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Skills Shortage vs. Job Creation: A Review of Empirical Evidence on the Issue of ICTs and Employment

By Hannes Selhofer*

"The highest economic and social priority for the European Union is to create jobs. Europe's unemployment rate is still far beyond an acceptable level. […] The Information Society creates new opportunities and jobs, and can aid competitiveness. It [the information society] will have a profound impact on European employment, growth and productivity for the next five years and for decades afterwards."

Erkki Liikanen, Member of the European Commission (2000)[1]

"We see no reason why Europe's dismal employment performance over the last six years — effectively a period of jobless growth — should suddenly be reversed to any degree by the advent by ICTs".

High Level Expert Group on the information society (1997)[2]

Summary

The creation of new opportunities for employment is ranking high on the political agenda and in the rhetoric of the European Union. The boom markets of the information and communication industries are regarded as a key area for future employment. The hope for new jobs is nourished by forecasts about future growth in these sectors. Also, studies describing the "IT skills gap", i.e. the quite dramatic lack of IT professionals across countries and sectors, may suggest that a significant number of new jobs are being created. This paper is a contribution to the employment debate. It argues that empirical evidence does not support the theory that information and communication technologies will create enough new employment opportunities to fulfil the "promise of the information society", although the dramatic demand for professionals is obvious. However, the paper argues that a defensive or hesitant strategy regarding policies for digital information and communication technologies will not be beneficial. The most important and practical question to be asked is: How can Europe improve and adapt its system of education and training in order to provide the digital economy with the required type and amount of skilled employees?

1. Introduction

The creation of new opportunities for employment is ranking high on the political agenda and in the rhetoric of the European Union. In search for growth areas that promise a significant number of new (i.e. *additional*) jobs over the next ten years, the boom markets of the information and communication industries give rise to great hopes. The discourse about prospective employment benefits from growth anticipated for these sectors is common to numerous European Union documents about the information society. Since the early 1990s, information and communication technologies and the related services are believed to have the "potential to promote steady and sustainable growth, to increase competitiveness, to open new job opportunities and to improve the quality of life to all Europeans."[3]

In 1997, a high-level expert group (HLEG) appointed by the European Commission to investigate the information society[4] took a more cautious position. The HLEG stated that they "see no reason why Europe's dismal employ-

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1 EITO (2000), 14–15.

2 European Commission (1997c).

3 European Commission (1993).

4 The HLEG on the information society was set up by the European Commission in May 1995 to analyse the social aspects of the

ment performance over the last six years — effectively a period of jobless growth — should suddenly be reversed to any degree by the advent by ICTs."[5] The group believes that ICTs provide opportunities for new forms of employment in high-value, high-skill occupations, but argues for a "common minimum social framework" in order to successfully exploit these opportunities.

The report of the HLEG could have been a milestone in the debate, but the experts' cautious approach to assessing ICT-related employment opportunities has hardly been echoed in the official rhetoric of the European Union since then. The Green Paper on Convergence (1997)[6] attributes a "multiplier effect" to convergence in its role as an enabler of the information society, and states that "there is likely to be a direct and positive impact on employment in the relevant sectors", since "the attendant demand for new content and services will generate a need for people with the requisite creative talents." Similar passages and phrases can be found in the EC's research programmes on multimedia, content and information technology, both in the 4th Framework Programme (1994–1998) and the 5th Framework Programme (1998–2002).

The optimistic view proposed by the European Commission has been adopted at the member state level in various white papers and national action plans.[7] It is fair to say that believing in ICTs as job creators has become a religion. The credo is that the new markets will create a huge number of new jobs and thus help to overcome unemployment if the required regulatory and competitive framework can be provided. This view is supported and echoed by several studies, mainly from consulting and market research companies. For instance, a recent study by Booz, Allen & Hamilton on employment opportunities in the German multimedia market finds that 350.000 new (= additional) jobs can be created in the ICT and multimedia sectors by 2003.[8] Critical views of the employment effects, even if supported by detailed employment statistics gathered by economic research institutes,[9] appear to have had remarkably little impact on the debate so far.

The "new jobs" paradigm, i. e. the assumption that *additional* jobs will be created on a macro-economic level as a result of massive revenue growth in the information and communication industries, seems to be confirmed by the dramatic lack of engineers and IT specialists in the related sectors. Indeed, the demand for professionals is obvious. A look into the jobs and careers sections of any newspaper these days is enough to confirm reports of a desperate search for database programmers, web designers, network operators and information engineers. On an individual level, these vacancies are certainly "job opportunities", since salaries for most of these jobs are enormous due to the shortage of skilled personnel available. A number of studies have tried to assess the economic dimension of the skills gap in these sectors, the effects of high wages for employers being only one aspect.[10]

Whereas the competitive importance of providing the economy with a larger pool of IT professionals is unchallenged, it remains unclear why the demand for certain qualifications should be a signpost for total growth of employment. Seufert (1996) shows that employment effects can be analysed on three distinct levels:

- on a qualitative level (emergence of new types of jobs requiring new qualifications)
- on a quantitative level restricted to a certain sector (how many people are employed in this sector)
- and on a macro-economic quantitative level (dealing with the overall employment effect of ICTs).

This paper contributes to the current debate on employment effects of information and communication technologies. It argues that the pressing demand for IT and networking professionals is not an indicator for total growth of employment induced by information and communication technologies. Following Seufert's systematic approach, the paper suggests that information and communication technologies have a massive impact on employment in terms of qualifications required, and that they create new jobs in certain specific sectors, but they cannot solve the employment problem.

To develop this argument, the paper will first deal with different approaches to defining and segmenting the sector(s) related to new information and communication technologies. The second section of the paper delivers an overview of studies that have assessed employment developments in these sectors. This will include studies focusing on the number of jobs as well as studies calculating the economic dimension of the "skills gap". This section will also comment on the different methodologies these studies apply, which may partly explain the remarkable difference of the results. Finally, based on this review of the empirical evidence, the paper will make a recommendation for employment policies. It proposes a practical and pragmatic focus on how to provide the *qualifications* people will need in the future and how to launch educational programmes that can provide these qualifications.

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information society. Chairman of the HLEG was Prof. Luc L.G. Soete from MERIT, University of Maastricht, Netherlands.

5 European Commission (1997c), 47.

6 European Commission (1997d), 11.

7 See, for example, Deutsches Bundesministerium für Wirtschaft und Technologie (1996).

8 Deutsches Bundesministerium für Wirtschaft und Technologie (1999a).

9 See, for example, Preissl (1997); Seufert (2000).

10 See, for example, Datamonitor (2000); IDC (1999); Ducatel (1999).

2. "ICT", "IuK", "TIME", "Multimedia": the Difficulties of Naming Convergence

Analysing employment effects of digital information and communication technologies immediately leads to the difficulty of defining the economic sectors that should be part of the analysis. Even studies that take a 'holistic' approach in trying to assess the overall employment impact of ICTs on a macro-economic level have to comment on "sectors" when assessing the potential for *additional* jobs, since the question arises where these jobs will be found. Seufert (1996; 2000) has dealt with the dilemma of providing sensible and 'workable' definitions for the converging sectors and refers to approaches of studies that have been discussed in Germany recently. Extending Seufert's list, the following table presents a few approaches and definitions. The list is not comprehensive, but may help to illustrate the dilemma. One of the differences between various industry segmentations is whether sectors related to content production are included or not.

The lack of common standards and definitions is a major methodological problem in socio-economic studies on new technologies. Researchers, even within the same discipline, seem to have lost a common language (if they ever had one). Even if they — literally — talk and write about the same issues and subjects, a closer look at their work may reveal that they use the same terms in very different ways, which makes comparisons of their findings quite difficult. Defining terms is an important issue in all sciences, but the situation is particularly unsatisfying in studies on the digital information and communication technologies. The general and indistinct reference to "ICTs" can lead to "inappropriate and uncritical conclusions".[11]

A major cause for the lack of accurate definitions is that the objects to be described are not stable, but in a process of ongoing change. A key term that has emerged in the 1990s to describe this process is *convergence*. The paradox, however, is that convergence itself is a (meta-)concept that remains necessarily quite vague: obviously, if the components of convergence are not clearly defined, the meta-concept also cannot be accurate. The use of the term convergence is inflationary, referring to very different aspects and processes. The problem of definitions makes estimates about future developments and employment effects even more risky. In order to compare the job situation "before" and "after", researchers have to translate old definitions of information and communication markets and sectors ("before") into a new, converging business envi-

[11] Preissl (1997), 6.

Table 1

Terms and definitions to structure the converging markets

Key term for industry	Used by (examples)	Definition
ICT	OECD, EITO	"… limited to those industries which facilitate, by electronic means, the processing, transmission and display of information, and it excludes the industries which create the information, the so-called 'content' industries." (OECD 1998) telecommunications + computer systems and services + office equipment (EITO 2000, 42)
IT sector	US Department of Commerce (1998)	"IT industries produce, process, or transmit information goods and services …" "… separated into categories of Hardware, Software and Services, and Communications"
M+K[1)] sector, IC[2)] sector	DIW	The DIW proposes a segmentation of the "information and communication sector" (IC / IuK) into three sub-sectors: IC-technologies, IC-services and IC-contents; employment figures are based on NACE codes attributed to these sectors.
TIME industries	Arthur D. Little	The TIME concept comprises the convergent industries of telecommunication, information technology, media and electronics.[3)]
multimedia	Booz, Allen & Hamilton (Germany)	definition is based on a value chain with four sectors: content and value added services, networks / transport, electronic components, consumer devices.
Mediamatik (mediamatics)	Austrian Academy of Sciences[4)]	The term "mediamatics" is a blending of media and informatics. "Mediamatics" is the second phase of convergence (beginning in the 1980s) after telematics, i.e. the convergence of telecommunications and computer (informatics) which started in the 1970s.

[1)] Media + communication. — [2)] IC = information and communication; in German: "IuK" (Informations- u. Kommunikationssektor). — [3)] In other references and studies, the E in "TIME" stands for "entertainment" or "e-commerce". — [4)] Latzer (2000). Latzer has already introduced the term in his previous book on mediamatics (1997).

ronment ("after") which has been undergoing fundamental changes. It is a tricky methodological problem to make projections if the definition of the analysed subject has to be changed.

Researchers have created different terms and approaches to deal with this problem. Based on the paradigm of convergence, Latzer proposes the term "**mediamatics**"[12] to describe the converging sectors of telecommunications, information technology and media. He argues that „mediamatics" — a blending of media and informatics — was the second step of convergence after informatics (information technology and mathematics), the convergence of telecommunications and computers which started in the 1970s.

A similar concept to describe the sector, albeit with a different term, is the "TIME" concept. In this approach, the acronym TIME is used to describe a converging industry including the following sectors: telecommunications (T), information technology (I), media (M) and entertainment (E). This concept is broader than the "ICT"-approach, since is not reduced to technologies, but also includes the services enabled by these technologies.

A working group of the OECD dealing with "indicators for the information society" has provided a definition of the **ICT** sector which suggests including only the infrastructure providers and operators but excluding the content providers: "The definition is a compromise, limited to those industries which facilitate, by electronic means, the processing, transmission and display of information, and it excludes the industries which create the information, the so-called 'content' industries."[13]

The European Information Technology Observatory (EITO) has developed a model with very detailed definitions of markets and sectors. EITO defines the "information business arena" as a conglomerate comprising the telecommunications industry, the computer systems and services sector and the office equipment sector.[14] EITO presents annual industry statistics for the size of each of these sectors.

EITO also presents a more detailed segmentation for the ICT market, which divides the market into the following sectors: computer hardware and datacom, office equipment, software, services, support services, telecommunication equipment and telecommunication carrier services. The total value of these markets for 1999 was 470 billion euro (+ 12 percent since 1998).

The market segmentation of EITO is similar to the DIW (German Institute of Economic Research) methodology which suggests dividing the "IC" (= information and communication) sector into three sub-sectors, i. e. **IC-technologies, IC-services and IC-contents**:[15]

- IC-technologies: e.g. computers, electronic components, broadcasting technology, cable technology, printing and copy machines
- IC-services: telecommunication services, data processing services, call centres

12 Latzer (1997); Latzer (2000).
13 OECD (1998).
14 EITO (2000), 42f.
15 Seufert (2000).

Table 2

EITO industry statistics: Western European information business arena (market volume in billion euro)

Sector	definition	market (1997)	market (1998)
ICT markets			
Telecom	voice and data network services, customer premise equipment, service providing equipment, installation and maintenance	183	221
Computer systems and services	hardware, packaged software, services	167	189
Office	typewriters, calculators, copiers, other	9	10
Other sectors of the "information business arena"			
Distribution	broadcasting, telex/mailgram, mail, parcel, courier	99	102
Media and publishing	films, TV programmes, videos, CDs, records and tapes	221	232
Marketing and advertising	online databases, online shopping, mail order catalogues, advertising, direct marketing, other business services	173	180
Consumer electronics	TV sets, VCRs, radios, tapedecks, watches, other	71	73

Source: EITO (1999, 2000)

- IC-contents (= media business): advertising, public relations, film, broadcasting companies, multimedia/online, publishing, news agencies

Based on this market segmentation, the DIW provides figures for employment, the net product and the gross product of the sectors for Germany (see next section). Employment figures are based on selected NACE categories attributed to one of the sectors.

In a recent study by the Austrian Institute of Economic Research, Leo also uses **NACE codes** to define the "ICT sector".[16] The advantage of this approach is that NACE codes are standardised, and employment figures are therefore easily available on an international level. The problem is, however, as Leo makes clear, that NACE codes on this level of aggregation also contain business sectors that are not directly related to the development of telecommunications and media. The author states that he has selected those NACE sectors that are characterised by a high demand for IT-qualified staff and therefore significantly influence the IT employment situation. The strategy to use NACE sectors is also applied by Wörter[17] within the framework of the „mediamatics" approach. Wörter suggests a series of four-digit NACE codes which seem relevant to the converging sectors covered by the mediamatics approach.

If the term "ICT" indicates a focus on the infrastructure sectors of the converging industries (networking technology, computer hardware, equipment), the term "**multimedia**" evokes a connotation to businesses involved with content creation. However, sometimes the term is also used in a broader sense, i.e. to relate to both the content and infrastructure layer of the industry. A recent study by Booz, Allen & Hamilton on behalf of the German Ministry of Economics and Technology[18] which analyses employment effects of multimedia defines „multimedia" based on a value chain with four sectors:

- content and value added services: e.g. multimedia CD-ROM production, games (CD-ROM and cartridges), TV channels, software, film, video, online services, call centres, e-commerce
- networks / transport: e. g. telephone networks (fixed network, mobile), TV cable network operators, LAN / intranet, switching services, routers
- electronic components: e. g. picture tubes, LCDs, screens, chips, drives
- consumer devices: e.g. consumer electronics (TV sets, VCRs, game consoles), IT-hardware (PCs, servers, laptops, printers), telecom equipment (mobile phones, etc.)

While each of the approaches has its advantages and disadvantages, depending on the research objectives, the author of this paper favours the IC-based approach with separate categories for technologies, services and content. The advantage of the IC approach is that it keeps the standard concept of "ICT" as a sub-sector of the total information and communication sector, but goes beyond the mere technological perspective. This seems to be a useful compromise between concepts that are either very general and broad or very specific and narrow. The IC market segmentation is — while flexible — accurate enough to provide researchers with a matrix to analyse employment effects and qualification requirements of new technologies. Within the framework of the IC terminology, "ICTs" constitute the sub-sector of those industries concerned with hardware and networking technologies.

3. Measuring Employment Effects: Different Methodologies, Different Results

Alarmed by high figures of unemployment, policymakers at both European and national levels are desperate for figures about future employment opportunities in the IC sectors. Researchers have readily reacted to this demand and presented studies with detailed estimates about employment trends in the IC industries. As the methodological approaches of these studies differ in some important factors, a direct comparison is quite problematic. Taking this into account, this section summarises the findings of some recent studies that provide estimates of future employment trends in the IC sectors.

Information and communication technologies can create jobs in two ways. Jobs can be the result of the rapid economic growth in the IC sectors, at least as far as growth in terms of *revenues* or *profits* translates into growth of *employment*. The development of new technologies can also have indirect employment effects, i.e. create jobs in other industries than the IC sectors. These jobs are mainly in the IT departments of any business that uses new technologies.

3.1 US studies: Estimates on employment in the digital economy

The United States Department of Commerce has published comprehensive studies on the "(Emerging) Digital Economy" which provide figures on direct and indirect employment effects of information and communication

[16] Leo (2000), 3. Leo includes the NACE codes 30 (manufacture of office machinery and computers), 31 (manufacture of electrical machinery and apparatuses), 32 (manufacture of radio, TV and communication equipment), 33 (manufacture of medical, precision and optical instruments), 64 (post and telecommunications) and 72 (computer and related activities) in the "ICT sector".

[17] Wörter (2000).

[18] Deutsches Bundesministerium für Wirtschaft und Technologie (1999a).

Table 3

Different research designs of studies on the employment effects of information and communication technologies

Factors of difference	
Market definitions / terminology	Studies use different terms and/or different definitions of the same term in their segmentation of the market(s) they analyse (see previous section)
Research methodology and sources of data	Studies tend to use one of the following methods or a combination of these: • studies based on past industry employment statistics, using extrapolation and trend analysis • studies based on surveys or interviews with experts and industry representatives in order to assess the future demand for employees • studies using econometric models to translate revenue figures (based on forecasts and estimates about prospective revenues) into figures for employment
Measuring direct vs. indirect employment effects	Some studies focus on direct employment effects, i. e. jobs created at companies within the analysed sector, for instance in content production companies or IT businesses. Other studies extend their analysis and try to measure indirect employment effects, for instance by counting in IT-related jobs in other industries than the IC sectors (e. g. employees in IT departments).
Measuring net or gross employment effects	Most studies on employment in the communication industries focus on the number of new jobs created. While it is difficult enough to assess this growth potential, it is even more difficult to measure the net effects of employment, especially if indirect effects are considered as well. There is a debate on whether rationalisation effects of information technologies, e. g. in production, should be measured against job creation (e. g. in businesses providing IT solutions). In general, the indirect (negative) employment effects are not being considered, as there is little practical value in observing that new technologies make certain types of jobs obsolete. There is no viable policy to "stop" the information society development in order to save jobs threatened by IT effects.
Different interests on the research agenda	The community involved in these studies (i. e. those who perform the research and those who have a professional interest in the results) are mainly research institutes, consultants, policy makers and the industry. The interest of these players may in some cases be divergent. While this is not to say that figures are deliberately "constructed" depending on the agenda of the player involved, the methodology and definitions adopted in the study will certainly reflect the specific interests of, for instance, research organisations or IT companies.

technologies. The reports forecast that by the year 2006, almost half of the US workforce will be employed by industries that are either major *producers* or intensive *users* of information technology products and services (up from 44 percent in 1989).[19] The 1999 report concludes that "innovation has increased demand for high paid, 'core IT workers' (e. g. computer scientists, engineers), created new IT occupations, changed skill requirements for some non-IT occupations, and raised minimum skill requirements for many other jobs. Wage gaps between workers in IT industries and all other workers continue to widen."[20]

However, the report is also quire clear about the limits of the growth potential of the IT producing industry in terms of direct employment effects. While the number of employees in IT *using* sectors is estimated to increase from 41 million in 1996 to 51 million by 2006, the workforce in IT *producing* businesses is expected to increase by slightly more than one million from five million (1996) to six million (2006), according to the report. Employment in IT-producing industries has grown by 2.4 percent annually in the 1990s, compared with a 1.7 percent annual rate of growth for all private industries. Among the four IT-producing industry groups, software and services is the fastest growing group (8.3 percent annually) and is now the largest (1.43 million workers), followed by communication services (1.42 million). In 1998, employment at IT producing companies accounted for less than five percent of total private employment. Growth figures, however, have increased dramatically in 1995 and thereafter. The annual growth rate is currently at about 6.5 percent.

The US Bureau of Labor Statistics forecasts that 75 percent of all net new jobs in the US in the next ten years will be in the professional, technical, and managerial areas. Computer and data processing services will add over 1.3 million jobs from 1996-2006. This would be a 108 percent increase. Only health care services will top that figure and account for 3.1 million new jobs, the largest numerical increase of any industry over the next ten years.[21] An update to this study provides even higher figures for the ICT markets. For the period from 1998 to 2008, the Bureau of Labor Statistics forecasts 1.6 million new jobs for "core ICT workers".[22] The main professions that contribute to

[19] US Department of Commerce (1998, 1999).

[20] US Department of Commerce (1999), 4.

[21] Bureau of Labor Statistics: 1998–99 Occupational Outlook Handbook. Quoted by D'Amico (1999).

[22] Braddock (1999): Occupational employment projections to 2008. In: Monthly Labor Review, November. Quoted by Ducatel / Burgelman (2000). "Core ICT workers" are defined as computer

Table 4

US employment in IT using and IT producing industries

Year	Employment in IT producing industries (million employees)	Employment in IT using industries (million employees)
1990	4	36
1992	4	37
1994	4	39
1996	5	41
1998	5	n. a.
2006	6	51

Source: Bureau of Labor Statistics / US Department of Commerce (1999, 2000)

growth in these sectors are system analysts (600,000 extra jobs by 2008), computer support specialists (450,000), computer engineers (300,000), database administrators (80.000) and desktop publishers (20,000).

3.2 European studies on employment effects of ICT

The European Union has also published a number of studies with estimates about employment effects of new technologies. However, it is difficult to identify a standard framework of reference for European figures such as e.g. the figures from the Bureau of Labor Statistics in the US. It is certainly more difficult to provide European statistics since at least 15 states with different statistical institutions and traditions have to be covered. More studies are available on a national level for different countries. Efforts to assess employment effects on a European level have given special attention to the content industry, the liberalised telecommunication markets and to e-commerce.

The information and communication markets have attracted attention as potential "job machines" since the early 1990s. In 1995, the European Commission stated in its communication to the European Parliament and the Council about the INFO2000 Programme (1996-1999) that the content industry offers "knowledge intensive jobs to more than two million employees in Europe" (EC 1995). The content industry was defined as a value chain including content creation, development, packaging and distribution. The EC took the position that this industry would offer even more and better opportunities for employment in the future, since the demand for high quality and easily accessible information services would increase. A European Commission study from 1996 on "Strategic developments for the European Publishing Industry towards the Year 2000" concludes that the content industry would create new jobs mainly on three different levels: at subsidiaries of large media corporations, founded to exploit the new media markets; in online departments of newspapers and magazines; and in entirely new businesses, mainly SMEs in the multimedia and services sector. The study estimates the employment effect for total Europe at "one million new jobs" by the year 2006.[23]

The European Union's FAIR project[24] has analysed the employment effects of e-commerce in Europe. The report states that "macro-economic analyses of developments in e-commerce have shown the potential for positive impacts on the EU economy by generating indirect multiplier effects on production, value added and employment growth, even when substitution effects and traditional job reductions are taken into account. The estimate for e-commerce employment impact in the four main EU countries [Germany, France, UK, Italy] is three indirect jobs for each direct job created."

Germany is probably one of the most intensely studied markets. Findings seem to be quite controversial at first sight, but a closer look at the various studies provides at least some common trends. Already in 1996, the German Institute for Economic Research (DIW) presented a critical assessment of the media 'employment hype'.[25] It concludes that the growth of employment in the German media and communication sector has been overestimated. The report states that even if the *demand* for communication and media services should triple by the year 2010, the potential for additional *jobs* would only be moderate. The DIW forecasts a net growth of employment in the sectors covered (see chart below) from 1.9 million jobs in

engineers, computer support specialists, database administrators and other computer scientists.

[23] European Commission (1996).

[24] FAIR (Forecast and Assessment of the socio-economic and policy Impact of advanced communications and Recommendations) was a project with the European Union's ACTS programme (1994–98). Reports and results of FAIR are available at the project web site. URL: http://www.databank.it/dbc/fair/

[25] Seufert (1996).

Table 5

Employment effects of e-commerce in Europe's four largest countries (France, Germany, Italy, UK)

Type of employment effect	Additional jobs (1998, units)
Primary: direct (industry direct requirements)	41,621
Primary: indirect (inter-industry linkages)	30,930
Secondary (consumption-income linkage)*	100,173
TOTAL	172,724

* the value added generated by primary effects increases household disposable income and consumption

Source: FAIR project (1998)

1992 to 2.1 million in 2010, a CAGR of only 0.5 percent between 1992 and 2010. The DIW argues that employment in the core sectors of traditional content production (print media, electronic media)[26] will stagnate between 2000 and 2010. It forecasts a moderate 6.5 percent increase of employment in the media and communication technology sector[27] (2000-2010) and a 9.2 percent increase of jobs related to the communication services[28] sector. Results are partly based on a market study by Prognos forecasting the future demand for communication services. The DIW report states that it does not take into account indirect employment effects, such as the effects on suppliers or on companies using the produced services.

In a recent paper, Seufert confirms his findings from 1996.[29] The paper focuses on the relative importance of the 'media industry' (defined as the content-related subsector of the IC industries, see above). Seufert finds that the percentage of people employed in the IC sector media has decreased from 4.4 percent (of the total workforce) in 1992 to 4.1 percent in 1998. The percentage of people employed in the media (content) sector has slightly increased from 1.2 percent (1992) to 1.3 percent (1998). In absolute figures, according to the DIW, 1.5 million people were employed in the IC industries in Germany in 1998, 470,000 of these in the media industry. The difference between the figures in the 1996 study — 1.9 million employees in the M+K sectors in 1992 — and the recent paper — 1.6 million employees in the IC sectors in 1992 — is a result of different definitions: in the 1996 study, the definition of the communication industry included employees of specialist stores and consumer electronics retailers, in the photographic industry and in postal services. These businesses are not included in the recent statistics.

One of the fast-growing sub-sectors within the IC-contents sector is the "multimedia" market. Experts discussing the employment effects of multimedia at a conference in Stuttgart (cf. Fuchs 1998) arrived at similar conclusions as Seufert from the DIW. There was broad agreement that the core 'multimedia' industry (i.e. digital content production companies) would — in spite of high growth rates — would remain a rather small industry. The number of such specialised multimedia companies is not believed to increase to a level of mass employment, not even in high-tech regions such as southern California. In Stuttgart, for instance, there were 40-50 multimedia companies with 12 employees on average in 1998.

The German HighText Verlag[30] estimates that German multimedia and online service providers offered about

26 Defined as "companies producing or distributing mass media".

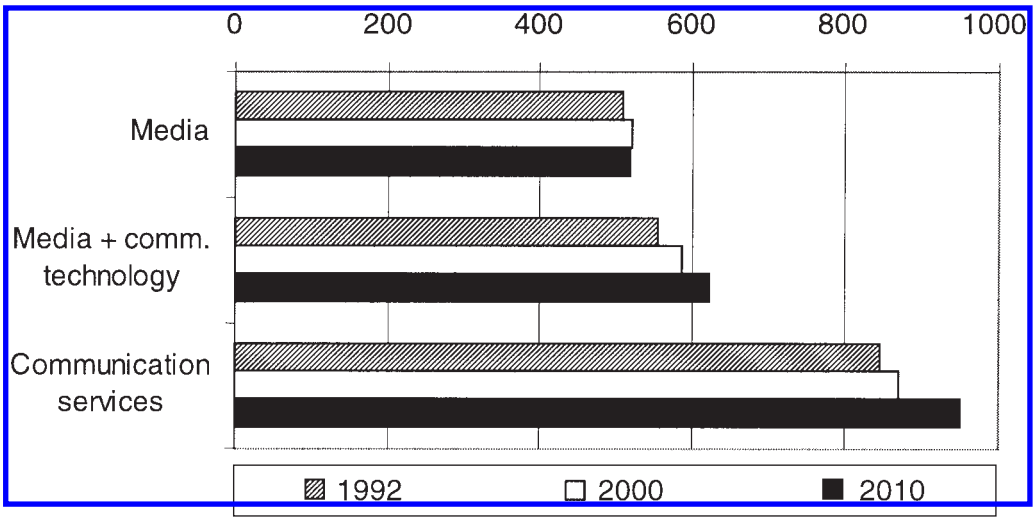
27 Comprising the following sectors: consumer electronics, IT equipment, telecom equipment, office equipment.

28 Comprising the following sectors: software, telecom services, postal services.

29 Seufert (2000).

30 Publisher of the leading German multimedia newsletter and annual multimedia directory ("multiMEDIA Yearbook").

Figure 1



Source: DIW (1996).

55,000 jobs in 1999. Their estimate is based on the data companies provide together with their entry into HighText Verlag's German multiMEDIA Yearbook. The publishing company concludes that more than 100,000 jobs in Germany are directly related to interactive media production, since the figure of 55,000 jobs in multimedia companies has its equivalent counterpart on the side of the businesses ordering multimedia productions. The Yearbook lists 1,550 German multimedia service providers. A 1996 survey on the German multimedia industry (companies offering interactive media production services) estimated the number of jobs at 30,000 in 1996, with a 50 percent increase in only one year (1995/96). However, only half of the staff counted in the survey was employed, the rest being freelancers. Due to the fast growth since the mid-1990s, employment at (core) multimedia companies today accounts for about 0.15 percent of total employment in Germany, following these figures.

Booz, Allen & Hamilton (BAH) have recently done a study on employment effects of multimedia on behalf of the German Ministry of Economics and Technology.[31] Using a very broad definition of the "multimedia" industry, BAH state that 350,000 additional jobs can be created in the German multimedia and IT industry by the year 2002. "Can be" means that this potential can only be realised if the required measures will be taken in order to create a positive business environment, i.e. increasing the availability of IT professionals, improving conditions for business start-ups and encouraging the use of innovative telecommunication technologies. If Germany succeeds in making "significant progress" in all these relevant lines of action, the following sectors are expected to show the most significant growth potential for employment: systems and services (130,000 new jobs), multimedia producers (115,000)[32] and call centres (70,000). This study — and especially the figure of "350,000 additional jobs" by the year 2002 — has received much attention in the debate about future employment opportunities. Critics point at some questionable definitions for sectors.

The German Ministries of Economy and Technology (BMWi) and Education and Research (bmb+f) have published an "information society action plan" for Germany.[33] Based on figures provided by industrial associations and the Federal Statistical Office, the report estimates that in 1999 about 1.7 million people were employed in sectors related to the "information economy" (i.e. the following sectors: hardware, software, telecommunication, industrial electronics, consumer electronics, specialist stores and media). 700,000 of these people were employed in the content (media) sector, according to the statistics. The annual growth of employment in these sectors was 2 percent (1997/98) and is estimated at 3 percent for 1998/99. The most significant area of growth (in absolute figures) was the IT sector with an increase of 54,000 employees (+ 14 percent) from 1997 to 1999 (see table below).

The Austrian Institute of Economic Research (WIFO) has presented a study on the labour and qualifications requirements in the telecoms and media sector.[34] The survey covered companies operating in the telephone (fixed and mobile networks), data services (ISP, ASP, content), cable TV and broadcasting, software, multimedia and telecoms hardware sectors. The study finds that 58,300 people were employed in these sectors in Austria in 1999, which is 1.6 percent of the total work force. Based on the interviewees'

31 Deutsches Bundesministerium für Wirtschaft und Technologie (1999a).

32 85,000 of these 115,000 new jobs are expected to be in companies offering e-commerce, LAN and Intranet solutions, and not in the core sector of multimedia, i.e. content creation.

33 Deutsches Bundesministerium für Wirtschaft und Technologie / Deutsches Bundesministerium für Bildung und Forschung (1999b), 18–19.

34 Leo (2000).

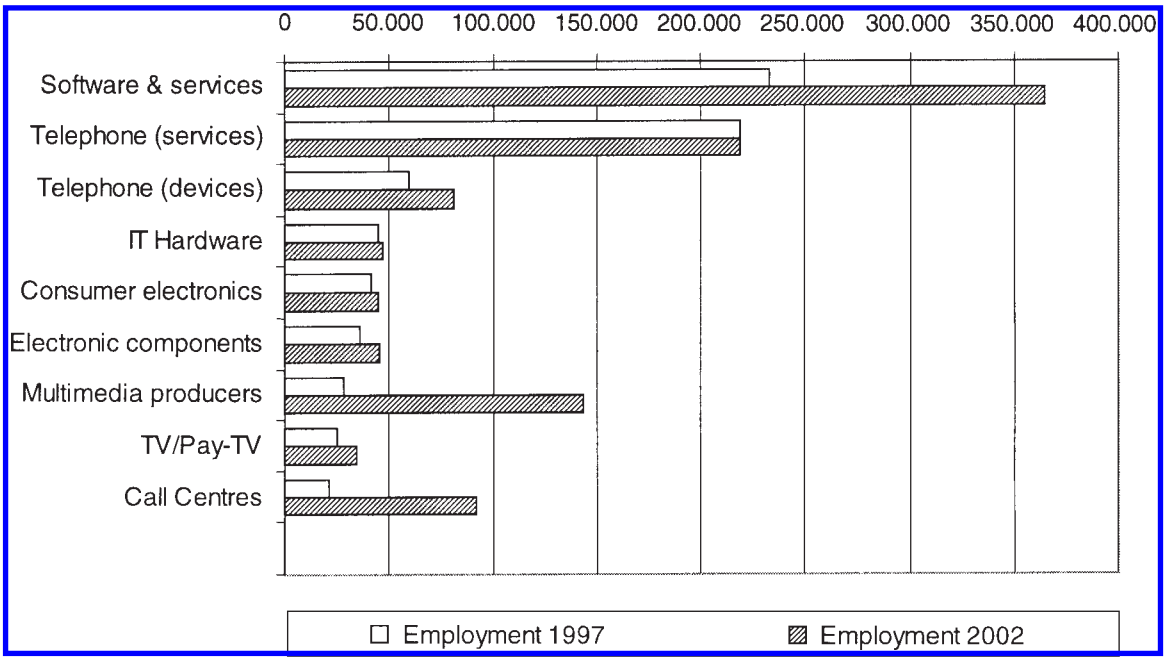
Table 6

Employment in the German IT and multimedia industry

	Employment (1997)	Employment (2002)	2002/1997	change (%)
Software & services	233,000	364,000	131,000	56
Telephone (services)	219,000	219,000	-	-
Telephone (devices)	59,000	81,000	22,000	37
IT Hardware	44,000	47,000	3,000	7
Consumer electronics	41,000	44,000	3,000	7
Electronic components	36,000	45,000	9,000	25
Multimedia producers	28,000	143,000	115,000	411
TV/Pay-TV	25,000	34,000	9,000	36
Call centres	21,000	92,000	71,000	338
TOTAL	706,000	1,069,000	363,000	51

Source: Booz, Allen & Hamilton / Deutsches Bundesministerium für Wirtschaft und Technologie (1999a)

Figure 2



"Multimedia Producers" include companies offering e-commerce, LAN and Intranet solutions.

Source: Deutsches Bundesministerium für Wirtschaft und Technologie (1999a).

Table 7

Employment in the German information economy[1)]

Sector	Employees 1997	Employees 1998	Employees 1999*	99/97*
Hardware, software and services	973,500	1,001,500	1,037,420	6.6%
a. Information technology	379,000	396,000	433,160	14.3%
— Office and data processing equipment	147,000	128,000	135,680	–7.7%
— Software and IT services	232,000	268,000	297,480	28.2%
b. Telecommunication	322,000	338,000	338,000	5.0%
— Equipment[2)]	101,000	101,000	101,000	0.0%
— Services	221,000	237,000	237,000	7.2%
c. Electronic components[3)]	83,500	83,500	81,500	–2.4%
d. Consumer electronics	41,000	36,000	35,280	–14.0%
e. Sales and distribution	148,000	148,000	149,480	1.0%
Media	692,000	691,020	698,690	1.0%
a. Publishing	222,000	217,000	219,170	–1.3%
b. Printing	285,000	284,000	284,000	–0.4%
c. Audio-visual industry (film, video, cinema)	24,000	32,000	32,640	36.0%
d. Broadcasting (radio + TV)	72,000	62,000	65,100	–9.6%
e. News agencies, independent journalists	38,000	44,000	45,760	20.4%
f. Book, magazine and music stores*	51,000	52,020	52,020	2.0%
Total no. of employees	1,665,500	1,692,520	1,736,110	4.2%

[1)] BMWi / bmb+f (1999). — *estimate. — [2)] Communication Technology Association; — [3)] Association Electronic Components.

Sources: IT Association in the VDMA and ZVEI; Federal Statistical Office;

estimate about future demand for employment in their companies, WIFO forecasts that the number of employees will increase to 69,020 people by 2003. About 44,000 of these 69,000 jobs will be located in Vienna. The study emphasises, however, that the figure does not take into account the expected downsizing of staff at Telecom Austria, the incumbent telecom operator. The highest increase in demand for IT and networking professionals is expected to occur in the following areas of business: network infrastructure, IT, and software development. In reaction to this study, the City of Vienna has launched a public debate about how to create educational programmes that can help to bridge the IT skills gap ("Vienna dialogue on qualification"). Political and industry representatives have been invited to bring forward proposals.

Based on the "mediamatics" approach and using ÖNACE categories, Wörter (2000, p. 231) calculates that around 147,000 people were employed in the sectors of mediamatics in 1997 (i. e. 3.8 percent of the total workforce). The growth of employment in these sectors between 1995 to 1997 was 7.8 percent. The largest sector is the telecommunication industry with approximately 64,500 jobs.

A study by Arthur D. Little on behalf of the Austrian Ministry of Economics and Labour (1999) focused on employment developments in the telecommunication market. The study finds that telecommunication contributes to job creation:

- The number of employees in the Austrian telecom industry increased from 36,000 in 1997 to 42,000 in 1999. Growth is expected to continue over the years to come.
- Mobile operators and new competitors in the fixed network sector are the main 'engine' for new jobs in the telecom markets.
- In the fixed network sector, the number of new jobs created by new competitors compensates for the downsizing of employment by the incumbent, i.e. Telekom Austria. The total number of employees in this sector remained about the same (19,100 in 1997, 19,500 in 1999).
- Employment at internet service providers is showing high growth rates, but still has little impact on the overall statistics in absolute figures.

The study also points to a lack of available qualified staff. It does not provide figures describing how many of the jobs cannot be filled, but reports that only every tenth applicant satisfies the industry's requirements. This leads to the debate about the "skills gap" and its economic consequences.

As these short summaries of different studies on employment effects in the information and communication industries demonstrate, it is difficult to make comparisons. However, the essence of these studies can be summarised in a few points:

- Most studies find that the sectors of the **information and communication (IC) industries** — comprising the three sectors of technology, services and contents — account for about four to seven percent of the total workforce.
- The **majority of "new jobs"** created will be **in the IC services sectors**, mainly in the provision and technical maintenance of intranet, extranet and internet solutions. Figures for the US (from: "The Emerging Digital Economy") find that the software and services sectors have been creating new jobs at a rate of 8.3 percent annually in the 1990s. Within the IC sectors, the relative importance of the services sector has increased compared to the technologies and the content sectors.
- **Employment in companies creating digital content** (e.g. multimedia producers, web designers) is increasing at enormous growth rates, however, still at a comparatively low level in total figures. "Interactive content companies" represent a rather small segment of the IC sectors. In advanced markets, employment at those companies accounts for about 0.1-0.3 percent of the total workforce. Booz, Allen & Hamilton estimate that the number of jobs at multimedia producers in Germany will quadruple from 1997 to 2002, which would be about 0.4 percent of the total workforce in Germany. However, 65 percent of these new jobs will be related to the provision

Table 8

Employment in the Austrian telecommunications and media sectors

Sector	Employees (1999)	Employees (2003)	Change	Change (%)
Telephone	23,000	26,450	+ 3,450	+ 15
Data services	3,500	6,650	+ 3,150	+ 90
TV / Radio	4,600	5,060	+ 460	+ 10
Software	12,200	15,860	+ 3,660	+ 30
Hardware	15,000	15,000	0	0
TOTAL	58,300	69,020	+ 10,720	+ 18

Source: WIFO (Leo, 2000)

of technical e-commerce and internet solutions, according to BAH, and therefore not be related to "content creation" in a narrow sense.

- **Traditional media companies** (broadcasters, publishers) are expected to keep the current level of employment, with quite different developments within sub-segments. Opportunities for new jobs are mainly based on their activities related to an extension of their core business into the new markets, e.g. publishing companies founding online divisions. However, this again requires system, networking and computing engineers rather than new content workers in the narrow sense (e. g. journalists).

4. The "Skills Gap": The Lack of IT Professionals and its Economic Impact

The previous section presented estimates about the employment effects in the IC sectors in terms of quantitative effects, i.e. how many jobs will be created in these sectors. This section deals with the qualitative effects. It addresses the lack of qualified staff and the potential economic impact of this deficit. The desperate search for IT and multimedia professionals across many economic sectors must not be mistaken as an indicator for total employment growth. However, the shortage of IT qualifications imposes an economic threat that clearly calls for action. Some studies have recently addressed this issue, offering estimates and assessments on two levels:

- Estimates of the current and future demand for employees with specific IT qualifications, i.e. estimates of the number of positions that cannot be filled due to the shortage of qualified personnel
- Estimates of the economic damage caused by the shortage of qualified personnel

The lack of networking specialists, information engineers, programmers, webmasters etc. is quite obvious, and it is commonly acknowledged that action is needed in order to supply the industry with qualified employees in sufficient quantity. The urgency of the problem is underlined by recent research that finds that the skills gap between demand and supply is likely to increase.

The EITO forecasts a dramatic increase of the skills shortage of qualified IT professionals. EITO estimates that there were about nine million "equivalent IT jobs"[35] in Western Europe in 1998. About 500,000 of these remained unfilled due to a shortage of appropriate skills. The forecast is that the number of IT jobs will increase to 12.3 million by the year 2002, with a shortage of 1.6 million (i.e. 12 percent of total demand).[36] The rapid development and growth of computing-based technologies as applied to commerce and business processes and the insufficient output of appropriately skilled graduates by universities and high schools are conceived as the major factors leading to the skills shortage. EITO concludes that the European IT market will not find a rapid solution to this problem. The acceleration in the development of new technologies, the globalisation of work and the workforce, the advancement of small companies in using ICT and the general move to e-business models will further increase the demand for IT workers. EITO presents consequences of this situation in the labour market, for businesses (e. g. deferred IT projects), for the IT market (e. g. reduction of total pace of growth, a huge opportunity for training services) and for IT spending patterns.

This estimate is confirmed by Guenther Juenger, Managing Director Central Europe of Intel. In a speech at the German Multimedia Congress in Stuttgart, Mr Juenger said that Germany would lack up to 200,000 network engineers within the next couple of years.[37] Targeted education of the workforce is therefore a pressing macro-economic issue, according to Mr. Juenger.

An IDC White Paper has studied the "network skills shortage" in Europe (Boyd/Rajah, 1999). The study concludes that there is urgent pressure on Europe to increase the supply of skilled professionals, or otherwise "individual countries and Europe as a whole will begin to suffer at the expense of other countries and regions which are already planning more strategically for the future." The argument is based on the evidence that the shortage of skilled professionals leads to inflated salaries and increased staff turnover, which raises the operating costs and lowers the profits for companies. At least on a macro-economic level, looking at international competitiveness, this analysis is quite plausible. Based on a continuous monitoring of the IT industry's need for skilled professionals[38], IDC estimates the demand for IT network professionals in Western Europe was 657,000 at the end of 1998, with a shortage of about 90,000. The average growth rate of demand for the years to come is estimated at 26 percent, which would translate into a needed workforce of 1.6 million in the year 2002. As the output of skilled professionals is estimated to grow by only 16 percent annually, the projection suggests a shortfall of almost 600,000 skilled net-

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35 "Equivalent IT jobs" are defined as jobs among in-house IT departments including "both full-time IT related jobs as well as IT-generated tasks executed on a partial description basis".

36 EITO (2000), p. 52–53 ("Skills requirements for the Internet economy").

37 Mr Jünger gave the key-note address at the German Multimedia Congress in Stuttgart, 11th April 2000. Quoted by iBOT — "iBusiness Originaltext" (online clipping service of HighText multiMEDIA), 11th April 2000.

38 The IDC estimates are based on 12,000 interviews with IS (information system, ann.) managers across Europe (to assess the demand) and a survey of the academic community in Western Europe (to assess the future output of professionals). cf. Boyd / Rajah (1999), 3–4.

working employees in Europe by the year 2002. IDC emphasises that this shortage, especially if it continues to increase, is "a problem for each individual member country, which it must tackle and resolve", mainly for the following reasons:

- companies are more likely to locate in areas in which a skilled workforce is readily available — Europe may be less attractive than other regions in the future
- SMEs, the "primary European economic engine", are most severely impacted by the shortfall, since they cannot train their employees to achieve the qualifications needed on their own
- the shortage of professionals causes salary escalation, increased staff turnover, lost business opportunities and reduced profits

Datamonitor has also published a paper on "the economic impact of an IT skills gap in Western Europe".[39] The paper refers to the IDC report on "Europe's Growing IT skills crisis" and builds its assessment of the threatening economic damage on employment figures provided by the IDC report. Datamonitor finds that "GDP in Western Europe could be 1.5 percent higher in 2002 due to productivity gains from IT", if the supply of appropriately skilled IT workers across the economy could be guaranteed. If the supply falls short of demand, the growth potential is likely to remain unexploited. This would result in loss of 380 billion EUR over the next three years. Datamonitor estimates that Europe has already lost 110 billion EUR in GDP value since 1998 due to the skills gap.

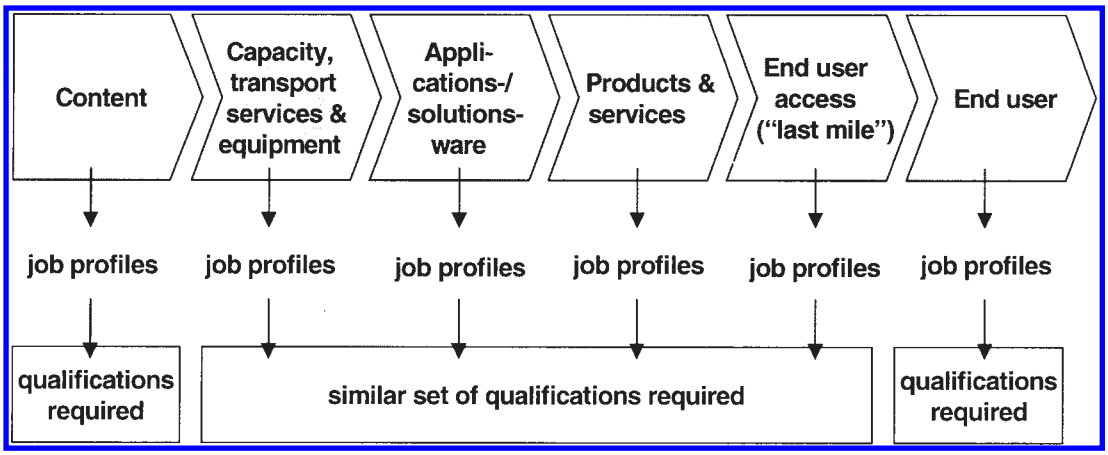
The study also comments on the likely loss in wage revenues and on the impact of the shortage on wages. Datamonitor argues that high wages can have a "positive ripple effect, increasing consumer purchasing power and boosting demand, leading to higher output and employment elsewhere in the economy", but also points at the problem of high costs of doing business due to rising wages for IT-specialist. According to this study, particularly small and medium-sized enterprises are suffering from the skills gap, as they are "being priced out of the market for IT workers". Based on these findings, the study makes recommendations to the industry, to governments and to universities. Most of these focus on how to encourage education and training programmes that meet the requirements of the market, e.g. by offering tax incentives, improving the image of technical professions and developing partnerships between science and technology departments and business schools.

A European Commission study on "content and commerce driven strategies in global networks" (EC 1998) comments on employment developments in the network economy. It states that the "network economy has created a demand for information technology specialists, software developers, webmasters, and content creators […]". However, the study points out that this demand is difficult to satisfy: "Although the European Union's unem-

[39] Datamonitor (2000). The paper defines the IT workforce as "all employees in IT industries as well as all workers in IT-related occupations across all industries and governments".

Figure 3

Systematic approach by Arthur D. Little to study qualification requirements in the telecommunication industry following the value chain (1999)



Source: Arthur D. Little.

ployment rate was about 10.2 percent in May 1998, roughly ten percent of all IT jobs remain unfilled." Job opportunities would particularly result from the growth of "network economy companies", […] leading a new generation of firms that are all involved in network commerce." The study quotes a paper by Takuma Amano and Robert Blohm (1997), saying that in 1996 about 760,000 Internet-related jobs were created in the United States, which is about half of the total number of jobs created in the US in that year.

The growing demand for professionals is also evident in the United States. The US Department of Commerce estimates that the demand for "workers in IT occupations requiring at least an associate's degree is expected to grow by 57 percent over the decade while the demand for less-educated workers is expected to decline. In addition, by 2006, employers will need more than one million more 'core' IT workers (occupations requiring at least a four-year degree) than were needed in 1996. On the other hand, lower-skilled, lower-paying positions like computer operators and duplicating machine operators are expected to decline."[40]

A study by Arthur D. Little on the employment situation in the telecommunication industry may serve as a model how to approach the skills shortage problem. ADL use the industry's value chain to describe job profiles in each of the segments and the related qualifications that are needed.[41] The value chain consists of six segments (content > transport services and equipment > applications- and solutions-ware > products and services > last mile > end user). The study finds that the required set of qualifications is quite similar for most of the job profiles defined in segments two to five of the value chain. Some of the job profiles in the content and in the end-user segments require different skills.

The definition of job profiles and the related qualifications needed constitutes the first step towards a goal-oriented employment policy. The next step would be the evaluation of existing educational programmes to find out if these offers can provide the required output of qualified talent.

5. Summary

This paper addresses the debate about employment effects of digital information and communication technologies. It illustrates that efforts to estimate the overall employment effects of these technologies are severely challenged by the lack of clear and unambiguous market definitions. In the network economy, the border lines between content production, software and service provision and network and hardware maintenance are blurring. Different conceptual frameworks have been created to analyse the converging industries, such as "ICT", "multimedia", "TIME industries", "IC sectors" or "mediamatics". They all describe closely related markets, but they differ in how they structure the market, in their scope and in their focus. Without standardised and commonly used definitions at hand, it is difficult to count the current total number of jobs in the sectors of convergence. It is even more difficult, however, to measure "net employment effects" within these sectors, or even *across* sectors. There is hardly any way to measure "new jobs created" against "jobs destroyed" by new technologies.

The most important employment effect of the digital revolution is — rather than the creation of *additional* jobs — the **demand for new skills** across industry sectors**.** There is a stunning and increasing demand for information professionals not only within the IC industries, but also in the industries *using* information and communication technologies and services. This demand cannot be satisfied by today's output of professionals by educational institutions such as universities and colleges. Several studies have tried to assess the economic impact of this "skills gap", pointing at e.g. the hindered business development and at the exorbitantly increased salaries for IT professionals that cause serious problems for SMEs and increased personnel turnover.

The conclusion to be drawn from the data available is that digital technologies will not be the cure to unemployment on a macro-economic level, but that the skills gap is the issue that really matters in the employment debate related to new technologies. To tackle this problem, it will be crucial to understand which skills and qualifications will be needed in the digital economy to satisfy the demand of businesses. In order to counterbalance negative employment effects of digital technologies by exploiting the new opportunities, it will be necessary to develop more and better programmes for education and training. There is an obvious and pressing demand in all member states for IT and computer specialists. The gap may even increase over the next two to three years.

Research into employment developments and the related qualifications should be a priority on the agenda of any information society policy or action plan. In the introduction to this paper, the official rhetoric of the European Union was criticised as it portrays the new information and communication technologies as able to free Europe from unemployment. It is unlikely that this will be the case anytime soon. As the economy is undergoing fundamental structural changes and developing towards a digital economy, however, a growing number of

[40] US Department of Commerce (1999), chapter IV: labour markets in the digital economy.

[41] Österreichisches Bundesministerium für wirtschaftliche Angelegenheiten (1999).

employees with skills in new information and communication technologies will be needed in every industry.

What Europe can do to support the economy is create new opportunities for education and training that particularly address the new demands of businesses. IDC draws the conclusion from its analysis of the skills gap that there is an "acute need for formal education and training programmes", and that "individual country ministries, agencies, and companies must therefore accelerate partnerships with industry and academic institutions to promote learning."[42] This paper supports the conclusion of the IDC study. A major concern of information society policies should be to find ways to improve and increase the current output of IT and networking professionals. The difficulty is in designing programmes that do not take many years to produce their first graduates and that manage to keep up with the rapid innovation pace of the digital economy. Programmes need to be flexible enough to adapt to new technological developments, but — at the same time — work towards certification and standardisation. Socio-economic research can support this process by estimating the future employment demand in a way that focuses on skills and qualifications. If these issues are left unaddressed or if information society policies remain superficial, European countries will continue to have a hard time fighting unemployment.

[42] IDC (1999).

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Zusammenfassung

Mangel an Fachkräften vs. Arbeitsplatzbeschaffung: Eine Interpretation von empirischen Ergebnissen zum Thema Informations- und Kommunikationstechnologie und Beschäftigung

Der Schaffung neuer Beschäftigungschancen wird in der politischen Agenda und in der Rhetorik der Europäischen Union ein hoher Stellenwert eingeräumt. Die boomenden Märkte der Informations- und Kommunikationsindustrie werden als vielversprechendster Bereich für zukünftige Beschäftigung gehalten. Die Hoffnung auf neue Arbeitstellen wird durch die positiven Wachstumsprognosen in diesen Sektoren genährt. Des weiteren ergeben Studien über das Defizit an informationstechnischen Qualifikationen, beispielsweise der eklatante Mangel an informationstechnischen Spezialisten in Ländern und Sektoren, dass neue Stellen auf einem signifikanten Niveau geschaffen werden können. Der vorliegende Aufsatz trägt zu dieser Beschäftigungsdebatte bei. Es wird gezeigt, dass empirische Befunde die Theorie, dass Informations- und Kommunikationstechnologien das "Versprechen der Informationsgesellschaft" ausreichend neue Beschäftigungschancen zu schaffen, nicht unterstützen, obwohl die starke Nachfrage nach Spezialisten offensichtlich ist. Der Beitrag stellt aber auch heraus, dass eine defensive oder zögernde Strategie hinsichtlich der Politik für digitale Informations- und Kommunikationstechnologien nicht förderlich ist. Es stellt sich die sehr wichtige und praktische Frage, wie Europa sein Erziehungs- und Ausbildungssystem verbessern und anpassen kann, um die digitale Ökonomie mit dem gewünschten Profil und der erforderlichen Menge an qualifiziertem Personal zu versorgen.