occupational estimates are based on small cell sizes in some regions ie below 10,000).

2.5.4 Age profile

Much is spoken about the relative youthfulness of the ICT workforce. The statistical evidence suggests though that its age profile overall is only slightly younger than the UK workforce. However, there are variations between sectors and ICT occupations and some, such as in the new areas of Internet development, web design, etc., do employ mostly young staff.

According to the LFS, the average age for people working in the ICT dedicated sector is 37 years, which is slightly younger than for all industries (39 years). The average for the computer and telecommunications services sub-sectors is younger than for other ICT sub-sectors (35 years). Almost half of employment in the ICT dedicated sector is aged under 35 years, and only 15 per cent aged 50 or over (LFS, 2000).

People working in ICT occupations have an average age of 35 years (LFS, 2000). Just over half of them (55 per cent) are aged 35 or under, compared with 40 per cent of the UK economically active population (LFS, August 2000). The largest group is 25-34 year olds. They make up 42 per cent of the total ICT workforce. The youngest occupational group is programmers/analysts, where 61 per cent are aged under 35 years. This compares with 35 per cent of IT/computer systems managers, who are more likely than other groups to be in the 35-49 age group (53 per cent).

The recent NCC/Computer Weekly (2000) survey showed that the largest group were the 'thirty-somethings' (one-third of respondents) but almost half (46 per cent) were 40 or over. This survey was targeted, however, primarily at 'IT decision makers' who are generally more experienced and therefore likely to be older.

2.5.5 Gender

Only one in four people (27 per cent) working in the ICT dedicated sector are women, and this proportion has not changed in the last five years, despite the growing number of women in the workplace generally. In the computer services sub-sector, the representation of women is lower, at 24 per cent, but higher in telecommunications services, at 31 per cent. More women are employed in ICT jobs in the non-ICT dedicated sector than within it.

The proportion of women in ICT occupations (all sectors) has actually fallen in recent years, down to 22 per cent compared with 25 per cent in 1995. The female percentage varies by occupation, from just eight per cent in the fast growing software engineer group to 54 per cent in the lower skill level, slower growing, computer operator group. The reduction in female representation overall is likely to be partly due to the faster growth in the occupations with lower representation of women, such as software engineering. It is also a consequence of the lack of any real growth in recruitment of women to ICT jobs (see below and also Chapter 3 relating to female graduates). A study by Millar and Jagger (2001) on the participation of women in ITEC related courses and careers internationally has systematically analysed the evidence and identified the main reasons for the continuing gender imbalance. This study had a slightly different definition for ICT occupations as the one used here and covered the wider ITEC sector, and so the female statistics on UK employment in that report are slightly different than those quoted above. The study showed that although the UK does not compare favourably with many other countries in the level of female participation in ITEC employment, it shares similar problems. The main barriers to

greater employment of women in ITEC identified in that report are at different stages in career pathways, both at different stages in education and in employment. They include:

- a belief that the prospect of an ITEC career is unattractive to many girls and women;
- that women are insufficiently aware of the benefits of ITEC employment;
- that insufficient opportunities exist for women to acquire ITEC skills, at various levels;
- and that the high costs of skill acquisition in ITEC, and ambiguity about who has responsibility for meeting these costs, can be off-putting;
- a lack of non-formal pathways in ICT, which are of particular importance to women's careers generally, which produces a clustering of women in low status, non-ITEC jobs;
- a low level of part-time employment opportunities, and also non-standard forms of employment, in the ITEC sector and in ITEC jobs. Very few women are employed on a part-time basis in ICT occupations, and less than ten per cent of all ICT jobs are part-time ones;
- the need for more family friendly policies in ITEC employment including childcare and flexible working, and also mechanisms to increase confidence levels among female ITEC employees.

There is a need for the entrenching of a new image of ITEC employment so that its associated culture will enable more people, including women, to be recruited, promoted and retained with skills in appropriate ITEC occupations.

2.5.6 Ethnicity

Although only a small minority of ICT jobs are held by people from ethnic minority backgrounds, this proportion has been growing slowly over time and currently stands at eight per cent (according to the LFS 2000). This is double the four per cent of ethnic minorities in aggregate in the workforce as a whole. At a sectoral level, communications and IT have slightly higher levels of ethnic minority representation than electronics; by occupation, software engineers and programmers/analysts have higher ethnic minority representation than lower level ICT jobs. Unfortunately, the LFS data are based on too small a sample of ethnic minorities to enable further disaggregation by ethnic group where differences are also likely to exist, especially between Asian and Black groups, and also ethnicity within gender breakdowns.

2.5.7 Job turnover and careers

Another often talked about characteristic of ICT jobs and careers is the amount of 'turbulence', or rapid job turnover levels associated with them. This may be slightly exaggerated in the media at times, but nonetheless job-changing in ICT does appear to be higher than the average. According to the LFS (2000) just under 20 per cent of people working in the main ICT occupations were not in the same occupations 12 months previously, which compares to an all-workforce average of 11 per cent. Those in computer operator jobs were more likely to have changed jobs in the previous 12

months (22 per cent) and those in software engineering least likely to (12 per cent). ICT staff were also more likely to have changed employers: overall 15 per cent of people in ICT occupations had changed employers in the previous 12 months, compared to 11.5 per cent in all occupations. Again, it was those in computer operator jobs who were mostly likely to have done so (21 per cent), and computer systems managers least likely to (seven per cent).

The NCC/Computer Weekly survey (2000) showed that two-thirds of respondents had been appointed to their current post within the previous three years. While more experienced IT professionals have a more settled career pattern, those with less than five years experience tend to move employers on average every two to three years.

2.5.8 Level of qualifications

The ICT workforce is generally better qualified than the workforce as a whole. Only three per cent of ICT personnel have a qualification below NVQ level 2, compared with 17 per cent of the total workforce, and employment of graduates is particularly high within ICT, at 26 per cent. This rises to almost a half of all employees in IT/computer services.

Further discussion of the qualifications of the ICT workforce and the supply routes into ICT jobs from the education sector is given in the next chapter.

2.6 Skill requirements

The skills employers are looking for from ICT staff are commonly divided into two main types (Bosworth, 2000):

- **technical** or 'hard', vocational skills; and
- **generic** or 'soft' skills.

Most of the discussion and evidence on skill requirements in ICT centres around technical skills, in particular those associated with specific operating systems and software products, and increasingly networking technology. Much less is around the generic skills needed and combinations of technical and generic skills, though this was seen in our interviews with employers and also in some research literature.

It is worth highlighting once more that this dialogue is primarily about skills required of ICT 'practitioners' rather than ICT user skills. There is a huge demand for ICT skills by users of PCs and the Internet in their work, and also first level technical support which are outside the scope of this dialogue report.

2.6.1 Technical skills

The most up-to-date and comprehensive evidence on ICT technical skills required by UK employers for their ICT professional staff comes from the ICT Skills Survey, conducted in early 2001 (e-skills NTO, 2001c). This survey was structured around key ICT functions (eg product development, external IT customer services, internal IT customer services etc. which fit broadly with the SFIA framework, see Figure 1.2.) and asked employers which specific technical or applications skills are needed to perform the main roles in each of the functions. Table 2.5 summarises some of the provisional survey findings by listing the five most commonly required skill areas for the main roles (at least in terms of the numbers employed) in the four largest functions.

For the purposes of this review, the points worth highlighting from the survey include:

- The overwhelming demand for skills associated with the **Windows/NT** operating systems - by far the most commonly identified skill area across nearly all functions and roles.
- The importance of being skilled in using **Microsoft** (MS) applications. **MS Access** was the application most commonly cited in a range of functions and roles. **MS Office** and **MS Publisher** were also important as were a range of other lesser known but still specified Microsoft applications (although the 'other' category does not include Excel which was specified separately and generally appeared further down the 'top skills' list).
- Understanding of the **Unix** operating system - both at operational manager level in internal IT or telecommunications operations and also at customer support level (both in internal and external support functions). It is worth highlighting here because it was felt to be important in more than one function or role.
- The object oriented programming languages **C and C++** - in particular for software development professionals in ICT-dedicated organisations and also among technicians and engineers involved in product development.

These findings largely mirror other survey information, but add valuable and greater insights into the depth of demand. For example, the NCC/Computer Weekly Tracking survey (2000) indicated a wide range of technical skills perceived as being significant to respondents in their jobs. The most commonly mentioned were those associated with: databases, Windows, networks, and generic design, support, programming, analysis and project management skills. The ICT Skills Survey provides a clearer ranking of demand, placing Windows/NT skills out in front.

The qualitative interviewing with employers, as part of this dialogue review, highlighted the importance of some of the newer skill areas which could be considered 'up and coming' - particularly languages and operating systems such as **Java**, **Perl**, **XML** and **Linx**. These appear lower down the 'top skills' list than the ones highlighted in Table 2.5, although they were particularly important to some sectors (such as finance). Our consultations also show that demand is growing for design skills in areas of multi-media and web and WAP technologies. While Internet-related skills (eg **HTML** and **Javascript**) are given a lot of publicity, it appears, from our interviews, that the highest demand is at the design end rather than the user/technical (ie web maintenance), and also in developing e-business strategy, and systems integration. Security specialists at various levels were also identified, and included in the recent CCTA Skills survey as an area of skill need by the vast majority of public sector organisations surveyed.

Other reports which identify growing skills areas, but based on apparently mainly qualitative research, include the European Information Technology Observatory (EITO, 2001). This also gives prominence to Internet-working technology in particular increasing demand for web-related programming languages (Java or XML) and skills for procurement and management of e-commerce systems. But it also highlights demand for 'good technological competence among senior developers' and the continuing demand for skills centred around UNIX-based servers as well as PCs in distributed computing systems.

The 2001 Skills Trend Report from the IMIS (Virgo, 2001), based mainly on recruitment market research, reports sharply rising demand for e-commerce and Internet skills, in particular those to build and maintain systems which will handle very high volumes of transactions in networked multi-media systems. Recruitment advertising for Java, HTML and Internet related skills has risen sharply over the last year while that for client-server skills has declined. Similarly the regular SSP/Computer Weekly survey of appointments (Enticknap, 2001) also highlights the recent importance of the trend towards e-commerce in driving the extent and nature of ICT skill demand. Generic Internet expertise and the ability to use Java and C++ were the most popular skills cited in a review of over 20,000 job advertisements in the trade and national press during 2000. A recent NCC survey (2000) also found Internet and Intranet development skills were the ones in most demand.

Table 2.5: Skill demand among ICT professionals

Function main roles	Top five skills needed	Comments
Product Development		
Software development professionals	Windows/NT Access C/C++ Java HTML	C/C++ more in demand in ICT dedicated organisations, while the non-dedicated sector is more interested in Windows/NT and Access
Technicians/engineers	Windows/NT Access C/C++ Netware TCP/IP	
External IT or Telecoms Customer Services		
Customer Service Support Professionals (eg engineers)	Windows/NT LAN/WAN Unix TCP/IP Oracle	Network-related skills are in greater demand in larger organisations and in non-ICT dedicated sectors. Database applications (such as Oracle and to a slightly lesser extent Access) are also more important outside the ICT-dedicated sector.
Sales and Marketing		
Sales Professionals/ Account Manager	Windows/NT Access Microsoft Office MS Publisher Other Microsoft applications	
Internal IT or Telecoms Operations		
Systems Support Operators/ Administrators	Windows/NT Microsoft (other than Access, MS Office, Excel and Publisher) Unix Microsoft Office Access	
Training professionals	Windows/NT Microsoft Office Microsoft (other than Access, MS Office, Excel and Publisher) Access Excel	
Helpdesk Support	Windows/NT Microsoft Office MS Publisher Unix Microsoft (other than Access, MS Office, Excel and Publisher)	
Operations Managers	Windows/NT Unix Microsoft Office MS Publisher Access	

Source: ICT Skills Survey, (e-skills NTO, 2001c)

The recent national ICT Skills Survey data help to place some of this qualitative and market-based information in a wider context. Although these newer, specialist skills are important to some people in some elements of the sector, particularly those at the 'cutting edge' of ICT developments and demand is growing rapidly, it is from a low base. It provisionally appears to be the more established and familiar ICT areas that continue to be driving the volume of demand across the piece.

2.6.2 Generic skills

Three main themes emerge in considering the evidence on generic skill needs of ICT staff:

- The first is that to develop or operate effective ICT solutions, ICT staff increasingly have to combine a high level of technical skill with the ability to work with other fellow professionals as part of a team and/or with internal and external customers to understand and meet their requirements.
- A second main development involves being capable of working in a rapidly changing environment, which means that attributes such as ability to work flexibly and imaginatively are of growing importance.
- Finally, ICT professionals need to be customer sensitive and apply their skills in an integrated business environment.

These themes were reflected in the ICT Skills Survey (e-skills NTO, 2001c) when respondents were asked to rate the importance of a series of specified non-technical skills for the range of ICT roles. The most important here were:

- **problem solving** - particularly for systems development professionals and ICT operations managers and people in customer or service support roles;
- **oral communication skills** - of most importance in support, sales and training roles;
- **general IT user skills** - thought to be most important in less skilled roles such as ICT support operators and administrators and helpdesk operators;
- **team working skills** - especially for customer systems support professionals; and
- **numeracy** - important in systems development and consultancy roles.

The main types of non-technical skills highlighted by the NCC/Computer Weekly survey as being of importance were management/leadership skills, communication (most often staff within the IT department but also end-users and clients). Furthermore, while software development clearly was a significant part of the majority of jobs covered by the survey, advice and guidance and project management were mentioned also as important activities for many ICT professionals. IS management and project management also appeared in the CCTA 2000 survey as an area of high demand.

A recent report looking at the skill implications of electronic retailing (Tackey *et al.,* 2000) found that in addition to technical skills there was a demand for two generic skill sets:

- the first was described as ‘entrepreneurship’ or ‘thinking outside the box’, and included the ability to develop creative yet practical solutions to problems, coupled with positive ‘can do’ attitudes and a high level of personal commitment;
- secondly, people with technical ICT and other skills were expected to have a much better broader understanding of business issues in general and those prevailing in retailing in particular.

Surveys of graduate recruiters highlight the high demand for generic or transferable skills among both IT and non-IT graduates, in particular commercial understanding and awareness and communication and presentation skills (DfEE, 1999; AISS, 2000). Mason (2000) points to the importance of ‘consultancy’ skills and the application of technical knowledge to specific business problems. An unpublished survey for NTO tele.com (2000) conducted last year also highlighted the growing importance of generic skills across a range of telecommunications occupations.

3. Supply of ICT Skills and People

'People are key to the sector's prosperity. Its people's knowledge and skills which determine the ability of business in the UK to compete successfully in today's global marketplace.'

(from 'Skills for the Information Age', a National Skills Task Force report, DfEE, 1999).

As shown in the previous chapter, there is a varied ICT employment and skill pattern, by sector and occupation. Furthermore, there is a diverse set of skill requirements, ranging from the very technical to the more generic, and at different levels of competence.

Employers obtain the kind of people and skills they require in four main ways:

- from the education system - especially higher education, but also from further education and schools;
- from private sector training courses (including vendor proprietary qualifications);
- through more informal learning 'on-the-job' and self-study by individuals from within the existing workforce;
- through immigration (foreign nationals with ICT skills).

This chapter presents the available evidence on these supply routes. First, though, there is a discussion on the qualifications of the workforce.

3.1 Key points

The most important findings presented in this chapter are summarised below:

- The ICT workforce is better qualified than the workforce as a whole, and many ICT employers have a preference for recruiting graduates.
- Higher education appears to be the main direct route into ICT jobs from the education system. The supply of graduates in ICT subjects has been growing much faster than all graduates (up by about 25 per cent in last five years).
- Computer science undergraduates tend to come from broader backgrounds than the average, in terms of age and entry qualifications, but women are still considerably under-represented.
- Employers recruit as many graduates from non-IT as from IT subjects, mainly for their personal skills, aptitude and intelligence. A higher proportion of non-IT graduates are recruited into ICT occupations in the non-ICT dedicated sector than are IT graduates.
- There are widespread concerns about the quality of some of output of the IT graduates, both in terms of their work readiness and underlying technical competence, and a number of initiatives have been taken to address this.

- A range of ICT qualifications and courses are offered in further education. Though large numbers are studying ICT in colleges, many do so at basic levels to enable them to make better use of ICT in their jobs and not as entry qualifications to ICT specialist occupations.
- Just under 5,000 N/SVQs are awarded each year in IT and Information at level 3 or above, and a similar number of GNVQ/SVQs. Another route into ICT is via Advanced Modern Apprenticeships, but numbers here are also quite low, about 5,000 per year in England.
- An unknown number of people with ICT qualifications at intermediate level enter ICT jobs.
- School qualifications, at GCSE and 'A' level, in ICT have also been growing at a relatively fast rate, and an increasing number of schools make widespread use of ICT in the curriculum. There remain concerns however about the quality of ICT teaching in schools, especially primary schools.
- Most large firms, and the majority of all firms, provide training to their ICT staff, often using commercial providers. Proprietary qualifications are very popular.
- About one in three of ICT personnel received job-related training (in a three month period), a slightly higher proportion than in the workforce as a whole. Those in technical functions were more likely to get training.
- In 1999, around 2,000 people from non-EU countries seeking employment in ICT were granted work permits.

3.2 Qualifications of the workforce

As shown in the previous chapter, ICT personnel are on the whole better qualified than other people in the workforce and, in particular, are more likely to be graduates. Within the ICT dedicated sector, over one-quarter of employees (26 per cent) are graduates (ie degree qualified), and if those with HND or other higher vocational qualifications are included, this proportion increases to 35 per cent. Only 7.5 per cent have no qualifications higher than GCSE (or equivalent). By comparison, just 18 per cent of the total workforce are degree qualified and 17.1 per cent have no qualifications higher than GCSE (Table 3.1).

The computer services sector has a much more highly educated population than the other ICT sub-sectors. It has fewer people with vocational qualifications, and more with 'A' level and especially degree qualifications (Table 3.1). Telecommunications companies are more likely to employ people with basic vocational qualifications than other sectors.

Table 3.1: Highest qualification held by workforce in ICT industries, 2000 (percentage of total employment)

	Electronics	Communications	Computer services	Total UK workforce
Degree or above	21.3	12.4	45.8	17.8
Higher vocational (eg HND. NVQ4)	13.0	7.5	11.1	9.7
Intermediate vocational (eg BTEC Nat, NVQ3)	16.0	17.4	8.0	17.2
'A' level/Highers	5.2	8.0	13.1	8.1
Basic vocational (eg NVQ2, C&G, RSA dip)	4.7	4.5	2.6	4.1
'O' level/GCSE	18.8	23.8	11.5	18.0
No qualifications higher than GCSE	13.8	18.1	3.5	17.1
Other qualification (no details)	6.9	8.0	4.2	8.0
Total (N)	***299,000***	***639,400***	***550,100***	***27,575,000***

Source: Labour Force Survey, 2000

Cutting the cake the other way, and looking at the ICT population in terms of occupation (Table 3.2), it is apparent that those in ICT occupations (across all sectors) are also better qualified than the workforce overall. Forty-one per cent are degree qualified (or equivalent) up from 34 per cent in 1995 and now almost three times as many as in the UK workforce as a whole. It is difficult to measure precisely changes to qualification levels over time because of changes to qualifications and occupations. However, by grouping the qualifications into NVQ levels, it is evident from the LFS data that:

- the proportion of the total in ICT occupations with qualifications at NVQ levels 4 or 5 has increased from 47 to 52 per cent, between 1995 and 2000;
- over the same period, the proportion at level 1 or below reduced from seven to just over three per cent;
- by comparison, the proportion of the total workforce at level 4 or 5 has risen from 24 per cent to 27 per cent, while the proportion at level 1 or below has reduced from 23 to 17 per cent over the last five years.

Differences are evident in qualification profiles of the ICT occupations. By far the highest qualified group are software engineers with almost 60 per cent holding degrees. By contrast, fewer than half of the programmer/analysts and IT managers are degree qualified, and less than one-quarter of computer engineers or computer operators (see Table 3.2). There is no evidence from the LFS data of graduates moving into traditionally non-graduate occupations (such as computer engineers and operator groups). Rather, it would appear that graduates are being increasingly recruited to the faster growing higher level technical jobs. However, graduates are also being increasingly recruited to jobs on help-support desks and to technician work, because of a shortage of applicants, so there may be some graduate substitution taking place (see Mason, 2000).

Table 3.2: Highest qualification held by ICT workforce, all industries, 2000 (percentage of total in each occupation)

	IT/ Computer manager	Software engineer	Computer analyst/ programmer	Computer operators	Total ICT occupations
Degree or above	44.3	59.8	43.4	14.1	41.1
Higher vocational (eg HND. NVQ4)	10.2	11.7	12.9	6.8	11.2
Intermediate vocational (eg BTEC Nat, NVQ3)	9.4	3.4	7.0	11.9	8.9
'A' level/Highers	16.6	9.9	14.1	15.3	13.7
Basic vocational (eg NVQ2, C&G, RSA dip)	1.2	0.6	1.5	6.4	2.3
'O' level/GCSE	12.3	7.6	12.9	30.6	14.4
No qualifications higher than GCSE	2.5	1.7	2.2	11.5	3.9
Other qualification (no details)	3.4	5.2	4.9	3.5	4.5
Total (N)	***184,900***	***199,900***	***341,300***	***151,000***	***938,400***

Note: computer engineers have been excluded due to low sample numbers

Source: Labour Force Survey, 2000

Other surveys also show a graduate bias among ICT staff. For example, the NCC/Computer Weekly Survey (which is biased towards higher level IT professionals) showed that 58 per cent of respondents had a degree, and those who started their careers in IT were more likely to (65 per cent) than those who had come from other jobs.

Although the number of women in ICT jobs is low (see Section 2.4.5), they are generally better educated than men (Millar and Jagger, 2001). Based on a slightly wider definition of ICT occupations, this study found that women in ITEC occupations were more likely to have degrees (45 per cent of the women compared with 39 per cent of the men). It also showed that particular ICT occupations had better educated women than men - more female software engineers were graduates (71 per cent) than male software engineers (57 per cent), though as shown in Section 2.4.5, women are vastly outnumbered by men in that occupational group (only eight per cent are female). For other ICT occupations there was little difference in the qualifications of men and women.

It is also worth noting that the majority of graduates working in ICT jobs do not hold a degree in an ICT related subject. While the most common degree subject is maths or computing (40 per cent), others include engineering and technology (21 per cent), physical sciences (11 per cent) and business studies (nine per cent). Graduates employed as computer analysts/programmers display the greatest range of degree subjects. Also, female graduates working in ICT occupations are more likely to have degrees in non-ICT or non-technical subjects (eg social sciences).

Looking to the future, it is likely that the density of graduates in ICT occupations will continue to rise, given two facts:

- increasing numbers of people are participating in higher education (therefore increased graduate supply);
- a structural shift towards higher skill level occupations in the ICT sector where there is a well-established preference for recruiting graduates or experienced people of 'graduate calibre' (see below).

The various influences on future supply are discussed further in Chapter 5.

3.3 Higher education

The available evidence, from the data presented above and known recruitment practices of ICT employers, indicates that a key source of supply to the ICT sector is higher education. Most employers see it as providing their main source of people needed to fuel the growth of new jobs in ICT, especially technical positions. For example, nine out of ten employers in the ICT Skills Survey (e-skills NTO, 2001c) who were looking to recruit expected to fill their vacancies for software developers with IT graduates or post-graduates, though not necessarily straight from university. Nine out of ten recruiters were also looking for IT graduates for positions as technicians, although employers in the non-ICT dedicated sector were much more likely to adopt this recruitment strategy. Around half the sample said that they were likely to recruit non-IT graduates, particularly to sales, marketing and training roles.

3.3.1 Supply from ICT degree courses

Although ICT related degrees can cover a variety of fields of study, including electrical engineering, mathematical sciences and business studies, the main group of degrees of relevance to ICT occupations, as defined for the purpose of this dialogue, are those labelled computer science.

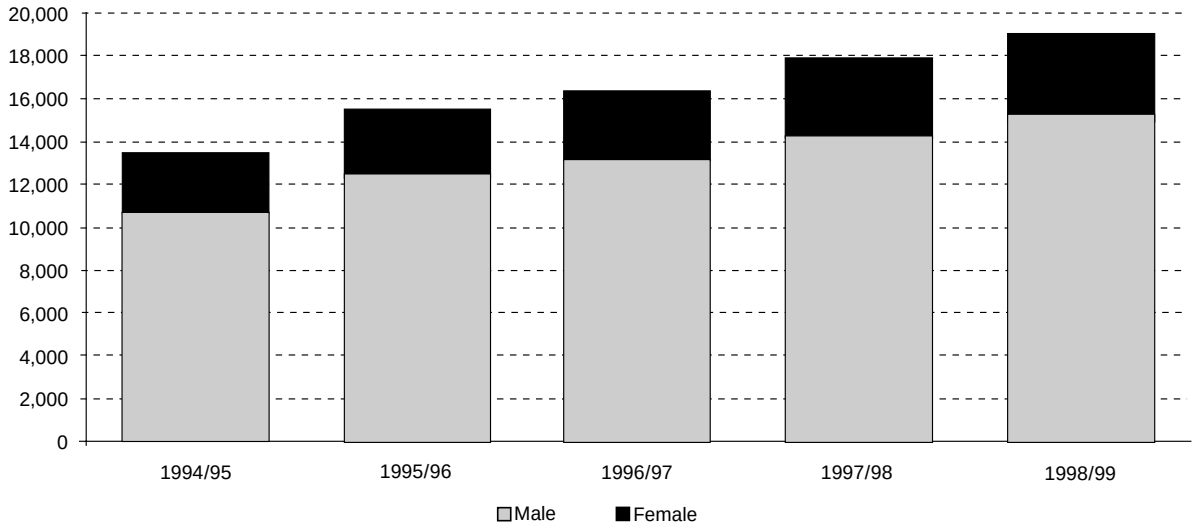
Computer science is often thought of as a relatively young discipline within universities, but it is offered very widely and subject to the same kinds of formal accreditation by professional bodies as many other subjects, such as engineering. A great number of new degree courses have been developed over the years to meet rising demand from students and employers, including many joint courses, combining computer science with other disciplines, which mean the boundaries of the subject can be fuzzy. The British Computer Society (BCS) has an accreditation relationship with 115 UK institutions, including nearly all UK universities. Over 1,000 courses have received some degree of accreditation or exemption from the BCS but there are also many others which have been looked at but not given BCS accreditation.

The growth in computer science first degrees is seen in the admission statistics. Student intakes to courses in single subject computer science have more than trebled in the last ten years or so while total HE admissions have merely doubled in number. However, in percentage terms, admissions to computer science degree courses are still very small compared to total admissions (about five per cent). If admissions to combined subject degrees that include computer science are included, this total increases to about 19,000 on full-time courses (UK domiciled, in 1998/99). This is an increase of 41 per cent since 1995, which is much faster than the growth for all admissions (six per cent) over the same period. In addition, there were just over 4,000 admissions to electronics engineering degree courses, but in contrast to computer science, this figure has grown by just eight per cent in the last decade.

In terms of their characteristics, students on first degrees in computer science are similar in many ways to other students but several differences are worth comment (source: UCAS/HESA datasets):

- computer science students are slightly older on average than those on most engineering or science degree courses, though younger than the average student: 11 per cent of first year students on computer science degree courses in 1997 were aged 21-24 and 12 per cent aged 25-39 years (23 per cent altogether), compared to 17 per cent on engineering and just seven per cent on physics aged 21-39 years;
- they are less likely to have traditional academic entry qualifications: 56 per cent of computer science degree course entrants have 'A' levels or Highers compared with 66 per cent to engineering and 85 per cent to physical sciences courses (and 75 per cent of all students);
- mean 'A' level scores of computer science course entrants are below that for all HE entrants, but have been rising over time. This suggests that computer science is attracting more able students, as it rises in popularity (Steedman *et al.*, 2000);

Figure 3.1: UK first year, full-time, first degree computer science students, 1994/95 to 1998/99



Source: HESA (various years) Students in Higher Education Institutions

- slightly more computer science students are female than on engineering degree courses: 17 per cent of 1997 entrants to computer science were women compared with 14 per cent for all engineering and technology. However, compared to all HE students, 53 per cent are female, so there is a considerable gender imbalance in computer science. Also, while overall participation by women in HE has been increasing, it has hardly changed at all in computer science or many technical disciplines;
- computer science students are more likely to be from an ethnic minority group (26 per cent of entrants) than the average student (15 per cent);
- computer science students are concentrated in new universities and 'lower' ranking institutions (Hanson and Vignoles, 1999);
- ICT subjects are a more popular choice among Black and (especially) Asian applicants to higher education than among White applicants. This holds true for both male and female applicants.

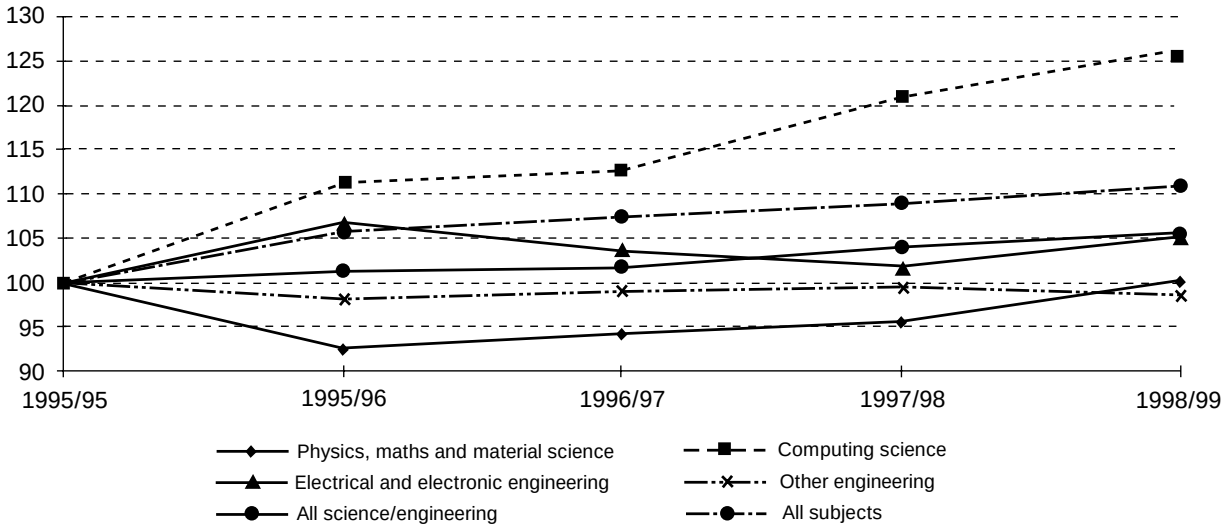
However, many graduate entrants to ICT jobs have degrees in other disciplines, and employers, in particular non-ICT dedicated ones, recruit from both ICT and other courses, with some not actively seeking computer science (see above). The supply to ICT employment from higher education therefore needs to take account of trends in the whole of the HE sector not just in core ICT disciplines.

The key point of note about overall graduate supply is that, following the massive expansion in intake to higher education in the early 1990s, numbers are now growing relatively slowly, only by about two per cent per annum (or 5,000) to full-time courses in each of the last two years (UCAS, 2000). While there continues to be competition for places in HE, especially for particular courses or institutions, there are concerns about current rates of growth in student demand for HE and some institutions have experienced shortfalls in filling places. A growing proportion of HE students are choosing to study in their home locality. Around one-third of HE entrants study part-time.

When making choices about what and where to study, applicants consider a range of factors from interest in the subject to expected career and employment outcomes. In a recent study on student choices (Connor *et al.*, 1999 and analysed further in Millar and Jagger, 2001), the main reason why students choose a computer science course as their first choice was career or job related reasons (39 per cent). Next came enjoyment/liked the subject (24 per cent) and 'sounds interesting' (18 per cent). Those choosing to study maths were more likely to give reasons of enjoyment/liked the subject (36 per cent) than did computer science applicants, and especially female computer science applicants, while those taking electrical/electronics engineering were more likely to give career/employment related reasons.

Mason, 1999b, showed that some sixth formers and undergraduates have negative impressions given by computer studies teachers who fail to create interest in ICT as a university subject choice. Those drawn to it are more likely to be attracted by the high salary prospects associated with ICT jobs rather than any great enthusiasm for it. Millar and Jagger (2001) also highlighted how many women, with high ability and good personal skills, can be put off by the image of ICT as desk-bound, 'nerdy' and 'anti-social'. The poor image of ITEC occupations among young people generally was also raised in the Stevens report (DfEE 1999b). However, more recent evidence from the 2001 survey of 2,635 secondary pupils carried out by MORI for EMTA (MORI, EMTA 2001) paints a more positive picture. This covers a younger age group (11-16 year olds) and shows that, on balance, more were attracted to a career in IT than not (38 per cent versus 31 per cent, with 30 per cent undecided). However, while IT was one of the most popular career choices among boys (mentioned by 22 per cent as preferred choice) and also ethnic minorities (23 per cent), it was much less popular among girls (just five per cent preferred it). Views about working in IT were positive overall - two-thirds agreed that IT is interesting and a similar proportion associate with good wages/salary. The 'nerdy, male only, boring image' was not held by the vast majority of pupils, of either sex.

Figure 3.2: Trends in UK ICT graduates 1995 to 1999 (where 1995 = 100)



Source: HESA

3.3.2 Graduate output

The total number of computer science graduates has increased annually since 1995 to just over 10,000, a 25 per cent increase. As shown in Figure 3.2, this is a much higher growth rate than for other technical disciplines, and also than overall HE output. Around four per cent of all graduates (about one-quarter of a million) are awarded degrees in computer science each year. If subjects which are ICT related are included (ie maths, engineering, business studies) then the total annual output in ICT-related disciplines increases to around 65,000. In contrast to computer science, the output of graduates in the group of other ICT related disciplines has changed little since 1996.

Currently, the total graduate UK output is growing marginally but may fall back this year (2001) temporarily as a result of a reduced intake three years earlier when some students entered a year earlier to miss paying tuition fees. The longer term outlook though is for continued steady, albeit small, expansion overall year on year, but with more graduates coming from a broader range of backgrounds (socially and educationally) and more growth in provision at sub-degree level (and the new two-year Foundation Degree).

3.3.3 Graduate recruitment

Of the total UK graduate output, almost 70 per cent, and slightly more from computer science, 80 per cent, go directly into employment (HESA, 2001). More male than female computer science graduates (the latter making up just 21 per cent of the total) go into employment, but the situation is reversed for graduates in other ICT related disciplines (eg electronics engineering, mathematics, and business studies) and for all graduates. A higher proportion of female computer science graduates go into further study, and slightly fewer are unemployed six months after graduating (4.5 per cent) than male graduates (5.2 per cent). The unemployment figure for computer science graduates is slightly lower than for all graduates (six per cent).

The most popular sector for computer science graduates is business services (which includes IT services), taking half of those entering employment. The remainder are spread widely across industrial sectors, including manufacturing, financial services and education. Women graduates are less likely to be employed initially in the business services sector (40 per cent).

It is more difficult to assess with any accuracy the extent to which computer science, or ICT related subject, graduates are taking initial jobs in ICT related areas. A survey of 2000 graduates in computer science who entered the labour market after graduation (CEL survey for DTI, 2001c) showed that 49 per cent went into an ITEC role in a ITEC organisation. A further 29 per cent went into an ITEC role in a non-ITEC organisation (ie in total almost 80 per cent in a ITEC role). NB the definition of ITEC used here is fairly loose and wider than the term ICT used elsewhere in the report. Mason (1999b) suggested that computer science graduates are widely dispersed across the economy, though clustered in 'business services', which includes IT services. His analysis is based on the HESA First Destinations Survey data which showed that almost 80 per cent of computer science graduates in 1998 went into employment in the UK, and of them, 49 per cent went into business services. Data on type of work of graduates are not presented in his report, possibly because of the inadequacies of the categories used (based on SOC codes). However, using the Labour Force Survey, he found that 70 per cent of young computer science graduates (under 30 years) are employed in IT occupations (including computer systems managers, software engineers, analysts, programmers and computer engineer trades), the remainder, 30 per cent, being spread across other occupations (eg teachers, other managers). This, too, suggests that the majority of computer science graduates do take up IT related jobs.

Furthermore, a 1999 project by ITNTO and AISS on the HE-industry interface showed that some two-thirds of IT graduates entering employment went into 'IT practitioner' work in 1998 (defined as the combined ICT SOC categories listed in Chapter 2). Just over half of them went into the IT industry, a number that has been increasing faster than those going into the user industries (ie non-ICT dedicated companies). Slightly more IT graduates than non-IT graduates entered IT practitioner work in the IT industry in 1998, and nearly twice as many non-IT graduates as IT graduates entered IT practitioner work in user or non-ICT dedicated companies (based on HESA data). The LFS data on graduate employment also show that particular occupations are more likely to be held by computer science graduates.

Table 3.3: Computer science as the main subject of degree qualified IT workers

	Computer system managers SOC 126		Software engineers SOC 214		Computer analysts and programmers SOC 320	
	(1,000's)	%	(1,000's)	%	(1,000's)	%
Computer science	17	22.4	44	39.6	60	43.5
Other subjects	59	77.6	67	60.4	77	55.8
Base	*76*	*100.0*	*111*	*100.0*	*138*	*100.0*

Source: Labour Force Survey, December 1999 to February 2000

The 1999 ITNTO/AISS study included a survey of 200 employers, covering both ICT dedicated and non-ICT dedicated companies. Over half had recruited from non-IT courses, and 14 per cent had only recruited from non-IT courses. The majority of reasons given for recruiting non-IT graduates was for their good personal skills, attitude/interest, and business and general IT competence/ knowledge. However, an e-business NTO report (2000) suggests that non-IT graduates are recruited to IT positions mainly because of an inadequate supply of IT graduates of good quality, and employers choosing to take graduates from any subject who have aptitude and then training them in specific technical areas.

Resourcing patterns are likely to vary by the varied nature of ICT jobs. Vacancies in electronics and software engineering would certainly be unlikely to be filled by non-IT specialists. Indeed the DTI graduate destination analysis (DTI, 2001c) showed that only 22 per cent of electronics engineering graduates were not employed in an ITEC role. In our interviews for this dialogue review, it was evident that some employers prefer some graduate recruits to have degrees other than computer science. They are looking more for an interest and aptitude in IT in graduates and other experiences and abilities relevant to their business. Other recruiters prefer to take a mix of IT and non-IT graduates to fill a range of jobs.

The recent analysis of the graduate First Destination Survey (FDS) (DTI, 2001c) for ITEC graduates showed that they generally did better at this stage in their career than other graduates. For instance, they are:

- more likely to be in permanent employment;
- more likely to be in their preferred career;
- likely to be earning more than average.

In summary, although, the evidence suggests that there is not as strong a link between IT degree courses and IT initial employment as might be expected, computer science (or IT/IS) degrees appear to be the core subject still for new entrants to IT jobs, especially in the ICT dedicated sector. However, the main message from the available evidence is that ICT needs of employers are met from a wide range of higher education provision, and that the needs themselves are wide ranging. This also implies that the potential supply from higher education to meet employer demand is much greater than simply the number choosing to study computer science degrees.

3.3.4 Quality issues

Employers have expressed considerable concern about the quality of output from higher education, which is not restricted to criticisms of IT courses and their graduates. In a well publicised survey last year, 70 per cent of employers '*claimed computer science degrees do not provide the skills needed to succeed in the workplace'* (Silicon.com, 2000), though the size and nature of this survey sample is unknown. The 'Stevens' report (DfEE, 1999b) commented on the mismatch between the 'quality' of some IT graduates and the skills and attributes being sought by employers, which tended to focus on non-technical skills. In particular, it highlighted the lower than average academic entry standards for computer science courses, and also employers' emphasis on the need for IT graduates to have good personal skills. In Mason's survey of employers recruiting technical graduates (1999b), 47 per cent cited personal qualities/interpersonal skills as the single most important quality sought in graduates from IT/computer science disciplines (compared to 17 per cent who cited technical knowledge). The ITNTO/AISS survey of employers (see Section 3.2.3) showed that while over half cited general IT competence/ knowledge as a key strength of graduates from IT-related courses, around one in six cited other personal attributes (eg ability to think quickly, relevant experience, intelligence). There appeared to be mixed views in that survey about the level of IT graduates' knowledge about current industry standard software and hardware.

The need for better matching of the content of higher education courses to employers' needs and improving higher education/ industry relationships have been highlighted as needed by several studies on the IT industries (see for example Digital Content Industries' Plan for Growth, DTI, 1999; e-skills NTO Strategic Plan), and also came up in the dialogue's consultations. Suggested ways forward include: better signposting of examples of individual collaboration between universities and companies to encourage further collaboration; a joint brokering service to facilitate introductions; and improved careers guidance. One example of the latter is the Gemini project in the South East, whose output has included a guide to IT careers which gives much more emphasis to the need to attract graduates with good 'people' skills. Work is also in hand on developing IT subject benchmark standards, through the work of the QAA and professional bodies (eg BCS).

Another source of supply from higher education are postgraduates, taking advanced IT study, usually MSc qualifications. They represent a much smaller source of potential recruits than first degree graduates, only around 2,000 or so annually, some of whom go on to further study (PhDs). In the mid 1980s, a new group of courses were developed to enable graduates from any discipline to 'convert' to IT through a one year MSc course, supported by the (then) SERC (now EPSRC). While these courses proved

to be popular and meet demand from industry, the graduates tended to be recruited into jobs similar to those taken by IT first degree graduates (Rick *et al.*, 1996). About 500 students were supported by SERC in the mid 1990s on 'conversion' courses, but this source of postgraduate funding has now been withdrawn.

3.3.5 Sub-degree qualifications

It is worth noting that in comparison to other countries, the intakes to sub-degree ICT courses in higher education in the UK are relatively small. For example, in France eight times as many students enter sub-degree courses as enter degree courses. In Germany it is more than half, while in the UK it is fewer than one-third - around 4,000 (Steedman *et al.*, 2000).

3.4 Further education and vocational qualifications

Much less information is available on the supply of IT skills from further education or with intermediate level, vocational qualifications. This may be partly because it is seen generally as a less important recruitment source for many ICT jobs, and employers view the competencies of school and college leavers more negatively than those of graduates (e-skills NTO, 2001). But, the lack of information in this area may also be due to the large number of different courses that exist and data deficiencies. Problems in classifications of different types of IT related courses at FE level make it difficult to obtain a clear picture of throughput and trends. Many courses are 'end-user' orientated (eg word processing) and at an introductory level (eg CLAIT).

Data provided by the FEFC indicates a total of 825,000 ICT students on courses in FE colleges in 1999/00. This is a considerably higher number than the 500,000 estimate in the Stevens report (DfEE, 1999b). Variations in estimates are likely to be due to different coverages, especially slightly different definitions being applied to the term ICT and level of course. Also individuals may be taking more than one IT course at a time (so some double counting).

Table 3.4: ICT students in further education in 1999/00

Qualification level	Part-time	Full-time	Total
1 (entry level)	365,412	14,058	379,470
2 (GCSE, TEC, GNVQ found/int and equiv)	170,079	59,643	229,722
3 ('A' level, GNVQ adv, and equiv)	41,771	126,150	167,921
4/5 (HND, degree and equiv)	9,706	6,764	16,470
Total	*618,902*	*206,910*	*825,812*

Source: Individualised student record (ISR), July 2000

A large proportion of the total from the FEFC database are people on basic short courses in IT (eg learning about using computers in business) often being taken part-time. Around 170,000 are students on courses at NVQ level 3 and 16,000 at NVQ level 4 (Table 3.4), which are more likely to be relevant for the kinds of ICT jobs covered by this review. The vast majority of the level 3 students are studying full-time, while part-time study is more prevalent on level 4 courses (58 per cent are studying part-time).

ICT does not fit neatly into one of the NVQ framework areas (eg engineering, providing goods and services, communicating) and so it is not easy to extract data on NVQ certification trends. The available data by subject area code relate to a broader subject area 'Information Technology and Information', which show that a total of 35,200 NVQ/SVQ awards were made in 1999/00. This includes 4,700 at NVQ level 3 (none at level 4 or above) (source: NISVQ, in DfEE, 2001). This total is slightly done on the previous year (45,200 awards). A further 16,100 were GNVQ/GSVQ awards, up from 12,000 since 1998/99. This included 5,100 at level 3 in 1999/00, compared with 4,100 in 1998/99. A further 221,600 awards of other vocational qualifications were made in 1999/00 in 'Information technology and information subjects.

Another set of figures comes from the Qualifications and Curriculum Authority (QCA). This shows 5,100 enrolments at so-called 'junior practitioner' level (roughly level 3) which is considerably lower than the level 3 estimate from the FEFC database. QCA also show 4,600 people enrolled in 1997/98 for HNC/HND awards (which are also included in the level 4/5 total in Table 3.4).

A relatively newly established entry route into the industry is via modern apprenticeship schemes. In 1999/00, there were almost 5,000 Foundation MAs (previously called National Traineeships) started in IT and telecommunications in England and Wales, and a total of over 8,500 total starts since the schemes began in 1997. Although 'starts' in IT and telecommunications are growing, they are still relatively low compared with other areas. This is likely to reflect in part ICT employers' preferences for graduates and also the greater attraction of progressing to higher education for the more academically able pupils than taking a work-based training route. The majority (70 per cent) of those starting a Foundation MA in IT or telecommunications are aged 16-18, and 30 per cent are 19 plus. This is a slightly older age profile than other areas. The average stay in training is around 30 weeks. About half of those on IT Foundation MAs are in jobs when they leave, compared to around 90 per cent of those in telecommunications. The leaving rate is slightly above the national average.

Advanced MAs are also offered in ICT fields, where there have been over 2,000 'starts' in IT plus around 100 in telecommunications.

3.5 School qualifications and pre-16

There has been considerable progress in schools in the use of ICT in learning and providing young people opportunities of developing knowledge and expertise in use of computers and the Internet (see for example the National Grid for learning NGf L). According to a recent survey of ICT in schools (DfEE, 2000b):

- the average number of computers in schools has increased steadily over the last three years (to 17.8 per primary school and to 112.6 per secondary school);
- 86 per cent of primary and 98 per cent of secondary schools are connected to the Internet;
- ICT is being used throughout the school curriculum, especially in design and technology, science and maths at secondary schools, and english and maths in primary schools.

School leaving qualifications in ICT subjects have also been growing at a fast rate:

- over a five year period (1994 to 1999), the number of entries in computer science GCSE/SCE (S grade) in Great Britain increased by almost 50 per cent, from 69,700 to 103,600; and the percentage achieving grades A-C increased from 51 to 57 per cent;
- over the same five year period, the number of entries in computer studies GCSE 'A' level/SCE (H grade) in Great Britain increased by almost 70 per cent, from 12,400 to 20,900; and the percentage achieving grades A-C increased from 44 to 48 per cent.

Provisional figures for 1999/2000 are available, but not on the same basis as the above, which show that for England only:

- 85,600 15 year olds, which represents 15 per cent of the total 15 year old pupil population, attempted GCSE in Information Technology, and 48 per cent of them achieved grade A-C (eight per cent of total);
- in addition, 1,882 15 year olds in schools obtained GNVQ part one at Intermediate level and 271 at Foundation level, and 294 and 41 obtained full GNVQs respectively at these levels in Information Technology;
- 21,500 16-18 year olds were entered for 'A'/'AS' level in computer studies, and 39 per cent of them achieved grades A-C;
- 3,700 16-18 year olds in schools obtained Advanced GNVQ in Information Technology, representing ten per cent of all such GNVQ awards to school students.

Unfortunately, there is no data on the extent to which people with these ICT qualifications are being recruited directly to the ICT sector and go on to take further ICT training.

Although there clearly have been achievements in ICT learning at school, there are fairly widespread concerns about the quality of teaching of ICT, especially in primary schools. The latest annual report from the Chief Inspector of Schools (DfEE, 2001b) paints a relatively bleak picture - one-third of schools inspected last year were 'substantially under-achieving' in the teaching of computing. OFSTED also report that pupil performance in computing is 'poor' or 'unsatisfactory' for one-third of 11 year olds and one-quarter of 16 year olds, and admits that training course take-up by teachers has been slow.

3.6 Employer-based training

Not only are graduates or 'graduate calibre' people preferred in recruitment by ICT employers, but new graduates are more likely to be offered opportunities for IT skills training and development than inexperienced people without a degree. Recruitment of graduates into technical departments is often accompanied by formal training programmes and/or substantial employer provided training resources, as shown by our interviews and also reported in Mason (2001).

Much of this training is provided from commercial sources or informally (ie on-the-job learning). There has been a tradition for IT employers and individuals to use more commercial training providers than publicly funded establishments, especially for very product- or application- specific types of training (ie technical training) and for the substantial amount of end-user training needed in IT. There has been a reluctance to use publicly funded educational establishments, other than for training associated with vocational qualifications such as S/NVQs (ITNTO/AISS, 1999). This may be because of perceptions among employers that they are less up-to-date technologically (because of resource constraints) and less 'hands on' and that they give an over-emphasis on theory (which gets out of date quickly) as suggested by some studies (see for example New Media Knowledge, 1999). However, this is an area where research evidence is weak. Amongst the most popular of the commercial courses are those in 'proprietary' qualifications which certificate individuals for working on specific software (see Section 3.6.1), but also includes a range of other IT training provided via interactive learning systems ('courseware'), or courses of varying lengths.

An estimate of the UK IT commercial training market is approximately £1billion (e-skills NTO, 2001). This compares with an estimated total spend among UK employers on training of approaching £20 billion (Hillage *et al.*, 2000). However, the IT sector figure includes a substantial amount of end-user training in ICT. A CSSA survey in 1997 suggested that IT employers spent on average three per cent of revenues on staff development and training annually. The vast majority of commercial training is paid for by businesses, but independent contractors are expected generally to invest in their own training, and many do so. A 1999 survey by e-business NTO indicated that two-thirds of IT employers provided training for their staff, though all of the larger ones did so (250+ employees). On-the-job training was the most frequently used, and technical specialists were the most likely group to get any off-the-job training. Despite the growth in self-study generally, on the job training is still the most popular method used (cited by 58 per cent of employers).

There is not yet evidence that e-learning has taken off in the UK, though signs are that it will be *'the next big thing here'*. According to Hillage and Pollard (2001), 92 per cent of US organisations in 1998 were planning to implement some form of Internet or Intranet based training, and in 1999, 20 per cent of corporate based training took place electronically. The EITO 2001 report estimate that the usage of web-based training is growing by 50 per cent year on year in Europe. In the UK, the Institute for Personnel Development (IPD) found recently that 40 per cent of businesses had Intranet and Internet access for training purposes. It is estimated that around a quarter of all learning will be done on-line within five years (EPIC, 1999). Both here in the UK and in the US, the IT training market dominates e-learning activity. Various ICT

companies have successfully introduced e-learning eg 70 per cent of IBM's management development training is delivered via e-learning; BT's safety training is delivered wholly on-line. Colleges and universities have also embraced e-learning in numerous ways eg college networking to provide small businesses IT training via the Internet (Hampshire); Scotland's Software Academy (a virtual learning centre) providing a 'one stop' approach for software businesses seeking support for training, recruitment and skill development.

The ICT Skills Survey (e-skills NTO, 2001c) suggests that in the region of a half of all ICT professionals had undertaken off the job training in the previous 12 months, most often learning about operating systems (such as Windows/NT) and Microsoft applications (areas of high skill demand, see Section 2.6) though a wide range of skill needs are also covered. More generally, the most common method of delivery was on the job (particularly in ICT-dedicated establishments) with (provisionally) 36 per cent of employers saying they used this method. The other main methods included: consultant visiting/training staff on site (24 per cent), computer based training/CD ROM/DVD (12 per cent), residential short courses (12 per cent), and part-time education at college or university (11 per cent).

3.6.1 Proprietary qualifications

Various estimates have been put on the number of people in ICT jobs in the UK with proprietary certificates (ie from vendors) but it is difficult to obtain precise estimates. The total is likely to be in excess of 20,000, with Microsoft providing the lions share. Others include Novell and CISCO. In addition there are qualifications for Users (eg MOUS - Microsoft user specialist qualification).

These courses for IT specialists are popular with many employers and individuals because they are very functional, focus on the latest features of the software or systems and provide evidence of practical skill attainment. However, they can be costly, especially to small employers, who tend to prefer on-the-job training. They are also sometimes criticised for being too narrow, and not dealing with underlying principles nor giving a broader understanding of the use of software tools and their business applications. Overall, they are generally well-respected by the IT industry.

One of the issues currently being addressed is how to incorporate these popular proprietary qualifications into the public sector provision and the NVQ/SVQ and QAA/SQA frameworks, as a way of helping to keep institutions and courses up-to-date. Microsoft, Novell and Cisco qualifications have been mapped to S/NVQs to show how they complement each other (see e-skills NTO). As yet they are available at only a small number of colleges and universities.

3.6.2 Amount of job-related training being received by individuals

The evidence on the amount of training being undertaken by ICT staff is mixed. On the one hand, there appears to be reluctance by employers (especially small ones) to provide training to new entrants, other than informal on-the-job training, especially to inexperienced people below graduate level. However, a substantial volume of ICT training is clearly taking place as evidenced by the size of the IT training market and the number of companies providing ICT training.

The Labour Force Survey shows that approximately one in three people in ICT occupations were in receipt of job-related training in the previous three months (September 2000), and that this proportion was higher than the all workforce average (28 per cent). But when comparable occupations to many ICT professionals and associate professionals are considered (ie at SOC level 3 or 4 eg accountants, technician engineers) the proportion in receipt of training is lower in ICT. Those most likely to be in receipt of such training were software engineers (39 per cent) and computer programmers/analysts (38 per cent) and least likely were computer operatives (27 per cent). These percentages have increased only marginally over the last five years. Employees in computer services companies were less likely to get such training (32 per cent) than those in electronic office equipment suppliers (35 per cent).

3.7 Immigration

A potential source of skills is people coming to the UK from abroad. The work permit regulations were relaxed in the summer of 2000 to help alleviate skill shortage problems, and this included ICT occupations. There is little evidence to suggest that, at least before then, that this was a sizeable source of supply. No data are available on the inflow from other EU countries. In 1999 (before the relaxation), 42,000 work permits were given to people from non-EU countries, of which just 2,000 were to immigrants seeking employment in an ICT occupation. Of these, two-thirds (1,200) were from India and the remainder were mainly from other English-speaking Commonwealth countries (such as Australia and Canada) and from the USA. It was evident from our interviews for the dialogue that some ICT employers had benefited from the relaxation of work permit regulations by recruiting ICT specialists from overseas, in particular from Eastern Europe, China and Algeria.

3.8 Conclusions

The evidence suggests that the supply of people potentially able to work in ICT occupations is increasing at all levels. However, the data beg a number of questions which are addressed in the next two chapters:

- *is the quantity of supply coming through the initial education system adequate to meet expected demand?*
- *are other routes into ICT employment sufficiently well-signposted and attractive?*
- *perhaps most crucially, is the quality of supply sufficient to meet changing employer requirements?*
- *are there more actions that can be taken to improve the responsiveness of the supply side to labour market needs, or would a period of stability allow current initiatives to run their course and be fully evaluated?*

4. Skill Deficits

In previous chapters we have presented evidence on ICT employment, skill demand and supply. In this chapter we look at the extent and nature of any mismatch between supply and demand, in particular the scale and nature of any skill deficit. This can arise either through shortages in the external labour market (for instance due to insufficient supply) or gaps in the internal market (with existing staff not being sufficiently proficient at key tasks).

A major source is the data from the ICT Skills Survey (e-skills NTO, 2001c), as it is the most up-to-date information available and concentrates specifically on ICT professional staff. Other evidence used in support of these findings comes from a wide range of sources, some of which have only partial coverage of the population or are more qualitative in nature (including data collected from our interviews with employers and others). We also include data on earnings as an indicator of labour market trends. Finally, we consider the impact of any shortfalls and the measures employers take to combat them.

4.1 Key points

The main points to emerge from the available evidence are that:

- Skills problems in ICT appear to have eased overall and the widely talked about skills crisis lessened in recent months. However, there continues to be 'hot spots'.
- The main areas of recruitment difficulties appear to be among software development professionals and technicians especially in the ICT-dedicated sector and sales professionals and ICT operations managers.
- Most of the problems appear to be skill-related. The skills in short supply are those in greatest demand - particularly generic IT skills and an understanding of Windows-based operating systems. The main problem is an insufficient number of applicants with the required skills.
- The vast majority of ICT professionals are thought to be fully proficient at their job. Technical skills gaps include e-commerce and Internet-related skills, Window/NT and networking skills.
- Generic skills gaps are also important, particularly general business knowledge in larger establishments and general IT user skills . Problem-solving, oral communication and customer handling skills were the other main areas of concern.
- Skill deficits - caused either through external labour market shortages or internal skills gaps - can result in companies failing to provide desired levels of customer service. They can also lead to delays in developing new products, difficulties in introducing technological changes and a loss of business.
- Companies try to get round the problems caused by skill deficits by improving training or recruitment, greater use of contract staff or outsourcing, changing working practices or living with sub-optimal levels of performance.

4.2 Skill deficits

There has been a burgeoning range of reports of a growing deficit between the quantitative and qualitative supply of ICT skills and the demand for them in recent years. For example, Stevens (1999) concluded that:

> *'There are genuine skill shortages and that recruitment and retention problems have become increasingly acute over the past two years' among ICT professionals.'*

However, many of the surveys that tend to hit the headlines are often based on partial information, eg a survey of recruitment advertising or a small, unrepresentative sample. Furthermore few distinguish between recruitment difficulties (hard-to-fill vacancies) ie problems with the external labour market and skills 'gaps' ie deficiencies of the employer's existing workforce which relate to the internal market. Nor are sufficient attempts made to isolate those hard to fill vacancies that are due solely to skills problems which are termed skill shortages (ie skill shortage vacancies). This is a distinction drawn by the Skills Task Force and in the Employers Skill Survey (Bosworth *et al.*, 2000) and one we make below.

4.2.1 Recruitment difficulties

The Employers Skill Survey was a national survey, representative of employers in England undertaken in late 1999 (Bosworth *et al.*, 2000). It found that employers in the ICT sector were far more likely than average to have a vacancy - 44 per cent of ICT sector employers had vacancies at the time of the survey compared with 32 per cent of employers from all sectors.

The recent ICT Skills Survey (e-skills NTO, 2001c) focused only on those establishments employing ICT professionals (rather than all establishments). It found that 11 per cent of UK establishments employing ICT professionals had unfilled vacancies for ICT professionals at the time of interview (mainly in January/February 2001). There was considerable variation by sector, with more ICT dedicated establishments having vacancies for ICT professionals than non-ICT dedicated sites. A quarter of the former were looking for ICT staff compared with only a tenth of non-ICT employers. The vacancy rate was highest for software development professionals and technicians especially in the ICT dedicated sector and system support professionals and ICT operations managers.

The main technical skills that employers are looking for to fill these vacancies are similar to those discussed in relation to skills in high demand. They are an understanding of the Windows and NT operating systems and/or knowledge of the C/C++ programming languages. Although demand varies across specific roles, the Windows related skill area is fairly ubiquitous. Other important areas include:

- Internet-related technical skills (such as knowledge of Java and HTML) for software developers and Web developers; and
- Microsoft applications skills among sales professionals, account managers and help-desk operators.

Employers in the survey were mainly looking for a minimum of two years or more experience, an obvious problem in some of the newer (eg Internet related) areas. Helpdesk operator recruits were required to have less experience and ICT operations managers, technicians and engineers were expected to have more.

Hard-to-fill vacancies

In the 1999 Employers Skill Survey (Bosworth *et al.*, 2000) some 24 per cent of respondents from organisations in the ICT sector reported hard-to-fill vacancies, compared with 16 per cent of all employers. Of these incidences of hard-to-fill vacancies, two-thirds (ie reported by 18 per cent of ICT employers) were defined as skill shortage vacancies (ie felt to be due to a lack of applicants with the right qualifications or experience as opposed to other reasons such as poor pay or image in the recruiting employer). This compared with half of the incidences of all hard-to-fill vacancies (ie reported by eight per cent of all employers). In other words skill shortages in the ICT sector were running at over twice the rate of the national average at that time.

A survey for (the then) nto tele.com in 2000 found that 11 per cent of employers in the telecommunications sector were experiencing difficulty in filling a vacancy over the previous 12 months (13 per cent in the computer and business services sector). Some 19 per cent of employers in the IT services sector were reported as experiencing difficulty recruiting, as reported in the e-business.nto's Skills Foresight report (2000c).

Just under a half of the establishments with vacancies in the ICT Skills Survey (e-skills NTO, 2001c) were experiencing difficulties filling vacant positions (ie hard to fill vacancies), equating to five per cent of all those employing ICT professionals. Around three-quarters of these hard-to-fill vacancies were due to shortages of skills among applicants, i.e. skill shortage vacancies. This hard-to-fill vacancy figure represents a lower percentage of all UK establishments with ICT professionals than previous surveys over the past two years.

The ICT Skills Survey data therefore suggest that labour market shortages may have eased over the last two years, a conclusion backed up by data from other surveys (eg NCC, 2000, Virgo, 2001, CCTA, 2000). In 1999, on the eve of the new Millennium there was a widespread overhaul of ICT systems and applications to prevent any problems associated with the 'Millennium Bug'. In the aftermath, a number of commentators (eg Mason, 2000) have referred to a 'post Y2K recession' in the ICT sector. Most recently concerns about a slowdown in global economic growth and reports of job losses in the UK electronics manufacturing sector have affected demand. On the other hand, below this general downward pressure on demand there is anecdotal evidence of substantial rises in demand for people with specific skills, in particular network and channel integration skills and other aspects of the 'e-business revolution' (as discussed above). The ICT Skills Survey data would seem to support this general thesis.

Roles in software and web development, technician and engineering areas, helpdesk support, sales professionals and account managers and operations management are proving to be the most difficult to fill. ICT sales and account managers are particularly scarce with around three quarters of the hard-to fill vacancies having lasted for over six months (e-skills NTO, 2001c). Although there are higher numbers of hard to fill vacancies amongst software development, technicians and engineers and operations managers.

The main problems appear to centre on:

- low number of applicants with required skills;
- a low number of applicants generally;
- insufficient interest in the job;
- applicants lacking the required level of work experience. There is some qualitative evidence (NOP and IES interviews) that the nature of the experience employers are looking for is not purely technical but relates more to the application of technical skills in a business environment (eg dealing with clients, rapidly changing requirements, linking with other business systems etc.).

The main technical skills that applicants lack include generic IT skills and to a lesser extent windows-based operating systems, UNIX and database programming.

Although there were concerns expressed in the interviews for this Dialogue about the lack of people with specific technical skills in the new computing technologies, there was a more widespread complaint about the quality of recruits. Two themes shone out:

- a lack of knowledge of the fundamentals of computing and technology; and
- an inability to apply technical skills in the modern business environment through a lack of generic skills.

4.2.2 Localised difficulties

In the ICT Skills Survey (e-skills NTO, 2001c) the biggest skill difficulties were reported from respondents in the South East. Other surveys also suggest that skill deficits are worst in the south and eastern parts of England (eg Reward, 2001; NCC, 2000).

A West London TEC survey (1999) found that while skill shortages among IT professionals 'remain an area for concern', they had not reached the magnitude of past predictions earlier in the 1990s. Key skill gaps were not specifically ICT related and included business knowledge, design skills, project management, problem solving and customer focus.

Northern Ireland appears to be a region with a below average skills shortage (at least as measured by the percentage of employers with vacancies). However, a study of IT skills shortages in Northern Ireland (NIERC, 2000) found that 70 per cent of firms in the province had difficulties recruiting people with experience to graduate level positions. The key areas of difficulty were:

- graduate project leaders - 45 per cent reported that it was very difficult to recruit at this level;
- project managers/strategic planners - 55 reported great difficulties.

The study found that firms with lower levels of new and inexperienced graduates were most likely to experience unfilled vacancies. This led the authors to conclude that firms' employment and human resource management practices may be contributing to

the incidence of skill shortage, with firms restricting the size of their available pool by setting high experience requirements. However, generally the authors did not envisage any major shortfall in supply over the next few years.

In terms of unfilled vacancies - the biggest problem area was project managers, followed (some way behind) by software development/installation and integration. Relative to the rest of the UK, the skills problem in Northern Ireland was worse in terms of project managers, but somewhat better (or at least not as bad) when it came to all levels of technical expertise (eg systems development, network support etc.).

Central and local government appear to have had a particular problem for many years recruiting and retaining people with IT skills and for many public sector organisations the problem continues to be real and immediate. However, overall, recruitment difficulties in the public sector have been declining and there was a sharp reduction from 44 to 27 per cent, between 1999 and 2000, in the number of Government organisations reporting a definite and immediate skills crisis (CCTA, 2000). Organisations in the London area continue to experience the most difficulty. Key areas of recruitment difficulty in 2000 were:

- knowledge management skills;
- security;
- risk management;
- business analysis;
- project management.

This list further emphasises the importance of finding people with distinct skillsets which address the alignment of IT and business processes (highlighted also in IDC, 2000 relating to Europe's IT skill shortages).

4.2.3 Skills gaps

We now turn to focus on skills gaps - ie deficiencies within the existing workforce. In the ICT Skills Survey (e-skills NTO, 2001c), data suggest that the vast majority (85 per cent on average) of the ICT workforce was considered to be fully proficient. These findings are broadly in line with the extent of skills gaps reported by all employers in the national Employers Skills Survey (Bosworth *et al.*, 2000). The results also broadly equate with those identified in the e-business nto's skills foresight (2000), but are lower than those reported in other, less representative, surveys (eg Silicon.com, 2000). In the telecommunications sector, a survey by nto tele.com (2000) found a slightly lower proportion of employers reporting a skills gap (under ten per cent).

Technical skills gaps

Although the recent ICT Skills Survey (e-skills NTO, 2001c) provisionally suggests that the vast majority of employers do not have a skills gap, those that do identified the main technical skills gaps amongst their ICT professional workforce as being:

- Windows/NT;
- Microsoft application skills, MS Access being the most commonly sited; and
- networking skills.

The main reasons given for having technical skills gaps of this kind were difficulties employees face with keeping pace with the changing nature of information and communications technology and a failure among employers to train and develop staff. The former point was also one that came up strongly in our interviews. While some employers felt that employees with a good grounding in ICT skills could relatively easily pick up skills in new programming languages for instance, others found it more difficult and looked to the external labour market to resource new skill demand.

Generic skills gaps

The most commonly identified skills gaps of a generic kind given by employers who felt that their ICT workforce was less than fully proficient, were:

- general IT user skills;
- written communication skills;
- general awareness of development in IT and telecommunications industry - particularly among larger establishments;
- problem solving - equally within the ICT and non-ICT dedicated sector;
- oral communication skills.

There appears to be clearly an issue of being able to combine ICT skills with a wider business knowledge and awareness which is highlighted in a number of other studies on ICT skill demand. A recent report on e-commerce in the retail sector (Tackey *et al.*, 2000) quotes one respondent who said that:

> *'There is a real lack of people who can combine ICT and business acumen.'*

Another report argues that 'there is a real shortage of those with the skills to, for example, develop an e-business strategy or integrate a set of websites with the existing value chain or enterprise system' (Virgo, 2001). Mason (2000) argued that two of the major skill deficits among ICT professionals were:

- general IT skills and competencies in areas such as networks and operating systems combined with the inter-personal, communications and team-working skills required for effective interaction with work colleagues and with customers; and
- IT 'consultancy skills'. This was defined as a hybrid skill set combining up-to-date technical knowledge with the capability to 'understand other people's businesses' and who could therefore take responsibility for the design of systems that will meet clients' IT and networking requirements.

This latter point was reflected in the interviews we conducted with employers, many of whom reported a lack of project management skills - people with a high level of technical skills in combination with advanced management and communication skills.

The Employers Skills Survey (Bosworth *et al.*, 2000) put more emphasis on a skill gap for the ICT sector in communications than in other generic skills areas - a problem identified across all occupations, but particularly in the semi-skilled area. The other main areas of deficiency identified by that survey include:

- customer handling skills;
- teamworking skills;
- technical and practical skills;
- management skills; and
- problem solving skills.

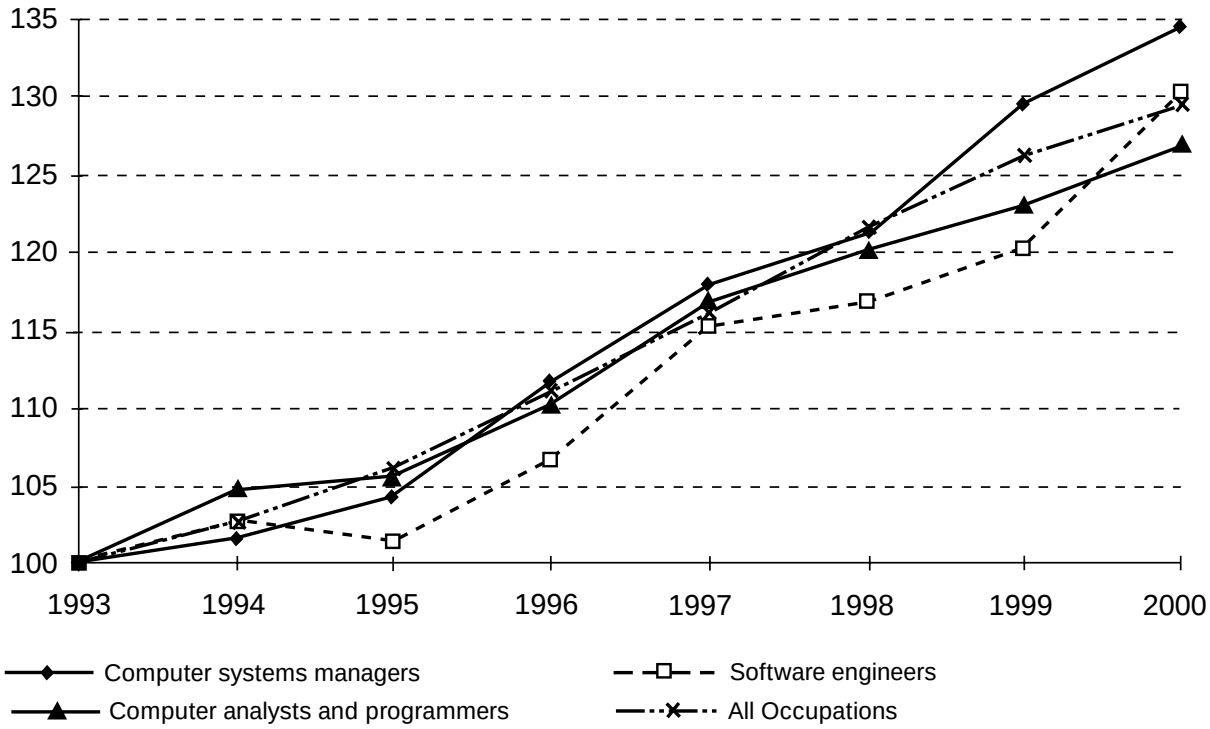
4.3 Earnings data

Data on earnings are often used as an indicator of skill deficit problems (see for example, ITNTO (1999)), though fast growing salaries can also be an indicator of other trends (eg fast growing and economically successful industries). In the UK, reported earnings of IT employees have pretty well tracked those for all employees (Figure 4.1). If anything, those of software engineers have dropped back slightly and computer system managers have gained slightly. Otherwise the parallels are very strong. However, these data taken from the New Earnings Survey (on which Figure 4.1 is based) may mask the full position through excluding self-employed contractors. According to the ITNTO 1999 report, day rates within the self-employed IT contractors market have been rising at much faster rates (in the 1996-99 period). Furthermore, the survey data may not pick up particular problems in certain skill areas or sectors, when outweighed by a relatively quiet labour market in others.

The data for the matched samples of NES respondents shows much higher levels of earnings growth (as it picks up internal progression as well as external supply factors). The fastest growth rates were among computer analysts and programmers, perhaps reflecting relatively high pay progression among younger people soon after joining organisations and being able to demonstrate proficiency.

Proprietary salary survey data also suggests that as a whole IT salaries have moved in line with those in the rest of the economy. For example the January 2001 quarterly survey from Salary Survey Publications (SSP, 2001), based on salaries in recruitment advertisements, suggests that salary increases across all IT positions averaged 3.1 per cent. Reward (2001) found average pay rises of 3.2 per cent in the year to January 2001 and the NCC found that basic salaries of IT staff rose by three per cent in the year to July 2000 (2001). In all cases, average pay rises for IT staff was reported to be similar to the average rate of national pay settlements (IRS, 2001b).

Figure 4.1: Average gross weekly earnings* of all employees and IT employees (indexed to 100 in 1993)



Note: * for those on adult rates whose earnings have not been affected by absence

Source: ONS (various years) New Earnings Survey Part A Streamlined Analysis

However, the average salary trends mask considerable variation in ICT sub-sectors and for particular skills. For instance, a series of salary surveys reviewed by IRS (2001a) suggest that the salaries of staff involved in e-commerce, including those with Internet related skills such as the ability to use Java and Javascript, have risen faster than pay rates in other areas of ICT. Although as most of the surveys appear to have been conducted before the recent difficulties experienced by some e-businesses, it is not clear whether this is a long-term or short-term trend.

4.4 International data

Earnings data from the US show a similar picture to the UK, as earnings of ICT professionals have grown no faster than those of other professionals (Freeman and Asprey, 1999). However, as with the UK, the basic earnings of employees do not represent the total income of the sector (ie which would include non-pay benefits and the earnings of the self-employed).

Looking briefly at other international data and comparisons, the IDC Survey (2000) updated in the latest EITO report (EITO, 2001) looked at IT skills across Europe and identified a 12 per cent shortfall between the supply and demand for ICT skills in the year 2000. The UK figure was similar (11 per cent). Care needs to be taken in interpreting these IDC survey figures for two main reasons: these surveys are based on a wide definition of the ICT workforce including e-business and call centre personnel and, more significantly, there are concerns with the methodology used for projecting IT skills supply. As Mason, (2000) points out, it is flawed because it takes insufficient account of the various sources of supply. The IDC supply figures are largely based on trends in employment destinations of students graduating from universities and other educational institutions. Some account is taken of graduates in non-IT subjects entering IT jobs and the supply from re-skilling of other workers, but far too much weight is put on the supply of new entrants from IT degree courses, especially in a UK context, and too little on the supply from alternative sources (As discussed earlier in Chapter 3, although graduate recruits are a preferred recruitment source not all who enter IT jobs come directly from higher education).

The main areas of skill deficit identified in the IDC report were:

- Internet-working skills - ie the skills involved in the design and implementation and to a lesser extent the support and management of routers, switches and mobile telecommunications devices (22 per cent shortfall across Europe, 25 per cent in the UK);
- applications skills - ie skills related to integrated multi-user applications such as SAP and Oracle (12 per cent shortfall in Europe, 11 per cent in the UK);
- distributed environment - centring around systems software such as Windows NT and Unix (ten per cent shortfall in Europe, ten per cent in the UK);
- technology neutral skills - ie the combination of general technical knowledge with business knowledge and skills (nine per cent shortfall in Europe, 12 per cent in the UK).

The main reasons for the shortages were identified as being the rapidly changing character of the demand for skills, particularly in the areas of web development and e-commerce, and the time lag inherent in adapting supply.

4.5 Impact of skill deficits

The main effects of skill deficits identified by provisional data from the ICT Skills Survey (e-skills NTO, 2001c) were:

- difficulties meeting customer service objectives - identified as having an impact by around three out of five of employers reporting hard-to-fill vacancies among their ICT staff and one-quarter of those with skills gaps.
- delay in developing new products - again a particular problem caused by over half with hard to fill vacancies - but also affecting around one in three of those with skills gaps;
- difficulties introducing technological change, one-third of organisations of those with skill gaps and over two fifths of those with hard-to-fill vacancies felt that their skill deficits had impeded them in this regard;
- difficulties meeting ICT departmental targets - a problem for over a third with hard-to-fill vacancies and just over a quarter with skills gaps;

In addition, the loss of business orders was felt to be a negative effect among those not able to fill key vacancies. Employers with skills gaps felt that they impacted in the form of higher operating costs and difficulties introducing new working practices. One of our interviewees reported that they had lost orders amounting to ten per cent of turnover due to skills shortages.

The unpublished nto tele.com survey (2000) found that the main adverse effects of skills gaps were the restriction of business development activities and a loss of business orders.

The IDC report (2000) argues that the impact of skills shortages was most felt by organisations whose industries are being restructured by Internet-related technologies such as companies in financial services, travel and retail.

The impact of the lack of project managers in Northern Ireland (McGuiness and Bonner, 2000) was reported to severely constrain the development of new products and have a negative effect on productivity, (although this was not confirmed by further analysis of sales per employee data).

4.6 Actions taken to limit impact of skills deficits

Employers adopt a range of responses to combat or contain the effects of skill deficits among their ICT professionals. Synthesising the information from our interviews and the literature, and including data from the ICT Skills Survey (e-skills NTO, 2001c), the main approaches appear to centre on:

- internalising the problem - by increasing or improving the amount of training and/or improving recruitment channels and methods;
- externalising the problem by recruiting indirect, contract staff, or contracting out operations;

- changing the nature of the problem, by changing working practices;
- learning to live with the problem and the consequences of sub-optimal performance.

Better training

According to the ICT Skills Survey (e-skills NTO, 2001c), three-quarters of the establishments with a less than fully proficient workforce said that they were aiming to provide further training to overcome skill gaps among their staff. Recruiting in less experienced staff and training them up to meet skill shortages was also an option but our interviewees reported that this often took too long to see results.

Improve recruitment

A quarter of establishments in the ICT Skills Survey (over a third in the ICT dedicated sector) were looking to increase recruitment of permanent staff as a means of overcoming internal skill gaps (e-skills NTO, 2001c). There are also some suggestions in the literature that organisations are seeking to broaden their recruitment strategy, eg to attract women and/or older people. Almost a quarter of the Skills Survey (e-skills NTO, 2001c) sample said that they had recruited mature people over the last year - a source with better 'soft' skills according to some interviewees. Some of our interviewees reported using head-hunters to tackle key recruitment difficulties - especially where they were looking for more experienced personnel.

Contracting out

Outsourcing ICT functions is another solution considered viable by around a fifth of ICT Skills Survey (e-skills NTO, 2001c) respondents. This is most popular in the non-ICT dedicated sector and especially in the public service sector, where pay levels etc. are thought to compound the problem of retaining ICT staff, (Tamkin *et al.*, 2000; see also Chapter 2 discussion on increased use of outsourcing). However, even in the ICT dedicated sector some of our interviewees had resorted to contracting out an increasing proportion of their work to combat technical skill shortages. Working in partnership with other organisations was seen as more efficient than taking on new staff and training them internally. In other companies it was the lower skill areas that were contracted out.

Large multi-national firms reported moving work overseas to locations where the necessary skills were in greater supply but, as discussed earlier in Chapter 2, recent survey evidence suggests that it is much more common for outsourced e-work to remain in the same region than cross national boundaries (Huws and O'Regan, 2001).

Contracting in

A further fifth of the ICT employers with skill deficits were planning to increase the use of indirect contract staff. This appeared to be a strategy adopted particularly in the telecommunications, rather than the IT, sector (e-skills NTO, 2001c).

Changing working practices

One-third of employers with skill gaps in the ICT Skills Survey (e-skills NTO, 2001c) were changing working practices to overcome skills gaps. One option is the adoption of the Application Service Provider (ASP) model of computing which is less labour intensive than distributed ICT. It is thought to be a useful way for small enterprises to address skills shortages (EITO, 2001).

Sub-optimal performance

Finally a number of employers learn to live with a slower than desirable development of new products or systems (see Section 4.6) or relying on higher levels of commitment from their existing workforce.

4.7 Conclusion

In this section we have reviewed the evidence on skills gaps and shortages.

There is clear evidence of a shortfall between demand and supply for ICT professionals. The main shortfalls are:

- technically specific skills - particularly in the newest areas of ICT technology. These can be seen as 'hot spots' (as described by Mason, 1999). They are perhaps better described as niche areas and include Java, XML, Unix etc. etc.. These tend to grab the headlines, but more widespread problems, of more significance, but slower changing, appear to be in more fundamental technologies such as Windows technologies, Unix technologies and C and C++ object-oriented programming languages;

- skills needed in the application of ICT technologies to business functions and business development; and

- generic skills among ICT staff particularly business knowledge and communication skills.

There is growing evidence that, overall, the worst of the UK's ICT skill shortage problem may have passed. It is still there, and still a severe problem in some quarters eg larger ICT dedicated employers at the forefront of technology. However, it does not currently seem to be getting any worse.

Skill gaps on the other hand are still widespread. This suggests the emphasis of the problem is switching from quantity to quality. The main reasons for the skills gaps are:

- the rate of change in the workplace in terms of the development of new products and the introduction of new technology;

- failure to the external labour market to keep pace - lack of people with relevant experience/unrealistic specifications on the part of employers;

- the failure of employers to train and develop staff.

5. The Future of ICT Skill Supply and Demand

In the previous chapters we have examined past and current trends on the issues of the supply and demand for people with skills in information and communication technologies. In the rest of this review we look forward to assess the likely path of those trends by pulling together the information on future demand and supply with a view to developing a series of future scenarios.

This chapter is therefore divided into three main sections:

We begin by identifying the main influences on the demand for skills, and review available data on future employment trends. Three possible scenarios for the future level of demand are developed;

We then turn to the supply side to identify the key drivers and possible future scenarios;

Finally we put the two together to look at the future for skills gaps and shortages.

5.1 Key points

The main points made in the chapter are set out below.

- There is a range of influences on the demand for ICT professionals including: those related to economic growth; the development of e-business and the structure of the ICT sector; the rate and nature of technological development; and the structure of governance over the sector including regulation and the development of standards.
- The two available sector-wide forecasts for demand predict growth rates of between four per cent (Institute for Employment Research, IER) and 7.5 per cent (European Information Technology Observatory, EITO). Other forecasts which focus on elements of the sector predict higher growth rates, particularly for the IT services sector and for people working in Internet-related areas.
- Synthesising the available information for this review, we have developed three demand scenarios:
  - The High Road - a fast growth rate scenario with employment rising by around eight per cent a year;
  - The Middle Road - a medium scenario based around two to three per cent annual growth;
  - The Low Road - where employment is at best static and possibly declines by one per cent a year.
- On the supply side a further range of influences apply including: the ability of the vocational educational and training systems to adapt to changes in demand; the perceived attractiveness of ICT careers; the efficacy of new e-learning training techniques; and Government policy on immigration and taxation.

- The only available forecast on supply (from EITO) predicts a six per cent annual growth rate, although the basis of the forecast has been questioned. The supply of ICT graduates from UK higher education is expected to increase slightly.
- Three possible supply scenarios have been developed for this review:
  - Full flow - with the potential recruitment pool increasing at a rate of six to seven per cent a year;
  - Medium flow - with the supply pool increasing at around three per cent a year;
  - Steady flow - with supply trends remaining constant if not actually declining.
- It is our view as consultant's that the medium road/full flow combination of demand and supply scenarios is the most likely, which suggests that there should be fewer, rather than greater, problems meeting the expansion of demand over the next few years. However there is still a large volume of 'replacement demand' to meet and further changes in technology and business organisation could lead to continual skills gaps.
- Therefore skills gaps and the lack of crucial generic skills, shortages in areas of rapidly changing technology, the quality of all technical skills and the ability to apply them in a business context, are all likely to remain issues of concern over the coming years.

5.2 The influences on future demand

We begin by analysing the main factors influencing the future demand for skills and distinguish four broad sets of drivers:

- economic - centring around the path of the emerging digital economy;
- business/industrial - including the development of e-business models and the changing composition of the sector;
- technology - from convergence to innovation;
- policy - in particular, the influence of regulation and industry standards.

These are not discrete but inter-related influences. Technological advances for example can influence the level and character of macro-economic growth, although reliable evidence of the global impact of technology-inspired productivity gains across the whole economy is hard to come by (EITO, 2001).

5.2.1 The emerging global digital economy

The overall level of economic growth is a fundamental driver of the demand for ICT services and products. Although expanding faster than the economy as a whole (e-business nto 2000b and also see Section 1.2) the rate of growth of the ICT sector is linked to the rate of change in macro-economic demand. The latter is linked to cyclical trends although in recent years there are suggestions that these have been in turn affected by structural changes including:

- the internationalisation of production and exchange;
- the progressive integration of global financial markets;
- the de-regulation of internal markets for goods, services, and capital flows; and
- more contestably, declining autonomy and policy capacity of individual countries to influence their domestic economy.

However, the relationship between the information and communication technology industry and the overall economy is not just one way, but symbiotic. The greater the development and take-up of ICT products and services, the faster the rate of economic growth. The former is dependent on a range of factors such as:

- national patterns of production and consumption;
- product innovation;
- business and management capabilities;
- the accumulation of marketing skill, especially among (SMEs);
- the spatial distribution, terms and conditions of employment;
- the spatial distribution of technical expertise;
- the significance of education, training and life-long learning;
- the scale and nature of the 'digital divide'.

Impacts on the demand for ICT skills

The overall demand for ICT professionals, ie the number of people employed, is clearly related to macro-economic demand. Simplistically, it can be assumed that, the faster the rate of economic growth, the greater the expansion of demand for ICT labour. However, it is not a linear relationship and the precise nature and pattern of increased demand will be affected by structural changes, not least the development of the global digital economy. The impacts of globalisation on employment and the demand for ICT skills depend on interactions between the various roles adopted by a range of actors, including nation states, multi-national corporations (MNCs), non-governmental organisations (NGOs) and social movements (Higgott, 1998).

5.2.2 New ways of doing business

Three main trends (Sheehan, 1999) in the transformation of business organisation and practice can be identified that are associated with ICTs involving:

- the rise of the on-line economy;
- changing industry composition; and
- the convergence of product and services industries.

They impact on the demand for skills in a number of different ways.

In the preceding chapters we have seen how the recent development of e-commerce and the use of electronic networks for the conduct of internal and external business communications and transactions has directly and indirectly influenced the demand for ICT skills (eg Tackey et al., 2000, Devins and Petrie, 2000). E-business also influences the demand for skills more widely through the adoption of new business models (see for example the Electronic Commerce Task Force Report, DTI, 2001). E-business growth not only influences the demand for particular ICT skills, it is also driving the development of new hybrid sets of multiple skills. The recent EITO report argues that the growth in e-business

> *'Is by far the most significant factor which affects the demand for Internetworking skills.'*

It also says that the growth of e-business is driving the demand for integrating pre-installed and new technologies, linking data on different sources and fast implementation of data cross-referencing and application sharing. To an extent therefore, e-business is driving a convergence of new technologies to maximise the efficient integration of systems, while at the same time ensuring that 'legacy' skills need to be retained to manage the interface between old and new systems (see Section 5.1.3).

Other factors such as the changing composition of the ICT industry, the convergence of products and services and the ability to move work around between various organisations and/or locations are further affecting the distribution, breadth and source of ICT skills demand as follows:

- **The distribution of skill demand** - There has been a shift away from ICT markets dominated by integrated producers (eg IBM) and towards firms located anywhere in the supply chain that can exert control over the evolution of key standards and determine the terms of competition because they own *de facto* standards. For example: with key component producers (Intel); operating system providers (Microsoft); applications providers (SAP, Adobe); and product definition firms (Cisco Systems, 3Com). If this shift continues it will concentrate particular technical skill sets in particular firms and sub-sectors. However, if standards are not adopted and/or affected by competition regulation (see below) the demand for ICT professionals and skills will become more atomised.

- **The breadth of skill demand** - Continued technical change in ICTs has extended the variety and the knowledge intensity of products and services provided. For example, many ICT producing firms have embraced marketing, converted into service providers, and now design, produce and sell technology direct to the customers. If this trend continues, and all the qualitative evidence we have collected suggests it will, then ICT professionals will be increasingly expected to adopt a wider range of business-related generic skills (or technology-neutral skills, to use the EITO term).

- **The source of skill demand** - ICTs have enabled the disintegration of value chains into constituent functions that can be contracted out (outsourced) internationally and performed on-line. In effect, ICTs have supported the creation of a global

division of labour. Outsourcing for example, of software development work to IT Service providers across the world that have developed high degrees of specialisation, meet acceptable standards of quality and have low costs, is increasingly feasible. It has been used to relieve skills shortages, cut costs, and penetrate foreign markets through increasing specialisation and enabling a finer division of labour within and across countries. Therefore, within the UK, the more that can be outsourced overseas to areas without a skills shortage, the lower the domestic demand for ICT professionals. Secondly the more that is contracted out domestically, the more the demand for skills is concentrated on the ICT-dedicated sector.

5.2.3 Changes in technology

Underlying many of the changes identified in the previous section are major technical trends. Industry sources identify technological change as perhaps the most important driver of skill demand (e-business.nto skills foresight). That change manifests itself in a number of ways:

- continued changes in the cost, power, performance and size of component systems - eg Moores Law (on the geometric expansion of computing power);
- an increase in the breadth of impact and the pace of change - pervading other technological areas, embedded in an increasingly wide range of products and contributing to shorter product life and development cycles;
- rising interoperability and interconnection - through ubiquitous computing, high capacity telecommunications and other communication networks and wireless applications;
- increasing convergence, digitisation and the rise of telemedia services;
- continued strategic innovation in software - eg middleware and tools for knowledge management, modelling and data warehousing.

Impact on the demand for ICT skills

These trends accentuate the continued high level of demand for professional, technology specialist skills. Knowledge of the ‘user’ market for ICT products and services is critical, and the skills that are associated with establishing effective communication with ‘users’ are ever more significant. Integration capabilities are required in order to enable the boundaries between previously incompatible technical systems to be traversed so as to achieve systems inter-operability. Increasing convergence between the information industries is driving the transformation of existing skills and the creation of entirely new skill sets (eg to do with telemedia), resulting in either the development of hybrid specialist skills or the assembly of hybrid teams of technical specialists. There is continued demand for ‘legacy skills’ as new software applications displace earlier technologies (which tend to be retained in particular markets where their strengths remain appropriate) and different generations of software co-exist. At the same time, the use of advanced software tools in production processes in the information industries is expected to raise the efficiency of those processes and decrease the number of skills that would otherwise be required, particularly among ICT professionals using standard applications.

5.2.4 Policy and legislation

The structure of governance for ICTs has been undergoing transformation in order to cope with changes in the structure of industries, trade and markets and in technology in the emerging digital economy. The main trends have been:

- the use of standards to safeguard openness and transparency in order to stimulate investment and competition;
- to secure agreed levels of access to key technologies and services for citizens;
- to protect consumers, for example, from exploitation.

Governance has involved the regulation of:

- Telecommunications - to promote competition and stimulate the development of the market for telecommunication services in order to achieve the best quality, choice and value for money for the customer. It has also influenced access to new markets through the cost of obtaining licenses to operate (for instance the third generation mobile phone networks).
- TV broadcasting - directed towards terrestrial broadcasting, to secure a wide variety of content and conformity to certain standards. The introduction of direct-to-home satellite broadcasting has enabled new service providers to enter the broadcasting services market transforming the market and reducing the requirements for regulation.
- The IT Industry - while there is no sector specific regulation for the IT industry, competition law has been used to protect against a dominant position, in (some argue an inadequate) an attempt to ensure standards of applications without the abuse of monopoly power.
- The Internet - as yet unregulated the increasing use of the Internet for commercial purposes has given impetus to efforts to develop extensions to existing measures in place to protect against violation of intellectual property rights (IPR) and to ensure the privacy and security, for example, of consumer information, in on-line environments.

Impact on the demand for ICT skills

In the absence of *de jure* standards, competition among firms for control over key *de facto* standards tends to result in a proliferation of incompatible applications and of the skills that support their use. The control of key standards enables control over technology and privileged access to markets. Standards are therefore the key to global competition and collaboration. The implementation of standards in order, for example, to secure open and transparent networking, or to establish one proprietary application as ‘best practice’ can, in the short term, condense the range of ICT skills required for professional practice. However, in the medium to longer term, the stream of revenue that can accrue, for example, to a *de facto* standard, can be used to stimulate the rate of technical improvement and accelerate the creation of advanced ICT skills and capabilities.

Table 5.1: Factors impacting on demand for ICT skills

Skills	Drivers of higher demand	Factors decreasing demand
Internetworking	Growth in Internet adoption	Online helpdesk
	Company reorganisation towards networked business models	
	Importance of security	
Applications	The need for web-based application developments	Faster implementation tools for many enterprise applications
	The commoditisation of many applications	
	Greater demand for application functionality from SMEs	
	ERP applications	
	Supply Chain Optimism (SCO) applications	
	Customer Relationship Management (CRM) applications	
	Increasing adoption of E-procurement	
	Electronic commerce applications	
Distributed	The use of Unix/NT servers as web servers	
	The growing complexities involved in supporting and managing distributed IT environments	
	Continuing demand growth for Windows NT skills	
	Continued migration from host-based environments to distributed IT environments	
Host-based	The need to manage and support existing mainframe infrastructures	
	The need to integrate mainframe infrastructures with more recent investments	
Technology neutral	Deeper knowledge of business benefits of ICT in order to optimise investments	
	The increasingly strategic nature of ICT	
Overall	Growth in E-business	Adoption of the Application Services Provider (ASP) model
		Job regulatory environment
		Standardisation/decreasing differentiation in technology adoption
		Outsourcing economies
		Mergers & Acquisitions (M&A) economy

Source: EITO, 2001

Secondly demand is also affected by the cost of entry to certain markets, eg mobile phone licensing, and the ability of employers to recoup that cost. If too high a price is paid the new technologies may take longer to be adopted and/or employers may have to look for ways to minimise the cost of development, by reducing the skill content of those involved.

5.3 Forecasting future employment demand

All forecasts are fraught with difficulties, given as we have seen the many factors at play and the problems associated with estimating their weight and inter-relationship. There are also difficulties identifying the baseline (as discussed in Chapter 2).

Nevertheless, some attempts to quantify likely future employment trends have been made.

5.3.1 Forecasts

We have sought out existing forecasts, of which there are few of any real substance, and investigated the basis on which they are made. The data in the forecasts of future demand for ICT skills focus on projected number of jobs rather than the skill content of those jobs. The two main sources which broadly cover the population of interest in this Dialogue review are the Institute of Employment Research (IER) and the European Information Technology Observatory (EITO). Each use a different forecasting approach and so results differ considerably. Other data on forecasts of future demand in specific areas are also presented.

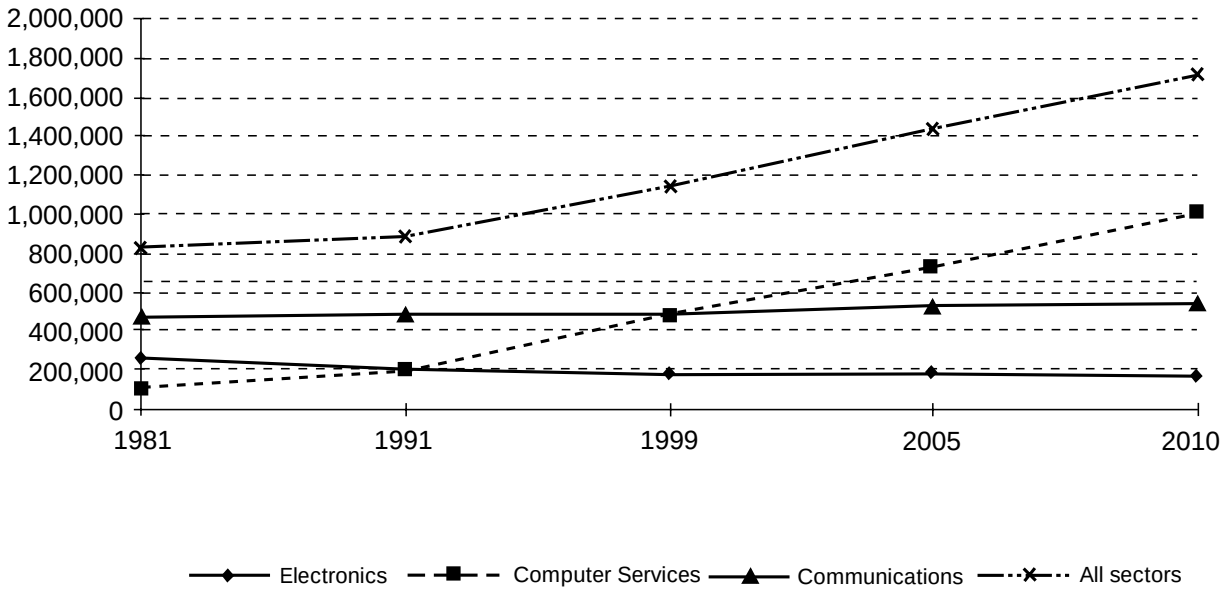
IER projections

IER has provided this review with a sector breakdown of their regular occupational and sectoral employment forecasts (Wilson, 2001). These forecasts are based on a macro-economic model which generates estimates for output and productivity and hence employment on a sectoral basis. Employment projections are consistent with the Annual Employment Survey. The sector breakdown provided for this dialogue covers the three SIC sectors identified earlier in Chapter 2: electronics, communications and computer services, ie the wider ITEC rather than the slightly narrower ICT sector. Unfortunately, no more detailed sectoral information is available from IER (Figure 5.1).

The forecast is in two elements as it looks at replacement demand (which includes retirements and other departures from the workforce, occupational mobility and migration) and expansion demand (ie new jobs in the sector).

Total employment in the sector, as they define it based on the AES (see Chapter 2), is expected to rise by some 24 per cent between 1999 and 2005 (c. 4.5 per cent a year) and by 50 per cent between 1998 and 2010, ie from over a million in 1999 to 1.42 million in 2005 and just under 1.7 million in 2010 (ie by around four per cent a year). The growth is driven by a rapid expansion in the computer services sector (of approximately 6.5 per cent a year) outweighing a decline in the smaller electronics sector and a slight rise in employment in telecommunications (Figure 5.1). Underneath the net expansion in the sector is a continual replacement demand to fill positions left by people who leave the sector, running between three and four per cent a year.

Figure 5.1: Employment in ITEC 1981:2010



Source: IER (Wilson, 2001)

In numerical terms, IER estimate that the ITEC sector as a whole will need a total of over one million jobs filled between 1999 and 2010, through a combination of expansion and replacement demand - that is roughly 100,000 jobs a year across the sector.

Detailed occupational projections covering all industries have been produced by IER as part of their work for the National Skills Task Force. There are two relevant ICT occupational categories, based on the SOC 2000 codes (see Chapter 2).

- Employment of ICT professionals (SOC 2000 code 213) is forecast to be one of the fastest growing occupational groups, rising by 39 per cent between 1999 and 2010, or a percentage annual increase of three per cent. By comparison, engineering and science professionals are forecast to grow by two per cent and a half a per cent respectively.

- IT service delivery occupations (SOC 2000 code 313 a broad group at the associate professional level) are expected to grow by 48 per cent, or 3.6 per cent per annum. This compares with a forecast reduction of 0.2 per cent in other science and engineering associate professionals, such as technicians.

Unfortunately there are no other clearly discernible occupational groups of relevance in the IER national occupational projection.

EITO projections

The European Information Technology Observatory (2001) estimates the demand for ICT skills across Western Europe, with national data for the UK. The employment numbers used appear to be broad estimates, calculated from business volumes, rather than taken from any census or sample count. Data are rolled forward by analysing changes in demand for ICT workers (broadly defined) through monitoring ICT job-related sites and unfilled vacancies. Demand for ICT skills are assessed over the five-year period from 1999 to 2003 in five skill areas (see Section 4.4, for an explanation of the terms used):

- Internetworking - where they predict UK demand to grow by over 20 per cent a year as e-business takes off;
- applications - a large segment of overall demand, but one with fairly modest growth (around four per cent a year) as the market consolidates and customisation is limited;
- distributed computing - again a segment of demand with relatively low growth (around two per cent a year) as Internet-technologies take over;
- technology neutral - the fastest growing segment, at over 25 per cent a year, requiring the combination of technical and business knowledge to exploit and adapt to the potentials of new business technologies;
- host-based - a relatively small area where demand is expected to stay largely static over the period as the market matures.

Overall, they estimate that the demand for ICT professionals will grow by 7.5 per cent a year (Figure 5.2).

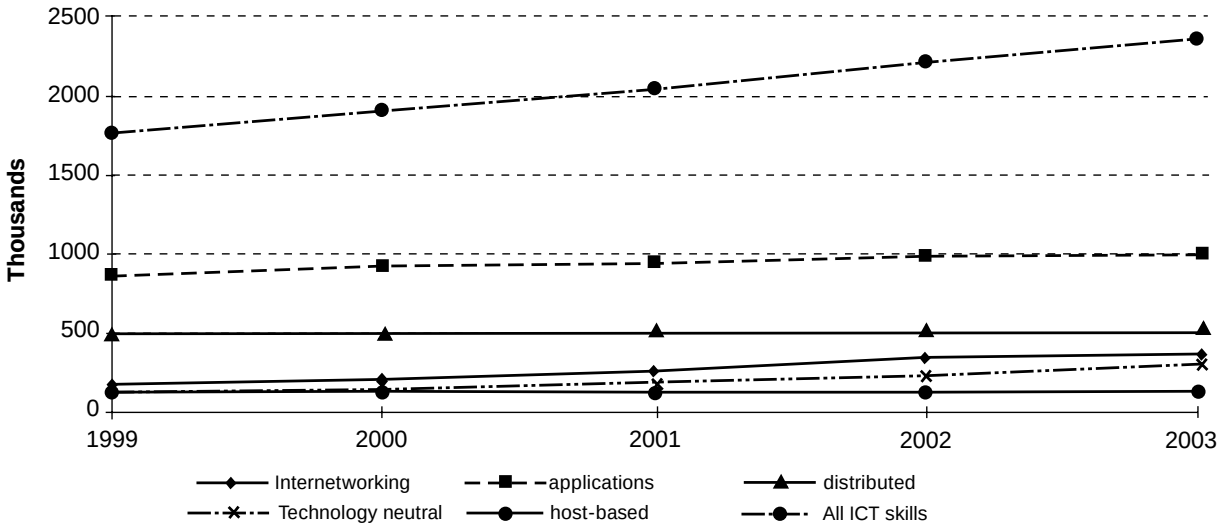
Other sources

Other sources confirm the importance of the Internet in driving up employment and demand for skills in the ICT sector. Spectrum (1999) predicted that by 2002 over 850,000 people would be working in the UK Internet economy, a 40 per cent a year increase on the 300,000 estimated in 1999.

Tackey *et al.*, in a review of the skill implications of e-retailing estimated that the retail sector would see a growth in the (relatively small) number of IT staff employed in the sector of between five and ten per cent over the next five years, depending on the rate of growth of e-retailing.

The e-business.nto (2000) report two potential employment growth scenarios for their segment of the ICT sector, one of 38 per cent a year (based on a continuation of the trend experienced during 1999) and another of 20 per cent a year (based on business growth forecasts).

Figure 5.2: Demand for ICT skills 1999 to 2003



Source: EITO, 2001

5.4 Future demand scenarios

The general consensus in the Dialogue discussion was that forecasting future demand for skills was fraught with difficulty. To help focus attention we developed three broad scenarios for future demand for ICT skills.

A number of scenarios have been developed to examine the possible impact of technology, economic growth and consequent social changes on future employment and society (see DTI/OST, 2000; Scase, 1999; PwC 1999). These were developed in the heyday of the 'new economy', before the recent experiences of the 'dot.com bomb' signalled fears that the Internet would not have the business benefits initially predicted and concerns over the onset of global recession. Although they may not have taken into account the most recent economic and business developments, they do help to highlight:

- the potential of the new digital and wireless technology to create new products and services in a *Wired World* which can be accessed *Any Time Any Where Any Place* and which can serve to further stimulate consumer demand (and hence the demand for skills);
- the vulnerability of economies increasingly dependent on technologies and mass communications to unforeseen shocks and disruption as they increasingly live *On the Edge;*
- the potential for people to reject rapid technological change and its consequences, both good and bad, in favour of a slower way of life in *Backwater Britain;*

- the potentially damaging inequalities which could flow from unequal access to technology and any economic benefits creating two clear camps of *Haves and Have Nots.*

Combining these broad notions with the growth rates implicit in the available forecasts and comments received during the Dialogue process, we have developed three possible scenarios for the demand for ICT skills:

1. **The High Road** - is based around projections that the rate of growth in demand will continue to develop rapidly, particularly in the area of Internet-related skills as the optimistic forecasts for the growth of e-commerce are realised coupled with more widespread adoption of applications, particularly among smaller enterprises. Not all elements of the sector will experience rapid growth eg as mainframe computers become relatively less important and skills needs centre on integration between various platforms. Telecommunications will recover with the development of third generation services and beyond. This is essentially the high end of current forecasts and is partly based on the assumption that growth has been under-estimated in the past. It assumes overall **demand for skills growing at around seven to eight per cent per annum**, particularly concentrated on technical skills related to Internet-based technologies and, of equal importance the generic skills, needed to exploit them. The demand for legacy skills declines as old technology is replaced with new generation systems.

2. **The Middle Road** - Under this scenario there is continued growth in demand for information and communication technologies but it is neither as rapid or as widespread as before. The rate of innovation declines as the costs of research and development rise, markets reach saturation point and new products lack sufficient innovation to stimulate replacement. The 'post-Y2K' hiatus in investment continues. As a consequence, ICT suppliers look to cut costs and increase the efficiency of product and service supply with a knock-on effect for the demand. Consumer-based e-commerce lacks penetration in the face of customer resistance to the e-retailing model, although the growth of business-to-business e-commerce continues apace. The continued high cost of further development of the telecommunications market restricts growth in this sector. Growth is also inhibited by increased political intervention (to regulate perceived anti-competitive behaviour) and lack of agreement within the sector on industry-wide standards. Under this scenario employment across the sector is forecast to **grow at between two and three per cent a year** (ie more in line with, but still lower than, the latest IER forecast). Skill demand broadens as new technologies exist alongside older ones.

3. **The Low Road** - Under the third scenario demand for ICT skills falls in the face of a series of technology and economic shocks. Global recession coupled to a series of high profile technology failures has a deleterious effect on confidence in the sector. The lack of growth leads to a number of large-scale corporate collapses resulting in job losses. Attempts by survivors to fill the gap are restricted by anti-competitive regulation. While a few sub-sectors continue to thrive other employment sectors go into decline resulting in at best **static and possibly negative employment growth of one per cent a year.** Demand for new technology skills is contained and demand is concentrated on tried and tested technologies and maintaining and securing existing systems.

5.5 Influences on future supply

In Chapter 3, we identified the main sources on which ICT employers, both in the dedicated and non-ICT dedicated sectors, can draw to meet any new demand for skills. Broadly speaking they fall into three related categories:

- initial supply from formal education, mainly at degree level;
- external supply sources - either through immigration or potential ICT professionals in other occupations or not actively engaged in the labour market (eg women returners); and finally
- existing employees able to acquire new skills.

The first two are both quantitative and qualitative sources- ie they provide more people who may (or may not) have the capacity to deliver the skills required. The last is a qualitative source, as existing employees are obviously already engaged in the sector but may not have the required new skills, but which they could, with training, acquire.

The factors affecting the supply of ICT skills include:

- the impact of school-based initiatives to improve ICT skills among pupils and to make ICT careers appear more attractive;
- the flexibility of the vocational educational and training system to adapt courses to meet changing requirements. This is related to their ability to read and respond to the labour market signals, in turn a product of the links between the employers and education and training providers;
- the impact of measures to widen participation in higher and further education and draw in students from all social classes. This could improve the quantity of higher level skills in all areas, but may also deleteriously affect the quality. New forms of qualifications such as Foundation Degrees which have been introduced partly to attract a wider range of students have so far met with a mixed reception from employers (at least those in our interviews);
- the time involved in training - higher education courses usually last a minimum of three years, although our interviews suggested new initiatives in this regard including fast track HND courses in electronics lasting six months, and proprietary training schemes which can last a similar time (EITO, 2001);
- the attractiveness of ICT careers - or lack of it among potential sources of supply, especially women but also young people generally (Millar and Jagger, 2001);
- new methods of training delivery - eg the European Computer Driving Licence (EITO, 2001) and more general e-learning developments which may have the effect of widening the potential pool of entry;
- government policy on immigration - which in the UK is being relaxed to make it easier for ICT professionals to obtain work permits;
- government policy on taxation - in particular the taxation of self-employed contractors (IR35) which could influence the cost of labour and for migration flows to and from the UK.

Table 5.2: Factors impacting on the supply of ICT skills

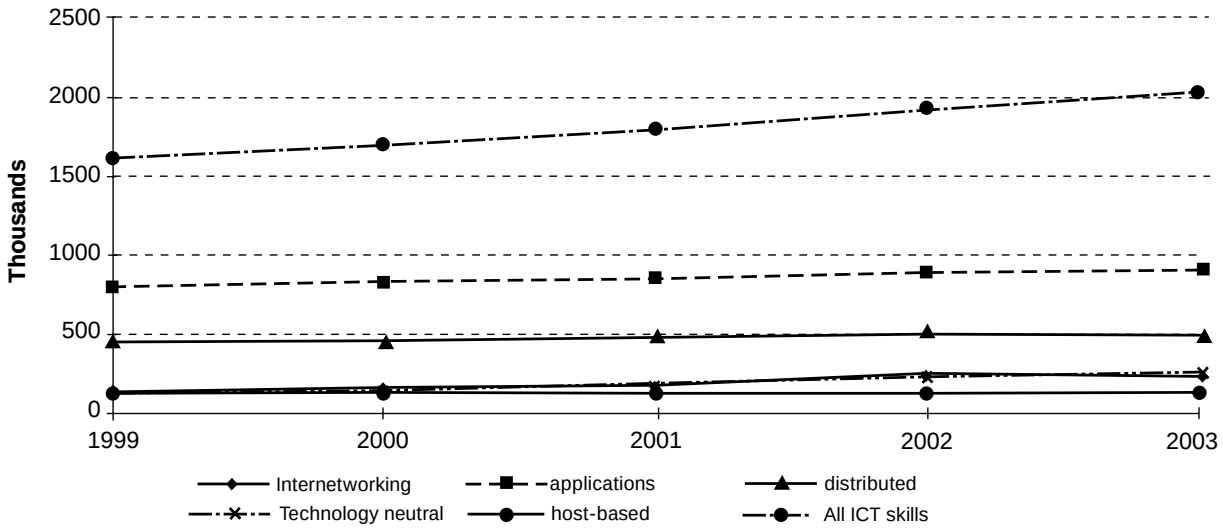
Skills	Drivers of higher supply	Factors decreasing supply
Overall	Development of new technology-related ICT skills training initiatives/schools	The cost and time involved in traditional training
	E-learning/E-training	Delays in education system curricula modernisation
	Partnerships between education systems/ businesses/associations/government	Private/public funding Funding of education enhancement initiatives
	Immigration policy	Lack of ICT skilled trainers/teachers
	Retraining from other functions in the same company	Decreasing interest in engineering/ technical studies
	Retraining from other sectors Human Resources (HR) policy orientated to alternative/new constituencies (part-time jobs, women, mature workers, 'protected categories')	
	Increasing HR policy on vocational training	

Source: EITO, 2001

5.6 Supply forecasts

There appears to be very few predictions as to the future level of supply of ICT skills. The EITO (2001) predict a six per cent increase a year - with growth rates linked to the level of demand (Figure 5.3). However, this forecast has been criticised for underestimating skills supply as it is based largely on entrants from higher education (Mason, 2000).

Figure 5.3: Supply of ICT skills 1999 to 2003



Source: EITO, 2001

There is no equivalent IER projection on supply or qualified labour at a sectoral or subject level of detail. The overall output of higher education is forecast to remain broadly static or slightly upwards for the next year or two (at least to 2003) (based on HESA data on intakes) with ICT related disciplines growing slightly faster than average.

5.6.1 Scenarios of future supply

In a similar way to the demand side, it is possible to produce some supply scenarios for the future:

1. **Full flow** - with the potential recruitment pool **increasing at a rate of six or seven per cent a year**. The rate of supply expands rapidly as interest in the sector grows among young and more mature people and the sector becomes more amenable to wider sources of supply. In particular, applications from women for degree places in ICT increase substantially and from women graduates for ICT jobs. The rate of growth of ICT graduates from the higher education sector increases further to ten per cent a year, as interest in mathematics and Information Technology at school

level expands. The student population generally increases expanding the potential for alternative sources of supply. Immigration controls are relaxed to allow for a greater influx of skills from abroad. Vocational education and training systems become more responsive to changing industry requirements, which in themselves adapt to the capacity of providers to develop skills. New e-learning techniques accelerate the pace of skill acquisition both in work and in the education sector.

2. **Medium flow** - the supply pool **increases at around three per cent a year.** Employers enjoy moderate success in attracting more young people and especially women, within an almost stable/slightly growing higher education sector with ICT graduate output rising by at least three per cent a year. Graduate Apprenticeships and ICT Foundation degrees become more popular. However courses take time to catch up with new technology trends other training initiatives take time to come on stream. Employers increase investment in work-based training, particularly in retraining older employees in new skills.

3. **Steady flow** - the recent initiatives to expand interest in the sector have little effect and the supply **trends remain constant if not actually declining.** ICT employment is felt to be a career for 'sad boys' rather than having mass appeal. Employers have little success in attracting recruits from alternative sources (eg mature people and women) as alternative careers continue to look more attractive. Employer training remains patchy, especially among smaller businesses. Recruitment from outside the EU is restricted. There is a net drain of ICT professionals overseas.

5.7 Conclusion: likely future shortages and gaps

The only available forecast which combines predictions of the demand and supply of ICT professionals is from EITO (2001) which estimates a shortfall (ie a surplus of demand over supply) of up to 14 per cent by 2003 - 36 per cent in the area of Internet-related skills. However some commentators urge that this estimate is treated with caution (Mason, 2000).

The supply and demand scenarios set out above could be combined in various (theoretically nine) combinations to help work out critical paths for skill development in the ICT sector over the next few years. In that they are largely based around employment rather than skill content they are more value in charting the future of external labour market trends and potential gluts or shortages rather than internal skills gaps. Furthermore it is important to recognise that the scenarios are largely conceptual constructs and not based on any econometric or other form of modelling and so should perhaps best be seen as 'orders of magnitude' rather than precise numerical estimates.

It is our view as consultants, considering the evidence, that at the present point in time, the 'middle road' demand scenario is the most likely. Recent events in the telecommunications and 'dot.com' sectors have dampened down previous bullish forecasts, at least temporarily. Therefore it seems most likely that the growth in demand over the next few years will be lower rather than higher than that experienced in the past few years.

On the other hand, we detected a general consensus that the rate of supply was improving, not just from higher education but from other sources as well, including overseas. Therefore, the 'full flow' supply scenario seems the most plausible.

If these two scenarios are borne out in practice, and we emphasise again the caution that should be attached to them, it does suggest that there should be fewer, rather than greater, problems meeting the expansion of demand over the next few years. However two key points need also to be taken into account:

- the large volume of 'replacement demand' that needs servicing, highlighted by the IER forecasts and required to fill vacancies created by labour turnover;
- further changes in skills needs, not necessarily affecting the numbers of people employed, but more the nature of what they do.

Therefore skills gaps and the lack of crucial generic skills, shortages in areas of rapidly changing technology, the quality of all technical skills and the ability to apply them in a business context, are all likely to remain issues of concern over the coming years.

6. Conclusions

This review has sought to draw together in one source all the available evidence on employment and skills in the ICT sector to provide a comprehensive assessment of the sector and build a consensus about the main skills issues faced.

The aim of this exercise has been to provide an authoritative statement of the skill needs of the ICT sector. The task has not been straightforward. Information and communication technologies are changing rapidly and with them the shape and form of the sector. Indeed the notion of ICT being a sector in its own right has only recently taken hold, with the convergence of computing and telecommunications. There is also the increasing convergence of hardware and software activities and the growth of digitisation which have brought parts of the electronics and media industries into the realm of the ICT sector. But a sector-based focus only looks at part of the skills picture. People whose employment is primarily dependent on their ICT skills are employed in almost equal measure in workplaces engaged in the development and/or delivery of ICT products and services (which we have termed the ICT dedicated sector) as in workplaces providing a different business activity but still using ICT technologies (the non-ICT dedicated sector). ICT skills therefore have both a sectoral and an occupational dimension and seemingly basic facts, such as the size of the sector, depend crucially on where boundaries are drawn. We have tried to capture both dimensions. Furthermore, there is a growing need for ICT user skills, both at a basic level in a range of occupations from secretarial to sales, and at more advanced levels in specialist functions such as publishing and healthcare, which this Dialogue has not aimed to address specifically.

The two-dimensional focus coupled with the newness of the 'sector', its fuzzy boundaries and its changing nature, inevitably means that reliable and in particular long-standing data sources are rare. As a new and dynamic element of the economy, ICT employment issues make good headline material and therefore it has been an important element of our task to distinguish reality from the rhetoric.

6.1 Five key messages

The main findings of the review are summarised at the front of the report. Put most simply, there are five main messages to emerge from this review:

- **Demand for ICT personnel and ICT skills continues to expand**. Skills needs of ICT employers are focused primarily on the core 'fundamentals' - the ability to use widespread operating systems languages and applications (eg Windows/NT). These are less likely to be subject to rapid change than skills in newer areas which can quickly become 'hot spots' (eg Java). The latter include skills associated with the new Internet working technologies, especially web design and systems integration, which are growing in demand at a fast rate, but are of lesser importance overall in numerical terms than demand for the more established ICT skills.

- **Supply is beginning to respond**, as ICT qualified output from school and higher education increases and new channels open up. Supply is not restricted to output from ICT degree courses but includes graduates from other degree courses who

have the appropriate personal skills and aptitude, and also from lower level vocational courses for some jobs in electronics and communications. It continues to exclude, however, much of the female population who are mainly recruited to ICT jobs requiring lower qualifications.

- **Skill deficits still persist**- in various forms, at different levels and different intensities. They include both technical and generic skill deficits. The former include shortages in the external market in areas of high demand, such as Windows/NT and various 'hot spots' which come and go as technology/business requirements change, and gaps in the proficiency of the existing workforce particularly in dealing again with operating systems (such as Windows NT) and networking activity. Generic skill deficits include business knowledge, problem solving, communications and customer service.

- **However the worst of the recent skills shortage crisis appears to have passed** (in mid 2001). This is partly because demand overall is expanding now more slowly from its peak in 1999 due to the economic downturn globally and the passing of Y2K problems, though growth is still as fast as ever in some areas. It is also partly because supply of potential new entrants from the education system has been growing and employers have looked to other relatively quick-fix solutions for their skills shortage problems, eg out-sourcing, recruiting from abroad. It is most likely that this trend will continue over the next year or two with supply beginning to catch up with, but not exceeding demand. However in a fast moving sector it is difficult to assess skill needs beyond 2002/3.

- **Concern is switching from inadequacies in the quantity to quality of skills supply** in order to meet future growing demand, as employers look to improve the value of the services they provide and the productivity of the staff they employ, in an increasingly rapidly changing technological environment. Skills gaps, especially in the application of ICT to business developments and in specific technical areas, both in fundamental technologies and new areas of Internet working technology, are clearly evident. There is a need to ensure that ICT attracts a high calibre of recruit, both to education courses and employment, that employers make use of the most effective recruitment sources to meet their needs at different levels and that high quality, relevant education and training is provided.

6.2 Actions arising

In the discussions following from the publication of the draft version of this report a number of comments were made about what could be done to tackle the prevailing trends. Proposed actions tended to centre on a number of key issues:

- building a consensus about the sector and a common language to discuss skills issues and monitor trends;

- widening the recruitment pool;

- improving the quality and responsiveness of the education and training system;

- monitoring progress and emerging issues.

Below we look at each in turn in a little more detail. None of the ideas discussed are particularly new or innovative, but taken together they form a reasonably comprehensive agenda for action. One underlying theme that also emerged was the need to concentrate effort on relatively few areas and ensure that they were met with concerted and long-term action with all the funding agencies, policy bodies and stakeholders pursuing the same (few) goals.

6.2.1 Developing a common language

The sector is not homogeneous, and embraces a range of people from software designers, (eg computer games, web-sites management systems) through computer and maintenance engineers to business analysts and consultants. Its boundaries are frequently changing and demand is subject to a range of influences. ICT has been fast growing during the 1990s and will continue to be. However, it is difficult to make forecasts of growth trends, not just because of the economic and business uncertainties which surround it and its heterogeneity, but because it does not have a shared language relating to ICT jobs, skills and work.

Participants in the Dialogue were keen to develop a consensus on what ICT jobs are, and promote the use of a more commonly shared language relating to actual ICT job titles and skills required in the workplace which would fit better with job definitions and descriptions used by employers. This would help provide a clearer picture both to young people when choosing careers and to training and education providers in responding to employers' needs. It would also help employers themselves in articulating their needs and in developing an industrial consensus on the scale and nature of demand trends and skill shortage problems. In particular it was felt that there is a need to build on the work undertaken in developing the SFIA framework with the aim of using it more widely in all future labour market assessments of the sector. The recent NOP survey undertaken for the group of ICT NTOs and DfEE was based on the SFIA framework and there may be important lessons to be learned from it for future surveys.

6.2.2 Widening the recruitment pool

Entrants into the ICT labour market predominantly come from one relatively small segment of the workforce, ie young, male graduates. It is widely accepted that there is a need to tap into a larger pool of talent through:

- **Tackling gender imbalance**: there are clear problems that need to be addressed in education and employment, to attract more women in to ICT professional jobs and to retain them and develop their careers in ICT. A range of measures have been suggested including improving the career image of ICT, building ICT capabilities among girls and women, improving career pathways and creating more opportunities for skill conversion.

- **Developing a more diverse and flexible workforce** - an uncertain and fairly volatile demand trend, together with the diversity of ICT jobs (see above), calls for a pool of potential ICT workers who are diverse and flexible. As well as employing more women, the ICT sector needs to make more use of flexible working. It also needs to look more at alternative sources to higher education to see how they may meet its diverse needs, especially at intermediate levels where a degree education

is less appropriate. For example, more output now is ICT qualified at lower education levels (eg GCSE, 'A' level, GNVQ, European Computer Driving License), and there is an increasing number of people in a range of occupations with a foundation of ICT skills they apply in their jobs, including older people. To achieve this greater diversity of intake will require:

- better presentation of the image of ICT and the different kinds of career options to different target groups, from primary school through to university graduates and adults;
- providing better career pathways and development internally so that the potential of the existing ICT workforce is recognised and nurtured better (see also below re quality);
- more emphasis by employers and careers advisers/ teachers to the importance of generic skills (communication, teamworking) as well as technical skills in ICT work, to attract and give guidance to potential entrants and also to select them effectively.

6.2.3 Improving the quality and responsiveness of education and training

The third strand of actions is targeted on the education and training system to improve the quality of provision and its responsiveness to employer needs (as well as helping to widen the potential recruitment pool, as discussed in section above)

- **Responsiveness of education** - ICT is increasingly being used across the education curriculum in schools, colleges and universities but there are areas where improvements can be made to the quality and effectiveness of the learning. Areas for action are:
- linking 'ICT learning' in schools more to 'ICT in work'. Improvements have been called for to the teaching of ICT to young people of different abilities, and also linking it more to careers guidance, so that more young people are encouraged to consider ICT as a post-16 choice (including modern apprenticeship and FE routes as well as HE);
- improving take-up of ICT training among school teachers so that the skills of teachers are increased and kept up to date. The role of teachers as 'ambassadors' for ICT careers and enhancing take-up could be addressed;
- improving the links between business and education/ training provision, so that providers are kept continually up-to-date and also that developments in curriculum design, qualification frameworks, etc. are relevant to business needs, at all levels, both in initial education and lifelong learning, throughout people's careers. There is a range of bodies within local and national training infrastructures (eg LLSCs, RDAs, NTOs, LAs) that can help facilitate better interaction, and it is important that these are used effectively and developed appropriately. The greater use of secondments (employer to education, and vice versa) would also be beneficial;

- in particular, there is a need to improve the quality of work experience in ICT given to students, at various levels from school to undergraduate study. Higher education courses in ICT in particular need to find ways of ensuring that curricula keep up to date with emerging trends in ICT work, perhaps through more exchanges of staff, shared use of equipment, joint project development etc;

- **Developing the training and qualifications infrastructure:** There is a need to develop a greater capacity in the UK for delivering flexible ICT training in the workplace eg through new methods of provision such as e-learning, and the greater recognition of short courses and units within the vocational qualification framework. The sector comprises a large number of self-employed professionals and small businesses, yet two-thirds of ICT professionals are employed in workplaces with over 50 employees. Smaller employers are harder to convince that investing in training pays but more effort is needed to do so. Larger employers may be able to assist smaller ones and self-employed to update their skills or acquire new ones and in particular access e-learning packages and materials. There may also be scope for small businesses to collaborate with each other to develop consortia for training or linking with local providers, and for continuous professional development purposes. Other improvements, detailed above in relation to widening the pool, include making better use of the existing workforce through improvements to recruitment and internal training practices.

6.2.4 Monitoring progress and emerging issues

Finally, there was felt to be a need to monitor progress and to provide an early warning of emerging hot spots in the future. While it is recognised that there are dangers in forecasting future demand in this area beyond a year or two, there needs to be better mechanisms in place to keep abreast of labour market trends overall and in the component parts of the sector. For example, this could be done via a regular employer panel survey, independently run so less reliance is put on evidence from market research surveys. There also needs to be more attention given to evaluating the success of initiatives taken to improve the supply system (eg those directed at women).

6.3 Other issues

In addition to these points of identified action from the Dialogue consultations, there are other outstanding issues which need to be addressed. These include:

- training in generic skills of the existing workforce - how can the increasing high levels of demand for problem solving, customer handling, team working and communications skills be effectively be met?

- meeting the continual technical skill development of the workforce, required as technology moves on - how can the potential for up-skilling and skill transfer be effectively met? Are there fundamental skills which people possess that form the foundation for continual skill development?

- the spatial distribution of ICT skills - should more geographical dispersion be encouraged to take place so that ICT skills become less concentrated in the South East of England?

- the global market in ICT - there is increasing evidence that this is growing as ICT diffuses throughout businesses which cross national boundaries and a growing global ICT skill market develops (eg in outsourcing work, international recruitment of professional staff). However, the impact of global market trends on the ICT skills base in the UK is relatively unknown, and the contribution of the various influencing factors.

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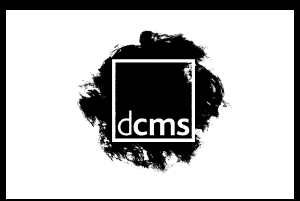

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