ANNEX III.1: European skill shortages in ICT and policy responses

Why has the demand for ICT skills increased in recent years?

Technological progress and the globalisation of the economy have increased the importance of human skills in our economies (see Berman et al., 1998). The share of university and college graduates in the population has increased trendwise since the Second World War. Evidence from econometric and case studies indicates that the demand for more skilled workers is positively correlated with capital intensity and the implementation of new technologies, both across industries and across plants within industries. Autor et al. (1998) find evidence for the US that "...skill-biased technological and organisational changes that accompanied the computer revolution appear to have contributed to faster growth in relative skill demand within detailed industries starting in the 1970s". This rapid skill upgrading was concentrated in the most computer–intensive sectors of the US economy and resulted in increasing wage inequality and growing educational wage differentials.

It is important not to oversimplify the relationship between the introduction of computers and demand for "skilled" workers. Several authors (e.g. DiNardo and Pischke, 1997 and Haisken-DeNew and Schmidt, 1999) stress that the causal relationship between computer use and demand for "skilled" workers is not straightforward but rather entangled with complex innovation processes which involve increased computer usage and, more importantly, changes in organisation and in production processes. Studies that analyse the employment impact of innovative activities support the existence of a relationship between skill upgrading and the introduction of new technologies. Innovations tend to increase the overall demand for labour but simultaneously lower the demand for unskilled labour (see Leo and Steiner, 1995 and Leo et al., forthcoming).

However, indicators of the use of new technologies (e.g. PCs), innovations and educational qualifications as a proxy for skills and competencies may not capture some of the fundamental changes behind the skill upgrade in the economy. In particular, educational qualifications may fail to capture many important skills which are needed at the workplace. Howell and Wolff (1992) conclude from case studies that "most jobs require a multitude of different skills for adequate task performance, ranging from physical abilities, like eye-hand co-ordination, dexterity and strength, to cognitive skills (analytic and synthetic reasoning, and numerical and verbal abilities) and interpersonal (supervisory, leadership) skills".

Howell and Wolff's analysis of the situation in the United States attempts "to account for skill composition and its change over time with direct measures of job skills and a more complete model of the demand for skills than appears in previous work". They therefore distinguished between cognitive, interactive and motor skill requirements for different jobs and adjusted their figures for industry characteristics. In their results they obtained little support "for either the standard factor substitution model or the widely accepted capital–skill complementary hypothesis". They found that capital intensity was strongly associated with rising interactive skills and declining cognitive skills. These results are in line with many case studies, which find that mechanisation is linked to the deskilling of production workers and to the growing share of managers and supervisors.

Although this annex focuses on the demand for ICT skills, it is important to recognise that the effects of

the new technologies on working life go beyond the increased demand for specialised technical skills. Firm-level evidence on the impact of ICT investment suggests that ICT use is correlated with increases in the demand for human capital skills, but also with more decentralised decision–making and greater use of teams (Bresnahan et al. 1999).[40] These authors conclude that "the combination of computerisation, workplace organisation and increased demand for skilled workers appears as a cluster of changes in modern firms, almost certainly because they are complements". This of course implies that the recent changes in the structure of the corporation and the demand for human capital have a common origin in technological change.

The demand for labour with skills in information and communications technology (ICT) has increased rapidly in both the ICT sector itself and in the rest of the economy. The ICT-producing sector ranks amongst the most knowledge–intensive sectors in our economies. ICT production is highly research-intensive: in 1997, more than one third of all business R&D in Ireland and Finland, and more than one fifth in Canada, France, Italy, Japan, Sweden and the US, was carried out in the ICT sector (see OECD 2000A). The rapid development and diffusion of new digital technologies in the fields of telecommunications, the Internet and new media has led to a pronounced expansion of the demand for ICT skills throughout the economy. During the 1990s, ICT became a common form of economic infrastructure. In the EU, computer density (PCs per 10 000 inhabitants) rose from 930 in 1992 to about 2 500 in 1999; during the same period, Internet density (estimated Internet users per 10 000 inhabitants) saw an even more dramatic increase, from 31 to about 1 600.

Several trends have shaped the demand for ICT-skilled personnel in the past quarter of a century:

– Digitisation of telephony led to a decrease in the demand for lower skilled ICT personnel who had been necessary for the operation and rollout of an analogue network. In turn, the demand for the skills needed to handle digital equipment increased. In net terms, the number of employees in public telecommunications operators has been falling since the beginning of the 1980s.

– Liberalisation of the telecommunications sector has not only forced former monopolists to introduce cost-saving measures, but has also permitted the entry of a large number of new competitors in the market. In the European Union, the number of operators authorised to offer public voice telephony almost doubled between 1998 and 2000 (European Commission, 2000).

– Internet and new media diffusion has created a demand for ICT skills both in specialised IT firms and in companies which have sought to establish a presence on the Internet and/or to engage in electronic commerce.

The downswing of Internet and technology stocks in spring 2000 led to significant layoffs and to low recruitment activity in the ICT sector. Nevertheless, given the positive long-term perspectives of the sector and the need for ICT skills in the rest of the economy, skill shortages are likely to remain a problem for the economy.

Estimates of ICT skill shortages in Europe

Existing studies on ICT skill shortages differ widely in terms of their methodology and scope. ICT skill shortages are measured, for instance, in terms of the number of vacant jobs, or the expected number of jobs to be created in the future, or the required number of persons with specific qualifications. Several studies analyse only the ICT branches of industry, which were the first to experience skill shortages. The ICT skill shortages have since spread throughout the economy, rendering it increasingly difficult to come up with an estimate of the skills gap for the whole economy.

Differences in educational curricula impose further difficulties for the estimation of skills shortages. Any estimate of the future skills gap requires information not only on demand, but also on the future supply of labour with ICT skills. In order to estimate the supply of skills, data are needed on the output of the educational system at a highly disaggregated level. Furthermore, training and re-training activities also generate ICT skills, while their overall effects are difficult to estimate.

The overall business cycle and developments at industry level affect the demand for labour with specific skills and increase the uncertainty of any projec-

40 These empirical results are confirmed by a survey of managers that found that ICT is skill–increasing, a tendency particularly pronounced in high human capital, ICT-intensive, and decentralised firms.

tions of skill shortages. This is particularly so in areas like ICT, where technological change is rapid and the organisation of commercial activities changes at an equally rapid pace. Hence, the estimates which are presented below should be taken as indicating the order of magnitude of the trends in the demand for and supply of ICT skills

Two studies on ICT skills shortages are available at European level, both carried out by the International Data Corporation (IDC)[41]. In 2000, the IDC finalised a study on ICT skills shortages for Microsoft (IDC, 2000). The study covered the skill needs for Internetworking Environments (i.e. Internet-related activities), Technology-Neutral Environments (i.e. IT-supported business processes) and Other Technology Environments (i.e. host-based, distributed and applications environments).

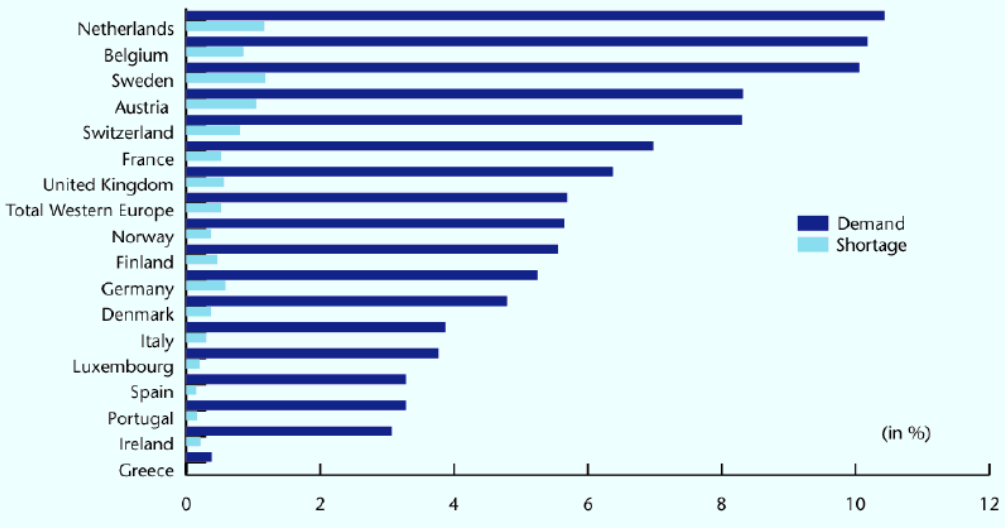
The demand for ICT skills was expected to grow from approximately 9.5 million ICT professionals in 1999 to 13.1 million in 2003, while supply was estimated to grow from 8.6 million in 1999 to 11.3 million in the same period. Consequently, the ICT skill shortages in Western Europe (EU-15, Norway and Switzerland) were estimated to reach 1.7 million ICT professionals by 2003, representing 13 per cent of the demand for such skills.

The level of demand for ICT professionals varies strongly among the West European countries included in the study (see Graph A III.1.1). On average, the demand for ICT specialists amounts to 5.7 per cent of total employment. This ratio is almost twice as high in the Netherlands, Belgium and Sweden, while Greece, Ireland, Portugal and Spain display the lowest levels of demand for ICT professionals.

In relative terms, the ICT skill shortages are highest in those countries where ICT also has the highest weight in total employment: in the Netherlands, the shortage of ICT skilled personnel amounts to 1.2 per cent of total employment; it is followed by Sweden, Austria and Belgium (Graph A III.1.1). At the opposite end of the range is Greece, where supply and demand are balanced.

41 As part of its continuous tracking of the IT services industry, IDC reviews, on a bi-annual basis, the level of demand for and supply of skilled professionals. From more than 12,000 interviews with information systems (IS) managers across Europe, IDC translates IS spending intentions into the amount of work that needs to be done in order to assimilate acquired technology. IT work is segmented into activities that have to be performed during the planning, implementation, maintenance, management and training phases. For example, in networking environments, these activities would include needs assessment, network design, configuration, capacity planning, optimisation, network monitoring, maintenance and management. This segmentation, along with trends in IT investment, is analysed by company size for each country, generating a picture of demand for skills over time. Investigation of trends among "intermediaries", typically recruitment agencies, provides a validation of this demand profile. IDC estimates that these intermediaries fill 40–70 % of all vacancies (depending on the country). Trends in their activities thus provide valuable validation of the demand profile generated by IT spending patterns.
The supply of resources has been analysed and forecast by researching output levels in the network of universities and other educational establishments. IDC conducted a survey of the academic community in Western Europe; the primary research was carried out in cooperation with administrators with insight on intake trends, evolution of courses and the subsequent employment tracks of graduates. These data have been used to compile baseline trends in the supply of new professionals to the IT sector. In addition to data from the academic community IDC has also factored in a contribution (12 % of new supply) from the re-skilling of workers from other industries, for example the defence and manufacturing sectors. Source: IDC (2000).

Graph A III.1.1:Demand for and shortage of ICT skills as a percentage of total employment, 1999



Source: WIFO calculations using IDC (2000); European Commission (2001).

The projected evolution of demand up to 2003 follows a fairly similar pattern in all the countries covered in the study. In most countries, demand for ICT skills is expected to grow at annual rates between 7 and 10 per cent in the period 2000-2003. After a moderate slowdown in 2001, growth is expected to accelerate again in 2002. In Spain, growth in the demand for ICT skills was significantly higher than in the other countries in 2000, while Luxembourg and Greece are expected to record below-average growth until 2002.

In 2001, the IDC carried out a second study on ICT skill shortages, this time on behalf of EITO (EITO, 2001). This study has a broader occupational coverage than the previous one: three main categories of ICT skills are analysed. The first category consists of ICT professionals, who support and develop technology environments in the industries that use ICT. This category roughly corresponds to the narrower scope of the earlier study (IDC 2000, see above). The second category covers e-business professionals, who support business strategies related to the Internet. The third category consists of call centre professionals, who provide sales and support activities. The total demand for ICT, e-business and call centre skills in Western Europe is estimated to have exceeded 10 per cent of total employment in 2001, exceeding the supply of such skills by 1.4 per cent of total employment (Table A III.1.1).

It is forecast that between 1999 and 2003 the demand for personnel with ICT, e-business and call centre skills in Western Europe will almost double. By 2003, demand for these skills will exceed 21.9 million jobs. The growth pattern of demand is similar across the countries covered in the study. Despite the expected increase in the supply of personnel with ICT, e-business and call centre skills, the skills gap will continue to widen.

The estimated shortage of ICT professionals in 2003 – the first of the three categories included, which corresponds to the narrower scope of the earlier study (IDC 2000) – is similar to the estimate given a year earlier, 1.7 million persons. Adding to this the categories of e-business professionals and call centre professionals leads to a total estimated skills gap of 3.8 million persons. The shortage of e-business professionals is expected to increase particularly rapidly, reflecting the more than threefold increase in the

Table A III.1.1:Demand, supply and shortage of ICT skills in Western Europe

	1999	2000	2001	2002	2003
Demand (1000 persons)					
ICT professionals	9 450	10 397	11 170	12 127	13 030
E-business	1 812	2 800	3 914	5 084	6 327
Call centre	1 000	1 300	1 690	2 113	2 577
Total	12 262	14 497	16 774	19 324	21 935
Supply (1000 persons)					
ICT professionals	8 613	9 188	9 815	10 609	11 344
E-business	1 481	2 255	3 040	3 761	4 347
Call centre	900	1 183	1 546	1 954	2 397
Total	10 994	12 626	14 401	16 324	18 088
Shortage (1000 persons)					
ICT professionals	837	1 208	1 355	1 519	1 686
E-business	331	546	874	1 324	1 980
Call centre	100	117	144	158	180
Total	1 268	1 871	2 373	3 001	3 846
Shortage in % of demand					
ICT professionals	8.9	11.6	12.1	12.5	12.9
E-business	18.3	19.5	22.3	26.0	31.3
Call centre	10.0	9.0	8.5	7.5	7.0
Total	10.3	12.9	14.1	15.5	17.5
In % of total employment					
Demand	7.4	8.9	10.2	11.6	n.a.
Supply	6.6	7.7	8.7	9.8	n.a.
Shortage	0.8	1.1	1.4	1.8	n.a.

Source: WIFO calculations using EITO (2001).

Table A III.1.2: Country level studies of the ICT skills gap

Country	Source	Period covered	Demand	Shortage	Scope/Sector
Belgium	IDC (2000)	2003	-	72 932	total economy
	INSEA (1)	Annually	-	5 000	Software engineers
Denmark	IDC (2000)	2003	-	24 679	total economy
	SHAPIRO (1998)	1998-2002	40 000	-	Employees MA level computer skills
Germany	IDC (2000)	2003	-	404 951	total economy
	EITO (2001)	2003	-	353 900	total economy
	D21 (2001)	Currently	-	150 000	total economy
	BMWI & bmb+f (1999)	Currently	-	75 000	total economy
	BMWI (1999)	1999-2002	350 000	-	total economy
	ZEW	2000-2002	340 000	-	total economy
Greece	IDC (2000)	2003	-	2 005	total economy
Spain	IDC (2000)	2003	-	101 011	total economy
	EITO (2001)	2003	-	107 100	total economy
France	IDC (2000)	2003	-	223 709	total economy
	OECD (2000B)	Currently	-	25 000	total economy
Ireland	IDC (2000)	1998-2003	-	9 881	total economy
Italy	IDC (2000)	2003	-	167 439	total economy
	EITO (2001)	2003	-	161 300	total economy
	Ministry of Labour (3)	Currently	-	50 000	total economy
Luxembourg	IDC (2000)	2003	-	967	total economy
Netherlands	IDC (2000)	2003	-	118 882	total economy
	FENIT (2000)	End of 2000	14 500	-	Telecom sector
	Dutch Ministry of Economic Affairs and Ministry of Education (2000)	2000-2003	-	24 000	total economy
Austria	IDC (2000)	2003	-	85 013	total economy
	Leo (2000)	1997-2003	13 000	-	ICT
	Synthesis (2001)	2002	-	7 400	total economy
Portugal	IDC (2000)	2003	-	21 913	total economy
Finland	IDC (2000)	2003	-	21 314	total economy
	Ministry of Labour (2000)	2002	-	8 000-12 000	Computer experts in the total economy
	Employers Confederation of Services Industry (1)	2001	2 500–3 000	-	IT service sector in member companies
Sweden	IDC (1999)	2003	-	67 092	total economy
	Swedish National Labour Market Board (2001)	Annually 2001-2011	10 500	-	total economy
UK	IDC (2000)	2003	-	329 573	total economy
	EITO (2001)	2003	-	326 700	total economy
	IER (2)	1997-2006	340 000	-	IT Service
	Cambridge Econometrics (2)	2010	421 000	-	Computer services
Japan	Ogura – Suzuki (1999)	1996	-	9 000	system engineers & programmers
US	ITAA (2000)	2001	900 000	843 000	total economy
	ITAA (2001)	2001	-	425 000	total economy

Notes:
(1) Quoted from WITSA 2001.
(2) Quoted from Department for Education and Employment, 1999.
(3) Quoted from Ministero del Tesoro, del Bilancio e della Programmazione Economica.

demand for e-business skills over the forecast period 1999-2003. For call centre skills, the gap between demand and supply will increase moderately in absolute terms, but narrow in relation to total demand in the sector.

In relative terms, the estimated skills gap is highest for e-business skills, where it is projected to amount to 31 per cent of demand in 2003. The skills gap for ICT professionals is forecast at 13 per cent of demand, and that for call centre professionals at 7 per cent of demand. Under the category ICT professionals, businesses appear to be looking primarily for Internet specialists (where the shortage amounts to 32 per cent of demand).

In Table A III.1.2, the estimates of the two IDC studies [IDC (2000) and EITO (2001)] are compared with a selection of national-level studies. Differences in the scope of the studies, sector definition, time horizon, data-gathering method or period of study are likely to explain at least partly the wide differences in the estimates for ICT skill shortages. National-level estimates for ICT skills demand, or skill shortages, are in most cases substantially lower than the IDC estimates.

In more recent studies, the estimates of ICT skill shortages tend to be lower than in earlier studies (see e.g. the studies by ITAA in the US). This is likely to reflect the recent downswing of the ICT industry. However, the studies still point to existing shortages, and these may aggravate once an upswing sets in.

Policy responses to the ICT skills gap

Many governments and businesses alike have taken measures to combat ICT skill shortages. Member States have introduced changes to their educational systems and intensified ICT training; some have also encouraged immigration. At the EU level, the European Commission launched the Initiative for New Employment, the eLearning Initiative and the European Computer Driving Licence. Ten Member States participated in a benchmarking project on "ICT and new organisational arrangements"[42], which recommended inter alia that more be done to train the personnel and management of SMEs in new technologies. Some firms have established learning centres outside Europe, or transferred part of their development and production units to non–EU countries (for examples, see EITO 2001).

The appropriate response to the ICT skills gap depends on the type and urgency of the skills needs. Table A III.1.3 groups the possible measures according to the level of skills needed, and to the urgency of the skills shortage.

In most cases, the obvious response to skill shortages would be the adaptation of the national educational system to provide more graduates with the required skills. If highly skilled ICT personnel with ICT specific training of more than three years are needed, changes in the education system may take too long to reduce current shortages. Introducing new courses has lead times of one to two years as new curricula have to be developed and additional resources are needed. Altogether, it may take five to seven years before additional highly-skilled graduates leave the education system and enter the labour market. Consequently, immigration or outsourcing to countries with sufficient highly skilled ICT personnel may be the only available short-term solution.

Short-term shortages of medium-skilled ICT personnel (with ICT-specific training of one to three years) may also call for outsourcing and/or immigration policies, but to a lesser extent than for highly-skilled ICT personnel. In the short run, ICT skills at both intermediate and lower levels can be increased through training measures. Training programmes may also have the beneficial side-effect of drawing more people into the labour market and increasing participation rates. To succeed, it is essential that public training measures be implemented in close co-operation with firms.

Only some governments and few experts predicted the skill shortages in time, and many were surprised by the magnitude of the problem in 1999 and 2000. While it is difficult to predict with accuracy the future demand for occupational skills, it is essential that the education and training regime be sufficiently flexible to accommodate shifts in skills demand, especially when these are of a permanent character.

42 See recommendations in "Summary of Results of Best Practice-related Activities in the field of Enterprise Policy" (SEC(2000) 1824 of 26.10.2000) p.4-5. Detailed information on the benchmarking project are available on Internet: http://www.benchmarking-in-europe.com/eu_initiatives/enterprise_dg/framework_conditions/index.htm

Table A III.1.3: Actions in response to the ICT skills shortage

	Short–term demand	Long–term demand
Highly–skilled ICT personnel	Immigration Outsourcing to non-EU countries with a highly qualified labour force	Increase output of tertiary education
Medium–skilled ICT personnel	Immigration Outsourcing to non-EU countries with a qualified labour force E-learning Training and retraining activities	Increase output of secondary education
Low–skilled ICT personnel	European computer driving licence Training and requalification activities	Increase computer and Internet literacy in primary and secondary education

Concluding comments

The long-term increase in the demand for highly skilled professionals and the recent shortage of ICT-skilled workers is bound up with technological change. The longer-term trend was matched by a constant increase in output from the education system. In contrast, the more recent surge in ICT investment in the 1990s led to a constant widening of the ICT skill gap, which was at its widest in the first half of 2000 and was not accompanied by an increase in the output of the education system. This more recent increase in demand for ICT skills is the direct product of the development and diffusion of new technologies and has been intensified by the digitisation and liberalisation in the telecommunication sector and the rapid expansion of the Internet and new media.

Shortages of ICT skills have appeared both in the ICT sectors itself and in companies which use ICT, for instance electronic commerce. The current shortages of personnel with ICT skills may be even as high as $1\frac{1}{2}$ per cent of total employment in Western Europe. The skills shortages are expected to worsen in the coming years, despite an increased supply of the requisite skills.

While changes in educational curricula may be the solution in the medium to long term, short-term skill shortages have been met by measures such as targeted training, immigration or outsourcing.

In recent years, measures to combat shortages of ICT skills have topped the policy agenda in the Member States and in ICT firms. Both have been promoting strategies, occasionally by co-operative arrangements, to increase the supply of ICT–skilled labour. The Commission put forward the Initiative for New Employment, the eLearning Initiative and the European Computer Driving Licence. Member States have also initiated changes in their education systems and have intensified training and requalification activities. Businesses have introduced new ways to recruit skilled people (most notably online recruiting) and to raise employee loyalty by offering stock options. They have also invested in technology-focused alliances with partners, launched eLearning systems, virtual learning centres, etc. Some Member States have also tried to solve the ICT skill shortages by encouraging immigration, and some firms have established learning centres outside Europe or transferred part of their development and production units to non–EU countries.

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