# ICT and e-business skills and training in Europe

## Towards a comprehensive European e-skills reference framework

### Final synthesis report

A. Willi Petersen
Peter Revill
Tony Ward
Carsten Wehmeyer

**Authors:**

A. Willi Petersen, Peter Revill, Tony Ward and Carsten Wehmeyer
(Flensburg University/Germany and York University/UK)

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# Foreword

This synthesis report summarises and complements the findings of four reports commissioned by Cedefop in 2003 as part of its programme on information and communications technology, (ICT) skills in Europe. The focus of this work was on innovative European ICT skills and curriculum solutions to address balance, mismatch and skills gaps primarily in qualitative terms. Researchers analysed the needs of ICT practitioner skills in the ICT manufacturing industry and in several important ICT user industries. One report delivered results on ICT practitioner skill needs at sub-degree (vocational) level, the other three reports covered ICT skills in the banking and finance, automotive and graphics/media industries across all skill levels including the highest professional ones. In all the reports special attention was given to the complex interdependencies of employment and education/training systems, demand and supply.

European diversity in these areas had to be considered. Some countries, however, were looked at in more detail; Germany, the Netherlands, Portugal and the United Kingdom. For banking and finance the French and Italian situation was the focus; for automotive, the German and French industries. The four reports have been published in the Cedefop Panorama series, were made available as PDF files and can be downloaded via the European training village or the virtual community: http://cedefop.communityzero.com/esf.

A major complement of this present report, however, is a proposal for a European e-skills reference framework, covering all skill levels and the variety of ICT manufacturing, business and work areas in the European economy. The proposed work and process oriented e-skills framework was elaborated on the basis of a comprehensive survey in small, medium and large European ICT companies. In addition a comparison of existing occupational classifications (e.g. ISCO, 88) and specific ICT skills frameworks (German IT continuing training system, skills framework for the information age (SFIA) from the UK, Dutch and Portuguese frameworks) were undertaken. In order to structure the identified ICT skill needs in the new framework, the authors retained generic ICT skills (occupational) profiles at different levels as well as the range of existing ICT work areas which they propose as representing European and international developments. The concrete and comprehensive description of the profiles is based on a work-oriented ICT skills model that combines core technical ICT skills (at all levels) with soft skills such as behavioural or attitudinal competences. The focus on ICT practitioner skills at non-university and vocational level was a complement to the European ICT industry's work on ICT generic job profiles which was supported and published by Cedefop in 2001 ([1]).

ICT qualifications were defined and guidelines for the development of ICT curricula were devised, corresponding to the description of ICT generic job profiles in the new European (reference-) skills framework,. The results aim to contribute to new conceptual approaches to

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([1])   See also the website hosted by Cedefop since 2003: www.career-space.org

(modular) curriculum development within a European vocational education and training credit (transfer) system ($^2$). They may also be of use to further debates on international and European level approaches to ICT certification, skills mobility and transparency and linked industry initiatives regarding vendor-neutral ICT certification and training.

All the activities were supported by a working party set up by Cedefop in 2002, which was composed of some 20 high level experts and expert bodies in the field ($^3$). In parallel to this work, Cedefop is currently promoting a workshop in the framework of European standardisation activities (CEN/ISSS) ($^4$) to validate the outcomes and to work towards a voluntary agreement on a European ICT skills (meta-)framework ($^5$) which was set up by CEN on this issue.

Since 2002 close links have also been established with the policy initiatives and activities of the European Commission. Cedefop was an active participant in the e-skills summit in Copenhagen in late 2002 and was invited as a member to the E-skills Forum and its steering committee which was set up by the Enterprise Directorate General in March 2003. The results of the Cedefop reports will be presented at a jointly organised e-skills conference in Thessaloniki in September 2004 and were fed into the policy declaration, which was adopted by the members of the forum and the participants in view of additional European level e-skills activities from 2005 onwards.

By actively contributing to the ICT skills debate in Europe, Cedefop will continue to play a major role in promoting innovative European ICT skill and training development strategies. An integral part and a precondition to its success is continuing identification, description and transfer of ICT skills needs from the viewpoint of ICT businesses and ICT user industries into training and provision. Based on this vital link with ICT industries, e-business and work processes the outcomes presented in this synthesis report will certainly contribute to such an innovative VET development in European countries and beyond.


Johan van Rens                                                    Burkart Sellin

Director                                                          Principal Administrator

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($^2$)    See the work of the Credit transfer technical working group set up by the Commission in late 2002, which is documented in http://cedefop.communityzero.com/Credittransfer.

($^3$)    See Annex 1, Cedefop/ICT skills workshop participants.

($^4$)    CEN: European committee for standardisation; ISSS: Information society standardisation system.

($^5$)    See also http://cedefop.communityzero.com/cen-ict.

# 1.    Executive summary

This synthesis report is an analysis and synthesis of the findings of four reports commissioned by Cedefop to several vocational education and training (VET) researchers as part of a project launched in late 2002. The topic was information and communications technology (ICT) skill needs, curriculum development guidelines and recommendations for training solutions for ICT- and e-business. The individual reports and, correspondingly, the synthesis report take into account all skill levels but primarily focus at sub-degree level skills and training issues with an emphasis on vocational qualifications. Three of the four reports considered the following sectoral areas: banking and financial services, the automotive, and media and graphical user industries; the fourth provided insights into the ICT (practitioner) skill needs in all sectors and at all levels. The following paragraphs give a summary of the findings and recommendations.

It is important to emphasise that this report concerns the need for, and the educational provision of, ICT practitioner skills primarily used in ICT hard and software industries. Phase one and two developments within the Career-Space consortium considered job profiles and guidelines for education/training provision at the 'professional' (1st and 2nd cycle degree) level ([6]). This project is focused on vocational and sub-degree level provision and sets it into the overall context of all skill and qualification levels. Though the evidence in these reports and in the synthesis is primarily based on a limited number of countries, it extrapolates from this comparison and takes into account the evidence and current discussion at European level, e.g. on European recognition of a transparent and flexible structure of qualifications (EC, 2004). The outcomes have also been submitted to an expert constituency for comments under this perspective in the virtual communities established by Cedefop ([7]).

It is imperative to set the context of this synthesis report in terms of recent political decisions within the European Union and the importance that education and training will play in their achievement. The European Council's strategic declaration in Lisbon stated in spring 2000 that

'by 2010 the European Union should become the most competitive and dynamic knowledge-based economy in the world, more and better jobs and social cohesion'.

In November 2002 the Copenhagen Declaration recognised the development of high quality vocational education and training as a crucial and integral part of this strategy ([8]). The recent accession to the European Union of 10 additional States presents a further challenge in terms of the need for high quality vocational education and training which meets the challenges of

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([6])    see www.career-space.org; the website hosted by Cedefop.

([7])    see http://cedefop.communityzero.com/cen-ict or ... /esf

([8])    see also the recent interim report of the Commission, approved by the Council this spring, on 'education and training in 2010'.

the rapid social and economic developments in all industry sectors. This needs to be supported by effective labour market information on supply and demand, based on a fit-for-purpose skills framework which reflects accurately the ICT practitioner field.

A common characteristic of the industry sectors examined is the significant impact ICT is having on the breadth and depth of an organisation's operations and competitive environment. No sector is immune from the advances of information and communications technology nor are there many, if any, parts of a business that are not being challenged and changed in response to the direct or indirect impact of ICT-related developments, neither at the operational level nor at the level of strategic business planning. Consequently, significant changes are taking place at both the macro and micro levels within large and small organisations and these changes involve staff at all levels. Current (public and private) training provision lags behind these developments and must begin to manage these changes proactively. A coherent skills and qualifications framework may be very useful for that purpose.

A range of research tools was used to investigate skills usage, needs and acquisition in the four-industry sectors. These research tools were applied in such a way as to draw out quantitative and qualitative data relating to demand (in terms of job profiles and their associated skills and knowledge) and supply (in terms of training and qualification programmes). Consequently, the reports revealed useful statistical data, such as the near-future demand for ICT practitioners in Europe, estimated by the authors of the order of 200-300 000 per year with a total of 5-6 million by 2010. Of the predicted demand, some 50-70 % is at the 'professional' level and 30-50 % at the 'vocational' level. This demand within the vocational field highlights the relevance of the report and the guidance and recommendations offered.

The study identified a number of key issues within the four reports:

(a) the lack of a clear common definition of ICT skills and skill levels relevant for ICT employment and of 'qualification' (learning outputs) definitions and qualification levels relevant for ICT education;

(b) little or no common approaches to skill and training standards, unitisation or modularisation of vocational training and of its assessment and certification across the European Union;

(c) no possibilities to get qualifications or modules of training assessed independent of when, where or how they have been achieved (credit transfer).

Core to the debate within the synthesis report are the questions of ICT skill needs and job profiles, their content and level structure for a European meta-framework that would allow the alignment of ICT skills to ICT qualifications and thereby better target investments into training as a consequence of a closer link between demand and supply.

*Table 1:* *Correspondence of European frameworks for employment and education and training in the field of ICT*

| European ICT frameworks | | |
|---|---|---|
| **Framework of ICT skills** | Correspondence | **Framework of ICT qualifications** |
| **ICT employment system** | Skill specialisation and skill level corresponding to education specialisation and education level | **ICT education and training system** |

This synthesis report provides analyses, findings and recommendations and implementation issues on the following topics:

(a)  ICT skill needs and comparison of existing European skills framework and models;

(b)  generic ICT skills profiles at all different skill levels within a new 'GAHFA' European ICT skills framework;

(c)  based on the ICT skills framework definition and description of ICT qualification (training) profiles and levels within a new European ICT qualifications framework;

(d)  guidelines for ICT training solutions and curriculum development.

The meta-reference framework of ICT skills delineated within the synthesis report proposes three [ICT] skill levels at sub-degree level labelled levels 2, 3 and 4. There are two additional (degree) levels 5 and 6. Together these levels are compatible with frameworks or classifications like ISCO-88, ISCED-97, and the new European structure of professional qualification levels incorporated in the new Directive approved in May 2004 (EC, 2004).

Table 2:    Five 'ICT education and qualification levels' corresponding to five 'ICT occupation skill levels'

| Europe | | | | |
|---|---|---|---|---|
| ISCO-88 level | ICT skill level 6 (work) | Occupation skill level corresponding to HE qualification level | ICT qualification HE level 5M (MA/SCD) | ISCED-97 education level 6 |
| ISCO-88 level 4 | ICT skill level 5 (work) | | ICT qualification HE level 5B (BA/FCD) | ISCED-97 education level 5 |
| ISCO-88 level 3 | ICT skill level 4 (work) | Occupation skill level corresponding to VET qualification level | ICT qualification VET level 4 (Specialist) | ISCED-97 education level 4 |
| ISCO-88 level 2 | ICT skill level 3 (work) | | ICT qualification VET level 3 (Technician) | ISCED-97 education level 3 |
| | ICT skill level 2 (work) | | ICT qualification VET level 2 (Assistant) | |

This framework aligns in a continuous and straight forward manner with level 5 and 6 profiles of Career-Space and levels 5, 6 and 7 of SFIA. In all cases the breadth of skills is wider at levels 2 and 3 becoming more specialised and hence narrower towards levels 4, 5 and 6.

The report considers the skills contents of both the GAHFA and SFIA skills models and concludes that they are very similar in fundamental structure but differ from a presentational viewpoint: GAHFA takes a process view while SFIA offers a functional view of the ICT sector job profiles. At a lower level of detail the models have some similarity and complementarity should be considered, therefore as less competitive; this is a potential cause of concern. Equivalence between the *biat* GAHFA, Career Space, e-skills UK SFIA and ISCO-88 models is presented in a, tabular form within the report.

*Table 3:*        *Comparison of different skill levels by cluster and origin*

| GAHFA | Career Space | SFIA | ISCO-88 |
|---|---|---|---|
| Skill level L2, L3, L4, L5, L6 | Skill level L5, L6 | Skill level L1, L2, L3, L4 L5, L6, L7 | Skill level L2, L3, L4 L- |
| ICT marketing, consulting and sales | Cross sector | Sales and marketing | Sales and marketing managers (1233) |
| ICT business and project management | | Management and administration | Computing services managers (1236) |
| ICT systems and application development | Software and services | Strategy and planning | Computing professionals (213) Computer systems designers, analysts and programmers (2131) Computing professionals not elsewhere classified (2139) |
| ICT integration and administration | | Development and implementation | Computer associate professionals (312) Computer assistants (3121) Computer equipment operators (3122) |
| ICT infrastructure and installation | Products and systems | | Electronics and telecommunications engineers (2144) Production and operations managers in ... communications (1226) |
| ICT Support and Systems Service | Telecommuni-cations | Service delivery | Broadcasting and telecommunications equipment operators (3132) Telegraph and telephone installers and servicers (7244) |

This report proposes an ICT skills meta-framework comprising:

(a)    8 generic skill profiles at level 2;

(b)    12 at skill level 3;

(c)    27 at skill level 4;

(d) 20 at skill levels 5 and 6 (18 profiles of Career Space (CS) plus two exemplary ICT skills profiles derived from the automotive report).

Following the GAHFA framework these ICT skill profiles were structured in the six generic ICT work (occupation) areas (see the complete table below).

Based on the skills framework and looking towards a European framework of ICT qualifications, the synthesis report proposes a further overarching meta- or reference framework of ICT qualifications from which curriculum development guidelines and training solutions can be drawn. The framework has been designed to be generic in such a way that any country within the European Union can use it to devise their study programme content to a common format without loss of individuality and national uniqueness, nor compromising the concept of subsidiarity. In evaluating and comparing existing frameworks in some countries, the need for a common, concrete and work oriented model that helps structure ICT qualification and training is imperative. In the structure of the six ICT qualification (training) areas, and corresponding to the work areas with generic ICT skills profiles and its contents and levels, the ICT qualification profiles in Table 4 were defined (see also the complete table later).

It is acknowledged that there is an important task for both public and private stakeholders and training providers not only at national level but also at European or even international level, to agree such an overarching framework. This would allow for improved transparency, cooperation and, eventually, for mobility in terms of both career and geographical dimensions, e.g. for increased European recognition of qualifications, common output standards and credit transfer in VET.

*Table 4:* *Legend for the next table 'List of all generic ICT skills and qualification profiles in the European GAHFA framework'*

| ICT skills profiles | ICT qualification profiles |
|---|---|
| **6 ICT work (occupation) areas** | **6 ICT qualification (training) areas** |

| **Generic ICT skills profiles** | **Generic ICT qualification profiles** |
|---|---|
| L2<br>Profiles at skill level 2 | L2<br>Profiles at qualification level 2 |
| L3<br>Profiles at skill level 3 | L3<br>Profiles at qualification level 3 |
| L4<br>Profiles at skill level 4 | L4<br>Profiles at qualification level 4 |
| L5/L6<br>Profiles at skill levels 5* and 6* | L5B/M<br>Profiles at qualification levels 5B and 5M |

*Career Space

*Table 5:    List of all generic ICT skills and qualification profiles in the European GAHFA framework*

| Framework of ICT skills | Framework of ICT qualifications |
|---|---|
| **ICT marketing, consulting and sales** | **ICT marketing, consulting and sales** |
| Generic ICT skills profiles | Generic ICT qualification profiles |
| L2 ICT marketing, consulting and sales | L2 Assistant of ICT business and sales |
|   L3 ICT marketing, consulting and sales |   L3 Technician of ICT marketing, consulting and sales |
|     L4 ICT marketing |     L4 Specialist of ICT marketing |
|     L4 ICT consulting |     L4 Specialist of ICT consulting and sales |
|     L4 ICT sales |       L5B e.g. Bachelor of Science in business informatics |
|       L5/L6 ICT marketing management* |       L5M e.g. Master of Science in ICT marketing management |
|       L5/L6 ICT sales management* | |
|       L5/L6 IT business consultancy* | |
| **ICT business and project management** | **ICT business and project management** |
| Generic ICT skills profiles | Generic ICT qualification profiles |
| L2 ICT business and project management | L2 Assistant of ICT business and sales |
|   L3 ICT business and project management |   L3 Technician of ICT business and project management |
|     L4 ICT business management |     L4 Specialist of ICT project management |
|     L4 ICT project management |     L4 Specialist of ICT quality management |
|     L4 ICT quality management |     L4 Specialist of ICT content and knowledge management |
|     L4 ICT content and knowledge management |       L5B e.g. Bachelor of Science in ICT project management |
|     L4 E-business management |       L5M e.g. Master of Science in ICT management |
|       L5/L6 ICT management* | |
|       L5/L6 ICT project management* | |
|       L5/L6 ICT content and knowledge management | |
| **ICT systems and application development** | **ICT systems and application development** |
| Generic ICT skills profiles | |
| L2 ICT systems and application development | |
|   L3 ICT systems and application development | |
|   L3 Database development and administration | |
|   L3 Multimedia design | Generic ICT qualification profiles |
|     L4 ICT systems and application development | L2 Assistant of ICT systems and application development |
|     L4 Database development |   L3 Technician of ICT systems and application development |
|     L4 Business software development |   L3 Technician of multimedia development |
|     L4 Web design |     L4 Specialist of database development |
|     L4 Multimedia design |     L4 Specialist of business software development |
|     L4 Communication network development |     L4 Specialist of multimedia and web design |
|       L5/L6 Research and technology development* |       L5B e.g. Bachelor of Science in informatics |
|       L5/L6 Software and application development* |       L5M e.g. Master of Science in multimedia informatics |
|       L5/L6 Software architecture and design* | |
|       L5/L6 Product design* | |
|       L5/L6 Automotive software engineering | |

| ICT integration and administration | ICT integration and administration |
| --- | --- |
| **Generic ICT skills profiles** | **Generic ICT qualification profiles** |
| L2 ICT integration and administration | L2 Assistant of ICT integration and administration |
|   L3 ICT integration and administration |   L3 Technician of ICT integration and administration |
|     L4 ICT integration and administration |     L4 Specialist of database administration |
|     L4 Database administration |     L4 Specialist of ICT testing |
|     L4 ICT testing |       L5B e.g. Bachelor of Science in integration and test |
|       L5/L6 Integration and test / implementation and test engineering* |       L5M e.g. Master of Science in implementation and test engineering |

| ICT infrastructure and installation | ICT infrastructure and installation |
| --- | --- |
| **Generic ICT skills profiles** | |
| L2 ICT infrastructure and installation | |
| L2 Network installation | |
|   L3 ICT infrastructure and installation | |
|   L3 Network planning and installation | |
|   L3 Communications planning and installation | **Generic ICT qualification profiles** |
|     L4 ICT infrastructure and installation | L2 Assistant of ICT infrastructure and installation |
|     L4 Network design and installation |   L3 Technician of ICT infrastructure and installation |
|     L4 ICT Industrial systems design |   L3 Technician of communications systems installation |
|     L4 ICT consumer electronics design |     L4 Specialist of network planning and installation |
|     L4 ICT security design |     L4 Specialist of communication systems planning |
|       L5/L6 Systems specialist* |     L4 Specialist of ICT security design |
|       L5/L6 Radio frequency (RF) engineering* |       L5B e.g. Bachelor of Science in IT networks |
|       L5/L6 Digital design* |       L5M e.g. Master of Science in data communications engineering |
|       L5/L6 Data communications engineering* | |
|       L5/L6 Digital signal processing application design* | |
|       L5/L6 Communications network design* | |

| ICT support and systems service | ICT support and systems service |
| --- | --- |
| **Generic ICT skills profiles** | |
| L2 ICT support and systems service | **Generic ICT qualification profiles** |
| L2 ICT User support | L2 Assistant of ICT support and systems service |
|   L3 ICT support and systems service |   L3 Technician of ICT support and systems service |
|   L3 Network administration |   L3 Technician of ICT systems administration |
|   L3 Web administration |     L4 Specialist of support |
|     L4 ICT support and systems service |     L4 Specialist of network administration |
|     L4 Network administration |     L4 Specialist of ICT training |
|     L4 Database administration |       L5B e.g. Bachelor of Science in technical support |
|     L4 ICT training |       L5M e.g. Master of Science in technical support |
|     L4 ICT operation | |
|       L5/L6 Technical support* | |

The report's review of the various ICT job profiles indicates an apparent variance in terms of breadth and depth of the areas and tasks associated with the jobs they analyse; these may differ according to ICT content areas such as networks systems and solutions, data management and database solutions or multimedia applications as well as the size of organisation being considered. Small and medium size enterprises (SMEs) in particular can rarely afford the luxury of people dedicated to specific job roles: here more flexible, adaptable multidisciplinary people are commonly found and, indeed, required.

A common feature of industry sector needs is the emphasis on competence in basic skills particularly at level 2, this being a precursor of digital literacy. The other common features demanded in both large organisations and SMEs are behavioural and personal effectiveness skills and, at level 3, basic (supervisory) management skills. A general skill model is defined characterised by skill categories: core technical skills, basic technical skills and basic soft skills such as behavioural and personal. This corresponds to all results on ICT skill needs.

The report recognises that the purpose of vocational training is more than merely training an individual in technical skills; it is also the development of a competent individual with the knowledge and understanding to undertake a job role professionally and safely, that includes the necessary social or soft skills and competences. Initial vocational education and training is a form of all-round provision that develops the individual's technical, social and behavioural skills as well as general awareness, such as health and safety. These are seen as the fundamental bedrock upon which lifelong learning is built. Nevertheless, work-oriented ICT qualifications and output standards must closely match skill needs. Furthermore, such qualifications, the report recommends, should be developed in the context of the workplace, i.e. 'situationalised' and guidance is offered on how this can best be achieved. It is also recommended that where vendor or vendor neutral content meets the specification requirements of a job profile, and where it can be demonstrated that the product fulfils or can be adapted to the appropriate accreditation criteria, they should be included in training/education programmes.

The report does not provide final answers to all of the issues identified. The following issues are commented upon but no solutions are offered at this stage:

(a) how to achieve compatibility of certification, competence and accreditation;

(b) transferability of achievement (European credit transfer);

(c) common descriptions of learning outputs;

(d) financing and the common use of teaching materials;

(e) training the trainers.

The issue of whether there is a need for a common skills dictionary or typology is discussed and a comparison is made between 'noun' and 'verb' job and qualification descriptor sets. The report concludes that within such a resource 'verb' descriptor sets provide a more activity-oriented and robust approach.

The report concludes that if the Bruges-Copenhagen Process aims at achieving increased cooperation in the field of vocational education and training, a major precondition is mutual recognition of qualifications and a credit transfer process which facilitates mobility of labour throughout the European Union and beyond. This study has shown that there are considerable differences in the way vocational education and training systems have evolved in individual states. However it states and proposes that establishing a 'European-wide a meta-framework' supported by a commonly accepted and adjudicated 'data dictionary' will promote understanding of vocational education and training, the establishment (and understanding) of equivalence, and mutual acceptance of, and hence the portability of, vocational qualifications across Europe. In this sense it finally argues that much still needs to be done to assess and, if convenient, to implement the developed ICT skills and qualification framework and to ensure mutual trust and sustainable steps forward in European ICT qualification.

# 2.    Introduction

This report is an analysis and synthesis of the findings of four reports within the Cedefop activity Curriculum guidelines and recommendations for training solutions for ICT- and e-business focusing on non-university and vocational level skills, the European banking and financial services, automotive, media and graphical user industries and SMEs.

This introductory section provides results on the following topics:

(a)   a general introduction to the situation within the ICT and the three user industry sectors;

(b)   a historical and socio-economic context concerning the skills, VET and Lifelong Learning delivery in Europe at schools, colleges and with in-company apprenticeship training;

(c)   an introduction to the state and deficits of training supply, access and delivery, horizontal and occupational as well as geographic mobility of skills staff;

It culminates in a brief description of the structure of the whole report.

The importance of vocational training is well stated by: 'At the Lisbon European Council in March 2000 the European Union, in response to the challenges of globalisation and the information society, set out its new strategic objective for the coming decade, viz.: 'becoming the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion.' Correspondingly in 'The Copenhagen Declaration' the European Ministers of Vocational Education and Training, and the European Commission, state: 'The development of high quality vocational education and training is a crucial and integral part of this strategy, notably in terms of promoting social inclusion, cohesion, mobility, employability and competitiveness' (The Copenhagen Declaration, Nov. 2002, p. 1)' (see report A, p. 14).

To set the context, the automotive report considers broadly the whole of Europe in its general discussion with a closer focus on France and Germany when it considers occupational profiles and job titles. The banking and finance report focuses on Italy and France. The graphic arts and media report takes a broader European view. The ICT practitioner skills and training solutions report (see report A) focuses mainly on Germany, the Netherlands and Portugal but allows extrapolations at European level.

## 2.1.    ICT industry and the three user sectors

The general and rapid spread of ICT technology is very apparent in today's world. When the first astronaut left the surface of the earth the craft he travelled in was equipped with less electronics than is common in the average modern toy. Computer technology is present in a very large percentage of appliances, elements of process control equipment and on almost

every professional's desk across Europe, as well as in a multitude of smaller computerised devices in handbags or jacket pockets. Electronics, computing and communications are very widespread and have had a profound impact on most industrial sectors. 'In recent years the spread and dynamic of information and communications technologies (ICT) across Europe have been steadily increasing. Today the importance of ICT for the EU economy and throughout business, services, domestic and leisure is obvious. ICT developments are changing society to an "information society" and new opportunities and challenges in all areas of work and life have arisen. In particular, this applies to ICT work itself' (report A).

The new technologies within ICT are creating fundamental changes within business and the world economy as a whole and success in this new, and digitally driven, economy will be critical to European competitiveness.

The ICT sector itself faces particular challenges in fulfilling its role in contributing to the European Union's economic success. These include keeping pace with the demands of rapid technological development, the constant innovation in products and services, and the emergence of new markets. Ensuring that there are sufficient numbers of people within this sector with the required skills, knowledge and competence will be critical. School, tertiary and higher education are key providers of technically skilled people to the sector, with tertiary education the most common providers of people skilled to intermediate, or sub-degree level. However, research indicates that there are insufficient numbers of competent and appropriately qualified students emerging from this phase of education, despite wide ranging provision from such institutions. Given the reported shortages of people with the required specialist skills, there is particular interest in promoting such provision, providing that the education programmes offered meet the skills and knowledge requirements of the sector.

Businesses have also indicated that, in some cases, students lack the necessary generic or interpersonal (behavioural) skills and are, therefore, not yet ready for work. Clearly, there is a need for programmes to ensure that the correct skills are developed, and that students are also able to apply these skills within the context of the workplace. The impact of ICT is especially pronounced in the automotive, banking and finance, and graphic arts and media sectors as identified in the reports that form the basis of this summary report.

## 2.2. The automotive industry

The opening words of the introductory section of the automotive report (see report B) are 'Information and communications technologies (ICT) are currently penetrating nearly all fields of occupational activities in the automotive sector.' In a BMW 3-series car, electronic equipment accounts for an equivalent of 30 % of a car's sales value. This is just a comment on the in-vehicle impact; to understand the full impact of ICT on the industry a more detailed look at the structure of the sector is necessary. The sector is essentially divided into three segments:

(a) development, research and engineering,

(b) production (manufacture and assembly),

(c) motor vehicle repair and sales.

ICT applications, including hardware and software, are both produced in these sub-sectors and used within them. There is the full range of interaction with ICT from users of simple packages to design of complex network systems, embracing both users and practitioners. The report makes the point early on that the transition between ICT users and developers and ICT practitioners is not clear; in reality it is a continuum. The report also notes the findings of the LEONARDO project EUQuaSIT (5) which identified three groups of differentiable jobs, ICT users, ICT operators and ICT developers/practitioners and concluded that there is a lack of clarity and confusion in definitions of groups of employees.

In terms of size, BIBB-IAB (6) shows that around '3 million employees or 8 % of all persons engaged in the sector describe themselves as "professional users" of ICT. The term professional user is, however, used as a colloquial term.' Employees in production amount to approximately 2 million (Eurostat, 2001) and in repair workshops affiliated to manufacturers, approximately 2.5 million. The number employed in the independent sector is unknown.

All areas of the automotive industry sector have been affected by ICT and hence require ICT competent individuals (at a range of levels): design, through advances in product design and CAD/CAM; production, through process control, use of PLCs and 3D measuring equipment; assembly, through programmable measuring devices and PLC tools; service, through soft documents and automated diagnostics; and quality control, through automated measurement systems and fault logging.

## 2.3.  Banking and financial services

As with the automotive sector, ICT is now visible at all stages of banking and financial services and is fundamental to the success of each institution. The value of the sector to the economy of the European Union cannot be understated. 'According to IDC (see Rapporto Federcomin, 2001), European banking and financial services has the highest penetration of the Internet and extranet (93 %), compared with industry (41 %) and transport (39 %)' (report C). Across Italy and France, over 750 000 people are employed in the banking and financial services sector. The number who are ICT skilled is currently low but needs to rise; the report notes the shortage of ICT skilled employees as a bottleneck for change.

'Banking and financial services have a high concentration of computer literacy and led the way in implementing new technologies on a large scale. Typical of this are magnetic ink character recognition (MICR), bankers' automated clearing services (BACS), automated teller machines (ATM), electronic funds transfer at point of sale (EFTPOS), electronic funds transfer (EFT), and smart cards' (report C). ICT in banking and finance has facilitated four

sector objectives, cost reductions, 'tailor made' services, faster customer servicing and better information flows.

A characteristic of the training provided within the banking and finance sector is that courses tend to be designed in line with the company's needs at a particular moment and seldom address long term strategic needs. A common component of the training is in general (English, computer literacy) and behavioural skills such as team working.

## 2.4. The graphic arts and media industry

The executive summary of the graphic arts and media report states 'Recent trends in technology, new e-business applications, and markets in diverse fields such as information technologies, networks and mobile telecommunications, have significantly influenced the graphic arts and media sector. Such developments have caused structural changes, affecting the business environment, market and products. As a result, new sector-specific business, administration, management and production processes are appearing.

The Comprint 2002 study suggests that the entire sector of communication, information, knowledge acquisition, and entertainment is undergoing a period of substantial change. New markets and new market forms are arising normally with one common aspect. The discovery of a possible market opening is accompanied by a forecast of virtually unlimited growth and rapidly booming market volumes. In addition, new technical possibilities in media integration and in telecommunication are opening up new forms of communication and information' (see report D).

Of all the sectors considered, graphic arts and media are both benefiting from and also leading the way in ICT applications and technology. This is driving skills needs within the industry.

Like the automotive industry, the graphic arts and media sector is divided into a number of sub-sectors:

(a) prepress,

(b) printing or press,

(c) post press or finishing,

(d) packaging,

(e) multimedia,

(f) newspapers.

Within each of these sub-sectors there are roles at different levels requiring different skills sets.

There are moves to an all-digital workflow production system. One modern trend is towards one-stop-shops where customers go for 'total solutions' to their needs. Another is towards automation, and hence a reduction in the number employed in production, to multimedia applications and an increase in the need for ICT skilled employees. Finally there is an increasing number of people employed in teleworking and freelance activities.

OECD data (⁹) indicates that, in 1998, over 750 000 people were employed in printing production across Europe; this figure excludes prepress and finishing, post-press and parallel activities. The specific trends in each country vary; the graphic arts and media report provides a good description of the trends in each country.

All four reports show fundamental similarities in the industrial sectors. All sectors are experiencing structural changes driven by an opening up of competition, the global market place and increases in competitiveness; all these are, in part, fuelled by ICT technologies. In all cases there is a call for changes in the skill set of employees towards ICT and the need for personal effectiveness and interpersonal skills.

## 2.5.    Socio-economic context

The trend of increasing pervasiveness of ICT shows little sign of slowing down. The cost of a desktop PC relative to its power, storage and capability continues to fall rapidly and we are still seeing an increasing focus on computing and ICT in everyday life. The automotive report predicts that 'from 2010 onwards the average value share of electronic equipment (of a BMW 3-series car) is predicted to reach 35 % (currently 30 %), and even 50 % in upper class vehicles' (report B).

Across Europe, the automotive sector is generally reported to be growing. Current thinking suggests that there are still cost savings to be made through increased application of e-business and internet purchase which suggests that, at least for the immediate future, there is a strong demand for ICT skills. 'A shortage of skills will be relevant for the next few years. For Germany, the 'Networking skills shortages' with the use of ICT technologies is estimated to an average of 33 %, for France to 28 % for the period 1999 to 2004 (IDC, 2001)' (report B, p. 14).

Changes in automation of manufacturing plants and increases in sophistication of built-in vehicle diagnostics have also helped fuel the move towards more ICT-aware and ICT-skilled employees across the board. Finally, customer expectations in terms of vehicle capability and fitted components continue to increase. In this respect there has been a significant increase in the complexity of in-car entertainment, comfort, engine management and security systems.

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(⁹)    *Die Druckindustrie in OECD – Europe hat sich 1998 erholt*, Willkomm, Deutscher Drucker, journal, No 6, 2000.

For the future, two developments are emerging in the automotive industry which are exerting unpredictable influences on ICT skills profiles: the implementation of the digital factory and the continuous growth of networking technology resulting in the intensification of automated processes.

In Europe, the financial services sector has 'traditionally been a sharply segmented sector, with clear distinctions between different types of institutions and the provision of different types of services' ([10]). The sector is, however, currently undergoing deregulation, liberalisation, privatisation and concentration throughout the market's value chain. 'These challenges are directly linked to new technologies that have enhanced the potential for competition' (see report C). This period of change is set to continue. 'The European Central Bank is supporting further financial integration because it might have many benefits 'in terms of increased efficiency and competitiveness of the real economy' ([11]).

The banking and Finance sector has changed from its 1980s model of large conglomerates offering the full spectrum of services to partnerships and alliances both within the sector and across sectors (into assurance for example).

In the graphics arts and media sector 'Substantial technological developments have taken place, primarily during the last decade of the 20th century, especially, innovations and improvements in prepress and printing, that affect the existing structure of production workflow, the technological processes applied and the working environment.' These technological changes are compounded by conventional business environmental changes of increased competition and increased customer expectations and demands.

In summary, both technology and customer demands have encouraged, if not forced, radical changes within all three industry sectors. Easy access to information on the Internet is also making the average customer in all sectors more informed and hence more able to make intelligent product comparisons and demands. The growth in Internet access is also dramatic, from less than 200 million users worldwide at year-end 1998 to over 530 million in 2014. These trends are unlikely to reduce in the foreseeable future and, with the increasing availability of broadband access, are more likely to increase. All the indicators are that the pressures for change in all three sectors will continue into the future.

## 2.6.    Training supply and demand

The current and recent past technological and social developments in information systems, production, e-commerce, customer intelligence and demands, together with the radical changes in the competitive environment, have led to some rapid and major changes in the way

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([10])    SERVEMPLOI, Financial thematic report, Trinity College, Dec 2001.

([11])    ECB, Banking integration in the Euro area – occasional paper, Dec 2002.

work is carried out within the organisation. All employees face the challenge of evolving jobs, within and between companies, the conditions under which they are employed (i.e. from employees at a company to independent workers in some cases), and the content of the work that is carried out. These characteristics of work lead to changes in job duties and the qualifications required to make the employee more attractive in terms of recruitment and retention to the company. This dynamic business environment and need for workforce upskilling is common to the automotive, graphic arts and media and banking and finance sectors.

As mentioned in report A, a first important result is the total number of employed ICT practitioners in Europe which, according to different studies, can be summarised at approximately 3 700 000 (see *biat*, 2001; EUQuaSIT, 2004 and CEPIS, 2002). This total number includes the ICT practitioners in the ICT and user sectors and at all skill levels and is approximately 2.2 % of total employment in Europe (total EU15 labour force approximately 167 million). In comparison, the USA has a proportion of approximately 2.8 % (total labour force approximately 140 million). The ICT practitioner proportion, split between the ICT and user sectors in Europe is:

(a)   45 % of ICT practitioners (approximately 1 700 000) are employed in the ICT sector;

(b)   55 % of ICT practitioners (approximately 2 000 000) are employed in ICT user sectors.

These proportions vary between European countries and depend on the economic situation and regions. And again, compared to the ICT employment in the USA it is interesting that also approximately 60 % of ICT practitioners are employed in non-ICT industries (NSSB, 2002, p. 11).

There are, however, clear problems in analysing supply and demand, as stated in the automotive report: 'The large number of surveys on the needs for ICT skilled workers are based on different definitions and differing methodological approaches; this emphasises that there is no generally acknowledged definition of ICT professionals or practitioners. The definition of ICT staff can in no way be confined to the core ICT sector nor to respective occupational titles' (report B).

That said, some important scene setting points can be extracted that apply generally across the sectors. The abilities, both academic and physical, of the population vary widely. 'Ten percent of the European population has a handicap or disability. That corresponds to at least 37 million people, about 70 % of whom are more than 60 years old. According to some personnel managers interviewed, ICT could contribute to social inclusion and to reskilling and upgrading the qualifications of the labour force' (report C). The sectoral reports also note the importance of gender in the supply and demand equation.

The automotive sector is a complex sector comprising three main sub-sectors, automotive development, automotive production and motor vehicle sales and repair. All three of these sub-sectors have experienced the rise of ICT and the resulting significant changes to the working environment and practices, to the point now where 'more or less the entire workforce

needs basic ICT competences' (report B). Specifically in the production and motor vehicle sales and repair areas, ICT diffusion has not only increased but is now integrated into all plants, though traditional technologies will prevail in combination with ICT applications. Consequently, it is insufficient to look at ICT in an isolated way. The study clearly reveals that:

(a) there is a great number of task profiles that require sophisticated ICT skills and competences;

(b) there are only a few highly specialised autonomous ICT task profiles.

The examination of the current developments and existing ICT skill profiles and training efforts at the sub-degree, degree and VET levels, indicates a need for ICT skill profiles and ICT competences for approximately 93 % of the workforce in the automotive sector.

In banking and financial services there is a demand for both degree level (approximately 12-20 %) and sub-degree level (approximately 88-80 %) employees in Italy and France respectively. In the graphic arts and media there is also a demand for both degree level and sub-degree level employees. 'With reference to higher education, the sector previously concentrated on engineering, physics, and chemistry with regards to specific applications used in printing production. Design and creativity was and continues to be one of the essential fields of graphic arts education. With reference to post-secondary education, a great percentage of the core of the education and training still concentrates on craftsmanship, mainly dealing with manual processes such as photography prepress and plate-making, all aspects of printing technology, machinery and processes, the finishing of printed matters and paper, as well as the knowledge of other printing substrates properties. Gradually, automation techniques, advanced engineering processes and production management systems, as well as quality control techniques started to be included in the education and training content in the graphic arts and media education' (report D).

Changes in the working environment include the application of digital production workflows, the emergence of industrial standards, an increased emphasis on teamwork, increased complexity of jobs leading to the need for enhanced competence and qualifications of workers) and changes in the working environment towards more flexible and distance working. These have led to changes in education and training needs. Some specific trends are: the requirement for the development of new modules, courses, and curricula; restructuring of studies mainly in graphic arts/media and printing departments and faculties of higher education, towards 'media' studies; development and application of new learning environments such as e-learning, distance learning, continuous further training and lifelong learning concepts; and the introduction of knowledge-management as a new field within the company environment.
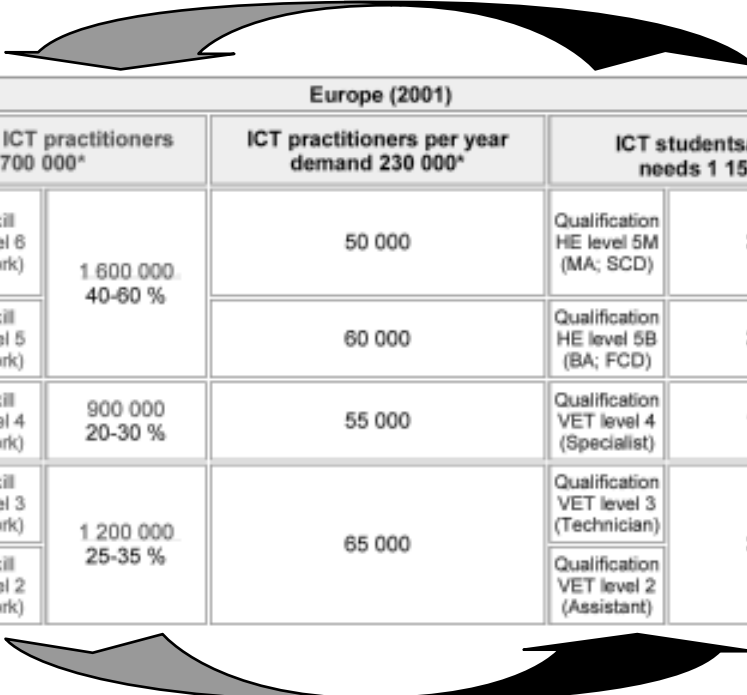
The total demand for ICT practitioners across Europe is approximately 230 000 per year; this figure includes replacements as well as new jobs. This is a significant number and forecasts predict this requirement will hold until at least the end of the decade (see report A). The

demand is also level dependant, as is shown in Figure 1 of report A and reproduced here for completeness.

Recognition of qualifications and the prerequisites of employment vary in the graphic arts and media as they do in banking and financial services. Report D gives a good summary of the situation in each country.

The reports all indicate that there is scope for improvement in the communications between industry and education in its broadest sense. Whether this is achieved through initiatives such as the one in this report or others, there appears to be the need for joined-up thinking across the board between education and training and industry.

*Figure 1:    European ICT employment, demand for ICT practitioners and need for ICT students and trainees at different levels*

| Europe (2001) | | | | | |
|---|---|---|---|---|---|
| Employed ICT practitioners 3 700 000ᴬ | | | ICT practitioners per year demand 230 000ᴬ | ICT students/trainees needs 1 150 000* | |
| ISCO-88 level - | Skill level 6 (work) | 1 600 000 40-60 % | 50 000 | Qualification HE level 5M (MA; SCD) | 375 000 |
| ISCO-88 skill level 4 | Skill level 5 (work) | | 60 000 | Qualification HE level 5B (BA; FCD) | 325 000 |
| ISCO-88 skill level 3 | Skill level 4 (work) | 900 000 20-30 % | 55 000 | Qualification VET level 4 (Specialist) | 150 000 |
| ISCO-88 skill level 2 | Skill level 3 (work) | 1 200 000 25-35 % | 65 000 | Qualification VET level 3 (Technician) | 300 000 |
| | Skill level 2 (work) | | | Qualification VET level 2 (Assistant) | |

*Sourcre: biat, 2001; EUQuaSIT, 2004*

One final point is that there is a varying degree of legislation, either at government level or from head quarters of large institutions, applied to training provision and prerequisites for certain job profiles. 'The importance of a special ICT job profile might be confirmed by the fact that training courses for new recruits and for continuous learning are decided at national level even if the bank is a multinational company. This reflects the different needs, skills and requirements linked with national business customs and culture in different countries' (report C).

This brief introduction paints a picture of three sectors and a general view that the demand for ICT skills is strong. It should also show that the needs of each industry sector are different and

that there are, in some cases, different requirements within each sector as well. This report, therefore, will aim, in its synthesis of the available information, to take a generic approach and hence will not present detail in all areas. In seeking the common ground, and conclusions that can be applied across the sectors, the main focus needs to be at the generic level.

## 2.7.    Report structure

Section 3 provides an analysis of industry needs, summarising ICT and user industry needs in terms of supply and demand. It starts with a review of the research and study approaches and the basis of data collection; it then provides a quantitative and qualitative summary of ICT employment supply and demand in the user sectors. Section 4 provides a synthesis and implications of ICT skills needs and proposes a comprehensive European skills framework. Section 5 considers the issue of levels in the structure and describes generic ICT skills profiles and the development of a new European qualifications framework.

Section 6 provides generic guidelines for ICT curriculum development and recommendations to curriculum and course designers. Section 7 concludes the report by considering implementation issues and recommendations.

# 3. ICT skills needs: analysis and synthesis of demand and supply

Growth, competitiveness and employment across the European economy have been increasingly dependent on the development of information and communication technologies (ICT) and the successfully applying ICT systems in industries across all sectors. Balance between industry needs for ICT skills and practitioners and an appropriate supply is an important condition for the potential of enterprises in the ICT sector as well as in the most other sectors, summarised as ICT user sectors.

Industry needs for ICT skills and practitioners have increased and rapidly changed, quantitatively as well as qualitatively in recent years. Data and studies of the ICT sector and ICT user sectors, specifically the automotive industry, banking and finance and graphic arts and media industries, indicate that the quantitative needs for ICT practitioners are highly dependent on the economic situation as a whole. The shortage around the year 2000 has reduced in the last four years as balanced demand and supply developed in the ICT labour market. However, today it is very relevant for all industries with ICT business, production and service areas to have a sufficient number of people skilled in managing, distributing, developing and deploying ICT solutions. It is also relevant, from a qualitative viewpoint, that all enterprises need ICT practitioners at varying ICT skill and qualification levels. Leading from employment and demand in the ICT and user industries, the need for ICT practitioners can also differ between degree and sub-degree/vocational levels.

Based on analyses, evolution studies and forecasts of the skill needs in ICT and user industries in Europe, there follows a quantitative and qualitative examination of requirements for ICT skills in companies and organisations of all sizes. The results provide the basis for a prospective and demand-driven development of a transparent European ICT skills and qualification framework.

## 3.1. Data collection and needs analysis

In order to investigate the need for ICT practitioner skills and training solutions in Europe, surveys and empirical analyses were carried out for the four reports.

First were written surveys, secondary study analyses, sector-specific (cross-ICT) studies, European comparative studies and case studies in the industries and companies of the ICT sector and ICT user sectors in selected European countries (in France, Germany, Italy, Netherlands, Portugal). These covered ICT employment and demand for ICT practitioners focused on the quantitative and qualitative needs in terms of programmes, main contents, range of skills and knowledge, etc. anticipating certain occupational/professional profiles and skill levels.

These were followed by analyses and evaluation of current ICT training and qualification programmes and profiles, including the supply of ICT practitioners in selected European countries (especially in Germany, France, Italy, the Netherlands and Portugal). The aims were evaluation and comparison of ICT training profiles in Europe at degree and sub-degree levels (VET, CVT and HE) in terms of programmes, occupational/professional profiles, targets, main contents, range of skills and knowledge, etc. and numbers of ICT students and trainees and expected supply of ICT practitioners.

Finally there was evaluation of demand and supply, and the gap or mismatch in ICT practitioner skills and ICT training solutions (see reports A, B, C, D).

These surveys and empirical analyses were carried out in different projects and studies, in cooperation with partners of various European countries. The sample of the investigations, questionings and case studies on ICT employment and skill needs focused on the ICT sector with ICT supplier companies and also on different ICT user sectors with ICT user companies (see report A) and within the ICT user sectors specific reports focused on the automotive industry (report B), banking and finance (see report C) and the graphic arts and media industry (report D). All the studies and reports took into account both large enterprises and the special ICT skill needs of small and medium sized enterprises (SMEs). The figure below summarises the relevant sample of the studies, highlighting the ICT sector and the three selected ICT user sectors.

*Figure 2:* *Economic structure of the ICT sector and ICT user sectors of 'Statistical classification of economic activities in the European Community (NACE Rev. 1.1)'*



| ICT sector (ICT supplier industries) Small-, medium-, large-enterprises / companies / organisations | | | | | |
| --- | --- | --- | --- | --- | --- |
| ICT services IT services / CT services (NACE G 51, I 64, K 72, K 73) | | | | | |
| ICT manufacturing IT manufacturing / CT manufacturing (NACE DL 30, 31, 32, 33) | | | | | |
| ICT user sectors (ICT user industries) Small-, medium-, large-enterprises / companies / organisations | | | | | |
| Manufacture of motor vehicles, trailers and semi-trailers (NACE DM 34) | Wholesale and retail trade; repair of motor vehicles, motorcycles ... (NACE G) | Manufacture of pulp, paper and paper products; publishing and printing (NACE DE) | Financial intermediation, except insurance and pension funding (NACE J 65) | Manufacture of textiles and textile products (NACE DB) | Manufacture of chemicals, chemical products and man-made fibres (NACE DG) |
| Manufacture of basic metals and fabricated metal products (NACE DJ) | Manufacture of electrical and optical equipment (NACE DL) | Manufacture of other transport equipment (NACE DM 35) | Electricity, gas and water supply (NACE E) | Transport, storage and communications (NACE I) | Insurance and pension funding, except compulsory social security (NACE J 66) |
| Real estate, renting and business activities (NACE K) | Public administration and defence; compulsory social security (NACE L) | Education (NACE M) | Health and social work (NACE N) | Other community, social and personal service activities (NACE O) | others |

EUQuaSIT 2004

All reports meet the criteria for an adequate sample, even though the country sample and investigation methods and instruments differ in each report. However, the reports also indicate

that the quantitative data are difficult to compare and more qualitative research is needed in the ICT business and work areas of the European countries.

## 3.2.    ICT employment, demand and supply of ICT practitioners at different skill levels

Determining the quantitative needs for ICT skills and practitioners highlights that a common definition with regard to the sectors and skill levels does not exist. For instance there are surveys and statistics on:

(a)   IT practitioners;

(b)   CT practitioners;

(c)   IT sector;

(d)   CT sector;

(e)   media and ICT user sectors, etc.

In addition, surveys and statistics sometimes only focus on ICT professionals without taking into account the whole range of ICT practitioners at all skill levels. In outline, some 3 700 000 ICT practitioners are employed in all sectors and at all skill levels across Europe (EU15) (cf. EUQuaSIT 2004). The total number for Germany is some 800 000, the Netherlands 280 000 and Portugal 70 000. The ICT practitioner proportion of the total employment in European countries varies between 1 % and 5 % and depends on the economic situation and infrastructure. The average percentage in Europe is approximately 2.2 % (total labour force in the EU15 approximately 167 million). This is slightly lower than in the USA with approximately 2.8 %, based on approximately 3 900 000 ICT practitioners and total labour force approximately 140 million (see figure below) ([12]).

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([12])   The number of approximately 3 900 000 ICT practitioners in the USA is based on numbers of the NSSB study, 2002, p. 8, 26, 27 with rough estimation and a combination of official statistics. In comparison the difficulty is the definition of what is exactly meant by ICT worker, skill level and sectors. For example the official statistic for the major occupational group 'computer and mathematical' indicates a number of 2 772 620 to which we need to add computer and information systems managers, ICT business or computer sales staff, electronics or communications engineers, telecomm practitioners, etc. (see U.S. Department of Labor - Bureau of Labor Statistics, 2002). Other figures indicating for the U.S. economy '10.3 million IT workers ... based on a telephone poll of 400 hiring managers in IT and Non-IT firms' seem rather unrealistic or defined IT workers in a broader sense including more IT user groups because the number of IT workers only in the non-IT firms is indicated with some 9 million (see ITAA, 2003, p. 2 et seq.). On the other hand this 90 % of IT workers in the non-IT firms seems also unrealistic and a former report by ITAA stated a proportion of only 60 %, too (see NSSB, 2002, p. 11).

*Figure 3:* *Current employment and estimated needs of ICT practitioners in Europe 2000 to 2010*

| | ICT practitioners 2000 | ICT practitioners (ICT sector) | ICT practitioners (user sectors) | ... | ICT practitioners (demand p.a.) | ... | ICT practitioners 2010 |
|---|---|---|---|---|---|---|---|
| Germany | 800 000 (2.1 %) | 300 000 | 500 000 | ... | 50 000 | ... | 1 100 000 |
| Netherlands | 280 000 (3.5 %) | 110 000 | 170 000 | ... | 17 000 | ... | 380 000 |
| Portugal | 70 000 (1.5 %) | 26 000 | 44 000 | ... | 4 500 | ... | 99 000 |
| ... | ... | ... | ... | ... | ... | ... | ... |
| Europe (EU-15) | 3 700 000 (2.2 %) | 1 700 000 | 2 000 000 including 360 000 (Automotive) 200 000 (Financing/Bank) 64 000 (Graphic/Media) | ... | 230 000 | ... | 5 100 000 |
| USA | 3 900 000* (2.8 %) | 1 600 000* | 2 300 000* | ... | ? | ... | ? |

The number of 3 700 000 ICT practitioners in Europe includes the specific proportion of employed information technology (IT) practitioners, estimated at some 2 500 000 (ISCO 213 and 312; not including are ICT business or computer sales staff or electronics or communications engineers, telecomm practitioners, etc.) (cf. Ottens, 2003, p. 59). For this (sub-) group of ICT practitioners the number of IT practitioners in the IT sector (supply companies) amounts 1 021 000 and in the IT user sectors 1 422 000 (CEPIS, 2002, p. 35). Comparable proportions between ICT and user sectors were indicated for all ICT practitioners in Europe (own estimates based on the sources indicated above):

(a) 45 % of ICT practitioners are employed by the ICT (supply) industry;

(b) 55 % of ICT practitioners are employed by ICT user industries.

That means the number of ICT practitioners in the ICT sector (supply companies) is estimated at 1 700 000 and in the ICT user sectors at 2 000 000. Apart from national differences in European countries, the overall comparison with the ICT workforce in the USA is interesting. An ITAA report indicated that approximately 60 % of ICT workers in the USA are employed in non-ICT firms (NSSB, 2002, p. 11).

Statistics for Europe for the year 2000 show employment in the ICT service sector as approximately 4.5 million and in the ICT manufacturing sector as 1.5 million (see Garland, 2003, p. 3). Therefore, the 1 700 000 ICT practitioners in ICT service and manufacturing in relation to total European employment of 6 million in the sector represents about 30 %. The actual workforce of ICT practitioners in the service sector is estimated at some 1 550 000, or 35 % of the total. In comparison, ICT manufacturing has a practitioner proportion of 10 % (cf. EUQuaSIT 2004, p. 64). The reason for the difference is that manufacturing covers the

production of computers, wire and cable, consumer electronics, and so requires a lower proportion of ICT practitioners.

Breaking down the ICT practitioners employed by specific ICT user sectors indicates that 360 000 are employed in the automotive industry, 200 000 in banking and finance and 64 000 in the graphic arts and media. These three user industries therefore employ approximately 30 % of the ICT practitioners in all ICT user industries (see Figure 3). The proportion of the ICT practitioners, for example, in the automotive industry and banking and finance is about 8 % of the total employment of these sectors (reports B, C, D and estimation).

Questions and data about current and future demand for ICT practitioners are of fundamental importance to the interaction of employment and education. Such data mainly depend on forecasts or assumptions of ICT employment growth in the coming years and in general on future economic development. Past development, however, showed that difficulties occur in regard to both but recent developments in the ICT business and labour market makes careful forecasts and different scenarios about future demand for ICT practitioners possible. Also of value are answers to questions on expected changes in ICT employment in European companies. These results indicate no short and mid-term changes in ICT employment in approximately 60 % of industries and companies in ICT and user sectors in Europe. However, in the ICT sector and small enterprises in particular, over 30 % expect higher ICT employment in the near future (see Figure below).

*Figure 4:*     *Change of ICT employment in European companies/enterprises in the near future*
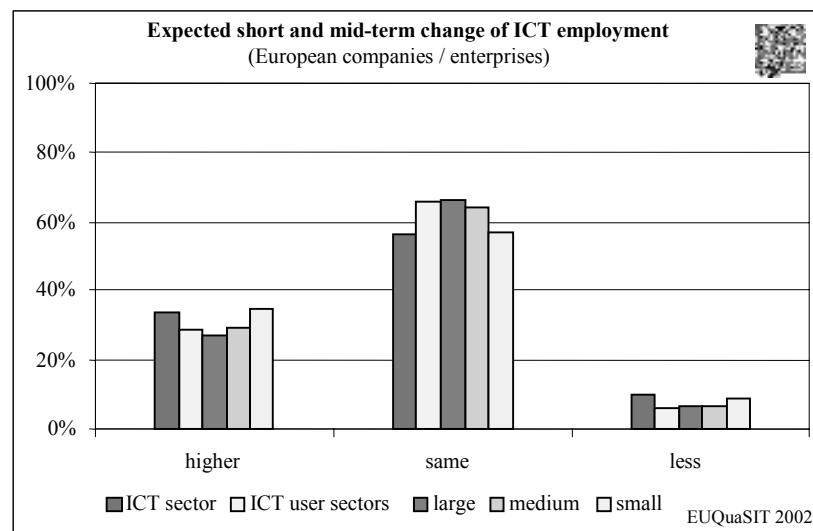


This expected demand and supply of ICT practitioners suggest that the ICT labour market situation in Europe is currently not too bad and the supply of ICT practitioners is mostly estimated by the companies as being 'fair' (see below). Of course there are differences between European countries, e.g. a significantly better situation in the Netherlands compared to Germany and Portugal.

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*Figure 5:*    *Companies' evaluation of how the supply meets the demand of ICT practitioners*
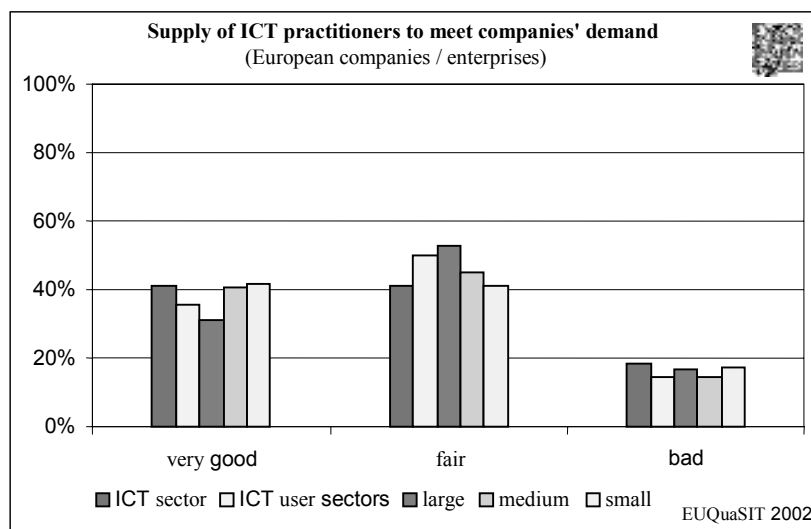


There are also small differences between the ICT user sectors and, in addition, within the sectors between European countries. For example, the situation of the ICT labour market for the banking and finance in France is currently better than in Italy. Only for 15 % of French banking and finance companies see the situation as 'bad' (report C; see figure below).

*Figure 6:*    *Bank companies evaluation of how the supply meets the demand of ICT practitioners compare to the 'normal' banking and financial services employees*
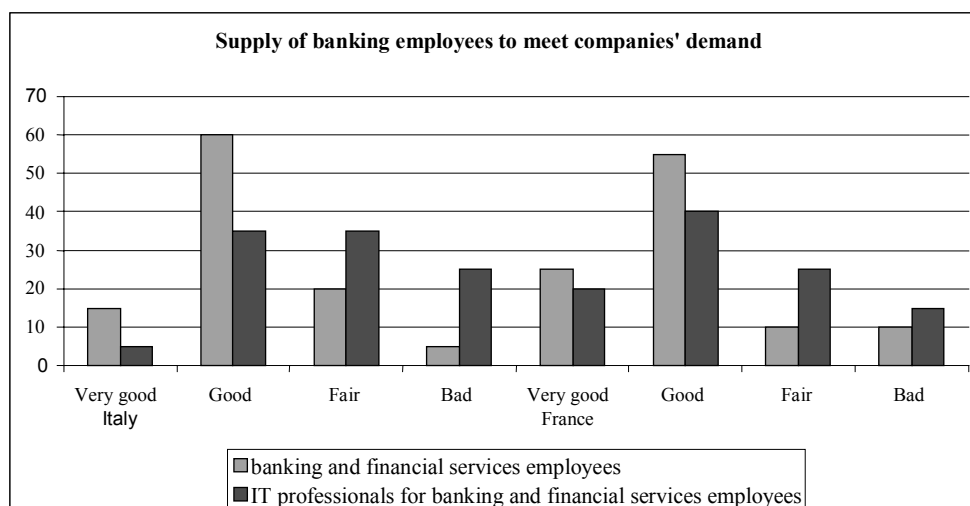


ICT employment growth between the years 2000 to 2010 can be estimated at 2 to 5 %, with an averaging 3.5 % per year. This means that total demand for ICT practitioners in Europe – including the 3.5 % growth and a 2.5 % replacement demand – can be roughly estimated at some 230 000 ICT practitioners per year. Total ICT practitioner demand per year in Germany is assumed at 50 000, in the Netherlands at 17 000 and in Portugal at 4 500. A corresponding assumption until the year 2010 suggests total estimated employment of 5 100 000 ICT practitioners for Europe (see table above). However, less realistic today are the previous

predictions of a huge shortage of ICT practitioners in Europe, e.g. the predicted 1.6 million gap by 2004 (IDC 2001, quoted in CSC/Cedefop, 2001a, p. 5).

These assumptions indicate only average data on industry needs. Other definitions of ICT practitioners or ICT and user sectors and assumptions of growth and replacement rates lead to variations in demand and ICT employment:

(a)   needs and demand of 200 000 to 300 000 ICT practitioners per year;

(b)   a total number of 5 000 000 to 6 000 000 ICT practitioners in the year 2010.

More difficult and comparable problems exist in relation to further questions on demand for ICT practitioners at different skill levels; a clear definition or description of ICT skills and ICT skill levels is needed to help provide answers. We need a European ICT skills framework which will be broadly accepted and provide a basis for all quantitative results and for further qualitative questions. A comprehensive European ICT skills framework does not yet exist.

The International Classification of Occupations ISCO-88 (ILO 1990) provides an orientation in this respect and offers initial answers. Within ISCO-88, occupations are grouped together and further aggregated mainly on the basis of the similarity of skills required to fulfil job tasks (Hoffmann, 1999, p. 6). The ISCO-88 classification is like a framework and splits occupation groups into five broad skill levels of which four skill levels are relevant for ICT practitioner groups (see figure below).

The four ISCO-88 skill levels are not concretely defined and in line with each ICT minor groups and unit groups. But in general each broad skill level shows a correspondence to one or two education or qualification levels, because 'the International Standard Classification of Education (ISCED) was used to define the ISCO-88 skill levels' (Hoffmann, 1999, p. 6). The purpose of the level structure and definition is quite clear: 'Only a few broad "skill level" categories can usefully be identified for international comparisons' (ibid.). Furthermore the ISCO-88 occupation groups show a subject-orientated structure which divides ICT practitioners more or less into IT and CT practitioners. Transferred to a European ICT skills framework with more detailed ICT results, the ISCO-88 classification can only be used in parts and needs to be expanded and adapted. However, available Eurostat data based on this classification of two minor groups can be used as first quantitative European results in terms of the ICT practitioner skill levels. The results only consider the two IT practitioner groups:

(a)   computing professionals (ISCO 213);

(b)   computer associate professionals (ISCO 312).

*Figure 7:    Relevant ICT practitioner groups within the International classification of occupations ISCO-88*

These two groups at ISCO-88 skill level 4 and 3 include some 2.5 million of the 3.7 million ICT practitioners in total and, therefore, two main IT practitioner groups of European ICT employment (see Eurostat upon CEPIS, 2002, p. 35 and results of the table above). IT practitioners can be divided into the skill levels 'professionals' and 'associate professionals' as follows:

(a)   for Germany some 54 % professionals to 46 % associate professionals;

(b)   for France 65 to 35 %;

(c)   for the Netherlands 50 and 50 %;

(see Eurostat upon CEPIS, 2002, p. 38).

By splitting up the professional skill level and one complementary non-professional skill level (which includes more groups than indicated at associate professional level) a similar proportion of ICT practitioners can be collated, based on results such as those in the reports

from Germany and the Netherlands (see especially report A). A summary of results allows the following average proportions to be determined for employed ICT practitioners for skill needs and/or the demand for ICT practitioners:

(a)  40 to 60 % of all ICT practitioners work or need skills at professional level;

(b)  40 to 60 % of all ICT practitioners work or need skills at non-professional level.

The actual proportions and demand differs depending on the country, the sector and the respective specific demand from companies; it also varies to a certain extent on the supply of ICT practitioners in European countries.

This provides first important 'level' for discussing European ICT practitioner needs, allowing a rough estimation of concrete numbers for each broad skill level:

(a)  a demand of 100 000 to 150 000 ICT practitioners at 'professional' skill level per year,

(b)  a demand of 100 000 to 150 000 ICT practitioners at 'non-professional' skill level per year.

Because the broad skill levels of ISCO 88 were defined in correspondence with different ISCED education and qualification levels, and although skills in general are not only obtained by formal education or training, these skill needs at different levels can also be interpreted as demand at 'degree' and 'sub-degree' qualification levels. This correspondence of skills and qualification levels is crucial importance and constitutes a signal for European education systems. Transferred to ICT, the following same rough estimations of needed ICT practitioners by qualification level can be given:

(a)  a demand of 100 000 to 150 000 ICT practitioners at degree qualification level per year;

(b)  a demand of 100 000 to 150 000 ICT practitioners at sub-degree qualification level per year.

The ISCO-88 classification is very broad and not sufficient for detailed information about the needs at different skill levels; it needs to be expanded and adapted towards a new European ICT skills framework. But a more detailed and European specific ICT skills and skill level definition is a complex challenge. To develop possible solutions, for a broadly accepted European framework, requires two stages using existing European results and different skills and qualification frameworks as references.

For professional skill levels, a more detailed structure can be defined with reference to the qualitative results of the European Career Space Consortium. The consortium, with support of Cedefop and the European Commission, has established a project 'to put in place a clear framework ... that describes the roles, skills and competences required by the ICT industry in Europe'. In this sense Career Space has indicated skill needs based on relevant key jobs directly in form of generic ICT skills profiles: 'The first step was to develop generic skills profiles relevant to key jobs ...' (Career Space, 2001, p. 3). The framework, therefore, shows a structure of developed 'generic skills profiles ... as well as the level of behavioural and technical skills required to carry out the profiled jobs' (Career Space, 2001, p. 2, 3). The

framework focused on ICT skills and skill needs at professional level and shows that these skills have a high correspondence to two qualification levels: persons suited to the profiled jobs must have work experience as well as a formal qualification (bachelor's and or master's, first or second cycle degree) (see. e.g. ibid, p. 40). Using the skills and profiling of Career Space at professional level, and correspondence to degree qualifications, it is possible to define the following:

(a)  ICT skill level 6 corresponding to qualification level 5M (second cycle degree or master's);

(b)  ICT skill level 5 corresponding to qualification level 5B (first cycle degree or bachelor's).

On the way to a comprehensive European ICT skills framework the next step is to define a more detailed skill structure for the broad non-professional ICT skill levels chiefly based on the results of the four Cedefop reports. The results of the Cedefop reports and the Career Space findings complement one another. The synthesis of the reports indicates a structure of three relevant skill levels. The ways of defining and implementing these non-professional skill levels are partly comparable to the other skills and levels and also the interdependence of skills and qualifications. 'One way of looking at the skill requirements within particular occupations is to examine the average level of qualification held by workers within specific occupation groups' (Elias et al., 1999, p. 12).

The empirical results of written surveys and company case studies in several European countries indicate that ICT practitioners work, and need skills, within a structure of three non-professional skill levels: levels 4, 3 and 2. Defining these skill levels according to qualifications required a specific ICT qualification profile framework (see especially euquasit.net) based on different international and European standards, frameworks and definitions (see the comparison in the Annex covering SEDOC 1985, ILO 1988, ISCED 1997 and the new European Directive EC, 2004, Article 11). The broad non-professional ICT skill levels and their correspondence to sub-degree qualifications at three levels is as follows:

(a)  ICT skill level 4 corresponding to qualification level 4 (advanced or specialist);

(b)  ICT skill level 3 corresponding to qualification level 3 (core or technician);

(c)  ICT skill level 2 corresponding to qualification level 2 (basic or assistant).

Assuming acceptance of the interdependence and correspondence of skills and qualification levels, but also recognising they are not identical, a first approach towards a new European ICT skills and qualification framework can be developed as follows:

*Figure 8:* *Framework of common description, separation and correspondence of skill and qualification levels*

| Europe | | | | |
|---|---|---|---|---|
| **ICT skill level** | | **Correspondence** | **ICT qualification level** | |
| ISCO-88 level - | Skill level 6 (work) | | Qualification HE level 5M (MA/SCD) | ISCED-97 education level 6 |
| ISCO-88 skill level 4 | Skill level 5 (work) | Skill level corresponding to qualification level | Qualification HE level 5B (BA/FCD) | ISCED-97 education level 5 |
| ISCO-88 skill level 3 | Skill level 4 (work) | | Qualification VET level 4 (Specialist) | ISCED-97 education level 4 |
| ISCO-88 skill level 2 | Skill level 3 (work) | Overall orientation: International ISCO 1988 - ISCED 1997 | Qualification VET level 3 (Technician) | ISCED-97 education level 3 |
| | Skill level 2 (work) | | Qualification VET level 2 (Assistant) | |

As a European ICT skills and qualification framework, this needs broad transnational acceptance, hence the use of a common description, separation and correspondence of skill and qualification levels. However, a European denomination of each level is very difficult because potential terminology must either be new and newly defined or already known, with countries assigning their own historical and cultural background. Definitions may have different meaning, as in countries such as Germany where qualification levels do not play a significant role. Some broad and common terms are more or less accepted in a European sense: professionals, craftsmen, workers or degree and sub-degree and based on the Bologna process first cycle degree (FCD) and second cycle degree (SCD) or bachelor's (BA) and master's (MA). However, the term master, for example, can be used in different contexts.

Common separation and number of levels is difficult and must be an accepted compromise. A level structure with broad and only a few levels would be accepted much more easily and is basically also easier to define and denominate. But the information content is poorer. Such level structures also reflect poorly the complex work practices of ICT practitioners, with various hierarchical structures, work organisations and models, where up to eight and even more skill levels are not unusual. This is one reason why frameworks, such as the UK skills framework for the information age (SFIA), which used a matrix with seven skill levels (e-skills NTO, 2001), must be a good compromise. From various case studies we know, for example, there is one German company using eight ICT skill levels for internal ICT employment and skills descriptions; another defined only five. These indicate different options for skill definitions and delimitations and attends to correspond to the ICT staff wages.

The European solution of five skill levels is a compromise and refers, internationally, to two professional and three non-professional skill levels. The advantage of this framework is a simple correspondence to five qualification levels which are a basis for the proposal of a new European framework of ICT qualifications.

It is now possible to relate the questions of ICT employment and the European demand, using the empirical results of the four reports, to findings according to the new framework and structure with five levels. For ICT practitioners in ICT and user sectors, a proportion of 40-60 % work and need skills at skill levels 6 and 5, 20-30 % work and need skills at level 4 and 25-35 % work and need skills at levels 3 and 2. Based on this allocation of employed ICT practitioners, the total of approximately 3.7 million and the demand for approximately 230 000 ICT practitioners per year in Europe, Figure 1 shows the approximate numbers of ICT practitioners which are employed and needed per year at each skill level.

In assessing annual demand for ICT practitioners, it is also necessary to consider any shortage of ICT practitioners in Europe and to estimate how many ICT students and trainees are needed to meet demand. We also need to know how many ICT students and trainees are required at different qualification levels. Initially, to meet a total demand for approximately 230 000 ICT practitioners per year, we need some 1 150 000 ICT students and trainees across Europe. This number is calculated from the average duration of existing ICT training of three to five years, modified by a drop-out rate. The table shows the numbers of ICT students and trainees needed, according to these factors. For example, to meet the demand for some 50 000 ICT practitioners per year at skill level 6, approximately 375 000 ICT students are needed at qualification level 5M (students who want to achieve a master's degree); for 55 000 ICT practitioners per year at skill level 4, approximately 150 000 ICT trainees at level 4 are needed.

Unfortunately, a comparison of estimated numbers of needed and enrolled ICT students and trainees in Europe is not possible because exact numbers are not available. We only know, for most of Europe, that approximately four years ago the numbers were too low. But we know today that, in line with increased demand for ICT practitioners during recent years, the numbers of ICT students and trainees have also increased in most European countries. In conjunction with the slow-down in economic development and the actual employment situation, the new numbers of ICT students and trainees are possibly sufficient to meet demand or at least to improve ICT labour market balance. Some countries have already achieved such a good balance but it is important to remember that outcomes depend on various economic, technology and labour market developments (including career choice) and we have only an estimate of demand in a dynamic business field. For better and more detailed information we need to improve transparency and definitions of terms and classifications as well as corresponding statistical surveys in the ICT business field, both nationally and across Europe.

## 3.3.   ICT skill needs for work areas at different levels

A qualitative approach to industry's need for ICT skills and practitioners is presented within a European ICT skills framework with five skill levels (L2 to L6). This brings together results from different studies and empirical investigations, mostly combining surveys and case studies as described above (see above Section 3.1.). The aim was to investigate qualitative ICT skill needs at different levels. Investigations were based on a broad sample covering the ICT business area in Europe and focusing on the ICT sector, ICT supplier companies and also on different ICT user sectors (see report A). Within ICT user sectors there was a focus on the automotive industry (see report B), banking and finance (see report C) and the graphic arts and media industry (see report D).

Investigation of qualitative ICT skill needs within the variety of ICT business areas shows that a new content-oriented skill structure is needed which describes and defines all ICT skills according to the five levels of the ICT skill level framework described above. Because this approach moves towards a European ICT skills framework, it is of importance which approaches and criteria are chosen as the basis of the content-oriented skill structure. The starting point of such a structure must be the overall European ICT business area in which ICT practitioners work and need skills at different skill levels.

As a first example of classifying skill needs in for ICT businesses, the International classification of occupations ISCO-88 (ILO, 1990) offers a content-oriented skill structure based on occupation and skill level. Identifiable contents of ICT work areas are, therefore, strongly related to only one occupation and skill level (see figure below). In reality, ICT sales or programming skills are of importance in more than one occupation and skill level, so this occupation-oriented approach and the objectives of classification are neither convenient nor helpful in finalising a coherent work-orientated approach for a European ICT skills framework.

*Figure 9:     International classification of (ICT) occupations of ISCO-88*

| ISCO-88 (COM) | | | ISCO skill level 2 | | ISCO skill level 3 | ISCO skill level 4 | Skill level |
|---|---|---|---|---|---|---|---|
| Major groups | Minor groups | Unit groups | ICT skill level 2 | ICT skill level 3 | ICT skill level 4 | ICT skill level 5 | ICT skill level 6 |
| ICT business area: information and communications technology (ICT) | | | ICT skill level 2 | ICT skill level 3 | ICT skill level 4 | ICT skill level 5 | ICT skill level 6 |
| Legislators, senior officials and managers (ISCO 1) | Other specialist managers (ISCO 123) | Sales and marketing managers (ISCO 1233) | | | | | X |
| | | Computing services managers (ISCO 1236) | | | | | X |
| | Production and operations managers (ISCO 122) | Production and operations managers in transport, storage and communications (ISCO 1226) | | | | | X |
| | Managers of small enterprises (ISCO 131) | Managers of small enterprises in transport, storage and communications (ISCO 1316) | | | | X | X |
| Professionals (ISCO 2) | Computing professionals (ISCO 213) | Computer systems designers, analysts and programmers (ISCO 2131) | | | | X | X |
| | | Computing professionals not elsewhere classified (ISCO 2139) | | | | X | X |
| | Architects, engineers and related professionals (ISCO 214) | Electronics and telecommunications engineers (ISCO 2144) | | | | X | X |
| Technicians and associate professionals (ISCO 3) | Physical and engineering science technicians (ISCO 311) | Electronics and telecommunications engineering technicians (ISCO 3114) | | X | X | | |
| | Computer associate professionals (ISCO 312) | Computer assistants (ISCO 3121) | | X | X | | |
| | | Computer equipment operators (ISCO 3122) | | X | X | | |
| | Optical and electronic equipment operators (ISCO 313) | Broadcasting and telecommunications equipment operators (ISCO 3132) | | X | X | | |
| Clerks (ISCO 4) | Secretaries and keyboard-operating clerks (ISCO 411) | Data entry operators (ISCO 4113) | X | X | | | |
| | | Calculating-machine operators (ISCO 4114) | X | X | | | |
| Craft and related trades workers (ISCO 7) | Electrical and electronic equipment mechanics and fitters (ISCO 724) | Electronics mechanics, fitters and servicers (ISCO 7242) | X | X | | | |
| | | Telegraph and telephone installers and servicers (ISCO 7244) | X | X | | | |
| All sectors/SMLEs | | | ICT skill level 2 | ICT skill level 3 | ICT skill level 4 | ICT skill level 5 | ICT skill level 6 |

*Source: ILO, 1990; Hoffmann, 1999, p. 7*

Another content-oriented skill structure can be outlined with reference to the European framework of Career Space. However, currently this does not cover the broad ICT business area but 'only' the ICT business areas in the ICT industry and is furthermore related to the required ICT skills at 'professional' levels 6 and 5. This structure clarifies corresponding skill needs and shows the developed 'Eighteen generic job profiles ... in the following areas' (Career Space, 2001, p. 2, 3):

(a)   cross-sector;

(b)   software and services;

(c)   telecommunications;

(d)   products and systems.

These four areas have a structure partly comparable to the IT, CT, and managers sub major and minor groups of the ISCO-88 Classification and reflect a specific subject and 'professional level' view in regard to the ICT sector because of the various criteria used.

*Figure 10:    Basic structure of the European ICT skills framework of Career Space*

| Basic structure of the ICT skills framework of Career Space | | | | | |
|---|---|---|---|---|---|
| **ICT business area:**<br>**information and communications technology (ICT)** | ICT skill<br>level 2 | ICT skill<br>level 3 | ICT skill<br>level 4 | ICT skill<br>level 5 | ICT skill<br>level 6 |
| ■  Cross sector | | | | X | X |
| ■  Software & services | | | | X | X |
| ■  Telecommunications | | | | X | X |
| ■  Products & systems | | | | X | X |
| **ICT sectors/LEs** | ICT skill<br>level 2 | ICT skill<br>level 3 | ICT skill<br>level 4 | ICT skill<br>level 5 | ICT skill<br>level 6 |

Another possible skill structure was developed and used by e-skills UK entitled the skills framework for the information age (SFIA). This focused on main categories or fields of work as follows:

(a)  strategy and planning;

(b)  management and administration;

(c)  sales and marketing;

(d)  development and implementation;

(e)  service delivery.

Within this structure, the skills in each category are further differentiated and described with regard to a framework with seven defined ICT skill levels. Because the six skill categories reflect the fields of work of the broad ICT business area, the criteria and structure used are different from those of Career Space and the ISCO-88 Classification. The structure can be understood as a work-oriented one and shows, for instance, that in the field of work 'strategy and planning' there are no skill needs at skill level 2 and in the fields 'sales and marketing', 'development and implementation' and 'service delivery' there are no skill needs at SFIA skill level 7.

**Basic structure of the ICT skills framework of SFIA (UK)**

| ICT business area: information and communications technology (ICT) | SFIA skill level 1 | SFIA skill level 2 | SFIA skill level 3 | SFIA skill level 4 | SFIA skill level 5 | SFIA skill level 6 | SFIA skill level 7 |
|---|---|---|---|---|---|---|---|
| | | ICT skill level 2 | ICT skill level 3 | ICT skill level 4 | ICT skill level 5 | ICT skill level 6 | |
| ■ Strategy & planning | | | X | X | X | X | X |
| ■ Management & administration | | X | X | X | X | X | X |
| ■ Sales & marketing | X | X | X | X | X | X | |
| ■ Development & implementation | | X | X | X | X | X | |
| ■ Service delivery | X | X | X | X | X | X | |
| ■ User | X | X | X | X | X | X | X |
| All sectors/SMLEs | | ICT skill level 2 | ICT skill level 3 | ICT skill level 4 | ICT skill level 5 | ICT skill level 6 | |

*Source: Skills Framework for the Information Age, UK, 2001*

A comparable work-oriented structure reflecting the ICT skill needs in view of the ICT business and work areas was developed based on the findings on qualitative ICT skill needs in the four reports. As described in report A, this is based on a generic structure of ICT work areas with reference to the variety of ICT business areas within the ICT and user sectors; it shows a high equivalence to five categories or fields of work of SFIA. The difference exists more or less only in regard to the name, number and borders of the work areas. The developed structure is part of the 'GAHFA' model and segments the variety of ICT business areas into the following six ICT work areas:

(a)   ICT marketing, consulting and sales;

(b)   ICT business and project management;

(c)   ICT systems and application development;

(d)   ICT integration and administration;

(e)   ICT infrastructure and installation;

(f)   ICT support and systems service.

Because job roles, skills and competences are defined at all levels within these ICT work areas as well as for both the ICT industry and the ICT user industries in Europe, the subsequent basic structure of a European ICT skills framework can be used to describe all further findings on qualitative ICT skill needs.

*Figure 12:    Basic structure of the European ICT skills framework of biat GAHFA model*

| Basic structure of the ICT skills framework of biat GAHFA model | | | | | |
|---|---|---|---|---|---|
| **ICT business area:** information and communications technology (ICT) | ICT skill level 2 | ICT skill level 3 | ICT skill level 4 | ICT skill level 5 | ICT skill level 6 |
| ■ ICT marketing, consulting and sales | X | X | X | X | X |
| ■ ICT business and project management | X | X | X | X | X |
| ■ ICT systems and application development | X | X | X | X | X |
| ■ ICT integration and administration | X | X | X | X | X |
| ■ ICT infrastructure and installation | X | X | X | X | X |
| ■ ICT support and systems service | X | X | X | X | X |
| **All sectors/SMLEs** | ICT skill level 2 | ICT skill level 3 | ICT skill level 4 | ICT skill level 5 | ICT skill level 6 |

For the GAHFA model it is important that the six ICT work areas are based on common ICT work criteria and empirical results from ICT business processes (case studies) and consequently reflect and aggregate the work process structures from all enterprises of the ICT sector and ICT user sectors. Within each ICT work area, the ICT skill needs (for example in ICT marketing or development or administration or service) depend on the concrete content of the business area, such as 'networks systems and solutions', 'communications systems, applications and services', 'data management and database solutions' or 'multimedia applications'. Dependent on the different ICT business areas, there are different ICT skill needs within all ICT work areas. Therefore, the following list of relevant ICT business and technology (sub-)areas completes the basic structure of the European ICT skills framework as well as defining and clarifying at the same time – by comparing the diversity of ICT business areas in companies – the complex contents of the broad ICT business area in a coherent way.

*Figure 13:    European ICT skills framework of the biat GAHFA model*

| ICT skills framework of biat GAHFA model | | | | | | |
|---|---|---|---|---|---|---|
| **ICT business and work areas:**<br>**information and communications technology (ICT)** | | ICT skill<br>level 2 | ICT skill<br>level 3 | ICT skill<br>level 4 | ICT skill<br>level 5 | ICT skill<br>level 6 |
| • Information systems, applications and services<br>• Communications systems, applications and services<br>• Sector-specific ICT solutions<br>• Automotive industries<br>• Banking and financial services<br>• Graphic arts and media<br>• Internet and intranet applications<br>• E-business and e-commerce<br>• Data management and databases<br>• Networks systems and solutions<br>• ICT security solutions<br>• Business (process) applications<br>• Industrial IT systems<br>• Embedded systems and control<br>• Multimedia applications<br>• Consumer electronics<br>• ICT training solutions<br>• ... | ICT marketing, consulting and sales | X | X | X | X | X |
| | ICT business and project management | X | X | X | X | X |
| | ICT systems and application development | X | X | X | X | X |
| | ICT integration and administration | X | X | X | X | X |
| | ICT infrastructure and installation | X | X | X | X | X |
| | ICT support and systems service | X | X | X | X | X |
| **All sectors/SMLEs** | | ICT skill<br>level 2 | ICT skill<br>level 3 | ICT skill<br>level 4 | ICT skill<br>level 5 | ICT skill<br>level 6 |

These basic structures of ICT skill frameworks initially show that all approaches try to cover the broad ICT business areas, which differ little in Europe between industries. The results show partly comparable structures and also differences, which chiefly depend on the different criteria used to create the matrix of the framework. The following synopsis of the skills frameworks with highlighted ICT work area comparisons, main areas, categories or classification can help to illustrate the equivalences and differences.

*Figure 14:    Comparison of equivalence of European ICT skills frameworks: biat GAHFA model, Career Space, e-skills UK SFIA and ISCO-88*

| ICT | GAHFA | Skill level | Career Space | Skill level | SFIA | Skill level | ISCO-88 | Skill level | ... |
|---|---|---|---|---|---|---|---|---|---|
| | | L2, L3, L4 L5, L6 | | L5, L6 | | L1, L2, L3, L4, L5, L6, L7 | | L2, L3, L4, L- | |
| ICT business and technology (sub-) areas | ICT marketing, consulting and sales | ICT practitioners | Cross sector | ICT practitioners | Sales and marketing | ICT practitioners | Sales and marketing managers (1233) | ICT practitioners | ... |
| | ICT business and project management | ICT practitioners | | | Management and administration | ICT practitioners | Computing services managers (1236) Data entry operators (4113) Calculating-machine operators (4114) | ICT practitioners | ... |
| | ICT systems and application development | ICT practitioners | Software and services | ICT practitioners | Strategy and planning | ICT practitioners | Computing professionals (213) Computer systems designers, analysts and programmers (2131) Computing professionals not elsewhere classified (2139) | ICT practitioners | ... |
| | ICT integration and administration | ICT practitioners | | | Development and implementation | ICT practitioners | Computer associate professionals (312) Computer assistants (3121) Computer equipment operators (3122) | ICT practitioners | ... |
| | ICT infrastructure and installation | ICT practitioners | Products and systems | ICT practitioners | | | Electronics and telecommunications engineers (2144) Production and operations managers in ... communications (1226) Broadcasting and telecommunications equipment operators (3132) Electronics mechanics, fitters and servicers (7242) Telegraph and telephone installers and servicers (7244) | ICT practitioners | ... |
| | ICT support and systems service | ICT practitioners | Telecommuni-cations | ICT practitioners | Service delivery | ICT practitioners | | | ... |
| ICT | biat Uni Flensburg GAHFA | L2, L3, L4 L5, L6 Skill level | Career Space Career Space | L5, L6 Skill level | e-skills UK SFIA | L1, L2, L3, L4, L5, L6, L7 Skill level | ILO ISCO-88 | L2, L3, L4, L- Skill level | biat 2004 ... |

Within the European ICT skills frameworks based on the *biat* GAHFA model, ICT skills at levels L2 to L6 must be described and defined in each ICT work area and linked to the appropriate ICT business area. For example, ICT skill needs within the ICT work area support and systems service linked to the ICT business area communications systems,, are different from those linked to the automotive industries. However, the differences of ICT skill needs across work and the different business areas and the skills and competences at all levels required by the ICT industry and user industries show that these can be described using a common skill model defined by four skill categories (see figure below). Even though each skill category is important at all skill levels, the corresponding contents in each category must be clearly defined for each level.

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*Figure 15:    General model of categories of the ICT skill needs at all skill levels*
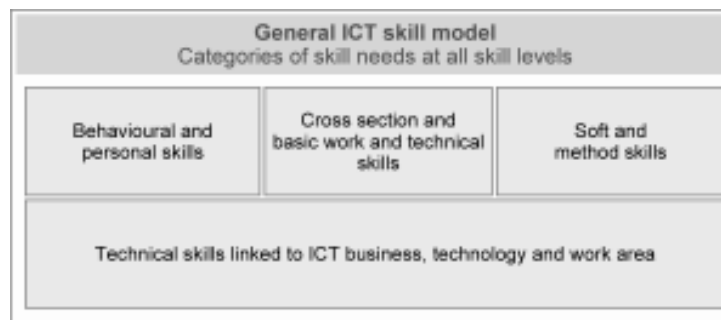


The skill needs within the European ICT skills framework according the *biat* GAHFA and the general ICT skill model can be summarised and described for each generic ICT work area as follows.


### 3.3.1.    Technical skills in ICT marketing, consulting and sales

ICT marketing, consulting and sales is a comprehensive work area covering commercial and consultancy activities with special focus on information and communications technology (ICT) projects, products and services. It applies to both the ICT industry and to companies of the ICT user industries (keyword: profit centre organisation). Successful marketing and sales of ICT products and services requires fundamental analyses of external and internal market and customer needs. Following various consultations, these requirements need to be translated into services and products that answer specific customer needs while providing benefits to the company or department at the same time. This combination of business and technical tasks demands specific skills, justifying the creation of a generic ICT work area and corresponding skills at different levels.


### 3.3.2.    Technical skills in ICT business and project management

ICT business and project management also combines business and ICT skills, ensuring the work flow success of an ICT project and business process. Within a wide range of project activities and responsibilities, business- and project-oriented ICT practitioners at different skill levels closely collaborate with internal and external ICT experts, providers and customers to ensure that customers' business needs are met when developing and deploying infrastructure and software ICT solutions and services. Together, business-oriented ICT practitioners constitute the crucial interface between the customer and primary ICT specialists and technicians. The common goal of more business- and technical-oriented ICT practitioners is a clear description of the business requirements within the technical specification of the ICT solution to be developed. In shared responsibility, more business- and technical-oriented ICT practitioners organise and implement applied support, training and instructions for the customer.

### 3.3.3.   Technical skills in ICT systems and application development

ICT systems and application development covers far more than individual programming or coding. In this work area ICT practitioners at different skill levels work in development teams that design, realise, update, test and document ICT systems and software applications. The work is carried out based on comprehensive analyses and descriptions of what ICT systems and applications are needed by the market, a specific sector or a specific (internal or external) customer. In practice contacts to the project manager and ICT business and technical practitioners within or without the company are important. In the daily work processes the transfer of technical and business requirements into a consistent data processing specification is crucial for the final success of the ICT systems and application development process. Primary criteria for software solutions are reliability and usability. Furthermore, the work as part of a team often runs under time constraints and must be constantly well communicated and documented. Eventually, the customer and its users often need applied support, training and instructions.

### 3.3.4.   Technical skills in ICT integration and administration

Following the development of ICT systems and applications these usually need to be professionally integrated, deployed, administered, optimised, supported, etc. depending on the platform the applications run on. ICT integration and administration teams configure, integrate, maintain and administer newly developed or already running systems and software applications. The work is carried out based on comprehensive analyses and descriptions of needed or existing systems environments for successful integration and deployment. In daily work processes, contacts to the project manager and ICT business and developers within or without the company are important. The customer and its users often need applied (help desk) support, training and instructions. As part of the (continuing and often contracted) technical support, systems and applications are optimised and upgraded, and troubleshooting needs to be coordinated and problems resolved at different levels.

### 3.3.5.   Technical skills in ICT infrastructure and installation

ICT infrastructure and installation covers the planning, integration, modification and installation of the wide range of different ICT systems, devices, telecommunications, networks, etc., summarised as ICT infrastructure. The work is carried out based on problem-oriented analyses and descriptions of what type and level of ICT infrastructure is needed by the market, a specific sector or (internal or external) customer. In practices, contacts to customers, project managers and ICT business and systems development practitioners within or without the company are important. For the realisation of the projects or project parts, and depending on the skill and responsibility level, ICT infrastructure practitioners need to consider aspects such as cost effectiveness, expandability and upgradeability, reliability, security, etc. The integration of standard, specific and innovative solutions (e.g. software applications, wireless network and telecommunication solutions, web based infrastructure) is part of this work. The work, sometimes as part of a team, often runs under time constraints

and must be constantly well communicated and documented. The customer and its users often need applied support, training and instructions.

### 3.3.6. Technical skills in ICT support and systems service

ICT support and systems service primarily concerns the analysis, troubleshooting and fixing of ICT infrastructure, systems and application problems. In principle this work covers a wide range of different ICT technologies and services and, correspondingly, the use of different soft- and hardware based expert and diagnosis tools, depending on the level of service and support. In order to narrow the faults down to the concrete technical problem, ICT service practitioners need to communicate well with customers, users and colleagues. As part of the service and maintenance, ICT practitioners must be able to propose possibilities of optimising and upgrading existing ICT systems.

### 3.3.7. Basic skills

Inducting the main contents and overall tasks within the six generic ICT work areas it becomes obvious that further capabilities beyond ICT skills are also required. The need for these skills directly depends on the type and contents of the work task. Such skills can be interpreted as basic skills and are summarised below:

(a) behavioural and personal skills: flexibility, self-learning, motivation and commitment, stress resistance and emotion, responsibility, managing risks, decision-making, negotiation, initiative and attention, persuasiveness, professional attitude (business or technical orientation and interests);

(b) cross section and basic work skills: quality awareness, commercial and market awareness, entrepreneurship, customer orientation and relationship, company and business organisation, work and project organisation, business and work process knowledge, work safety and health protection, labour law and data privacy, environmental and resource awareness;

(c) soft and method skills: communication and moderation, languages and culture, collaboration and interaction, teamwork and mentoring, conflict and consensus, creative and innovation, analytical and reasoning, problem analysis and solving, strategy, conception and planning, context and causal connection thinking, information handling, documentation and presentation.

# 4. Skills needs in a comprehensive European ICT skills framework

Further to the desire for a common European ICT skills structure, ICT skill needs must be reflected in more detail towards a comprehensive European ICT skills framework. For a further description of ICT skill needs within the framework, it is necessary to name and define more detailed information in addition to the ICT business and work areas, namely fields of activity and concrete ICT work tasks carried out by ICT practitioners at different skill levels. The following paragraphs analyse and summarise detailed outcomes from the reports in this direction as well as other initiatives like Career Space, SFIA and the German further skills and qualification initiative called APO.

The proposed framework aims to promote the transparency of ICT skill developments and provide detailed guidance to all those developing and evaluating career opportunities as well as qualification programmes. It also aims to enhance the mobility of qualified practitioners across Europe (EC, 1999). For a rapidly growing and fast-changing business such as ICT, the development and approval of a coherent skills framework is a significant challenge, especially in defining and applying adequate ICT skills profiles from entry to senior levels. There is still unsystematic knowledge and a lack of common understanding and description of needed ICT skills; there is also no coherent picture nor common evaluation criteria for ICT qualifications in Europe (see Reports A-D and also ICT Skills Monitoring Group, 2002, p. 3f.).

There exists currently no European solution in regard skill levels definitions which at the same time are relevant for qualification levels. As stated in Report A: 'Information on this aspect is difficult to find for most European countries and for Europe as a whole, a consequence of the lack of a classification or framework with Europe-wide recognition … There are difficulties with ICT occupations because they are fairly new and the transfer of common definitions is not always easy. Also, ICT work and skill contents change continually. There is a need, therefore, to find a practical method of relating a skills level framework to ICT employment' (report A, p. 20 et seq.).

In this context, the outcomes summarised in this report stress the importance of clarifying and systematically describing ICT skills needs with regard to ICT practitioner work areas and their skill levels. This is a precondition for a European ICT skills framework, considering the following criteria, beside others:

(a) coverage of the whole ICT business area, reflecting the skill needs and levels of large, medium and small companies as well as those of all industries (primary ICT industry and ICT user industries);

(b) provision of a European view of ICT skill needs and standards, to promote mutual trust between EU member states and candidate countries;

(c) usability regarding the analysis and description of ICT skill needs at different skill levels in companies and sectors;

(d) flexibility with respect to the wide range of ICT as well as the rapid technological and business developments in this business area.

In this section analyses are synthesised and lead towards such a comprehensive European ICT skills framework. Reference is made to the four reports and, in addition and for comparison, the Career Space results and other European projects and studies, such as the SFIA results of e-skills UK (SFIA, 2001) and the new German further training structure in ICT (APO). Based on the identified skill needs, general and sector-specific ICT skill structures have been proposed in the reports. In the following descriptions they serve as the basis for developing a European ICT skills framework focused on vocational levels.

## 4.1.    From analysis to a comprehensive framework

The basis of the detailed ICT skills framework is the structure of six ICT work areas and corresponding fields of activity (skill needs) within the ICT business area proposed in report A (see also ICT skill needs in Section 3). The framework considers the needs of both the ICT industry itself and the ICT user industries. The broad ICT business area covers a structure of major ICT (sub-)areas that contain sector-specific ICT solutions, e.g. the automotive industry, banking and finance, the graphic arts and media industry, health, etc. The ICT skill needs described in the special user industry reports allow incorporation into the overall framework. All the Cedefop reports refer to the importance of defining ICT skill needs in relation to a specification of respective skill levels (see also ICT skill needs in Section 3).

In the automotive industry there are three sub-sectors to be considered: automotive engineering/development, production and sales/repair services (see report B, p. 7 et seq.). For these sub-sectors, four groups of practitioners related to ICT fields are identified as follows:

(a) ICT practitioner (4 % of the workforce): software development and services (levels 2/3-5), multimedia and web design (levels 3/4), communication network design/network design (levels 3/4);

(b) ICT practitioner plus (4 % of the workforce): automotive knowledge management (levels 4/5), automotive software engineer (levels 5), automotive technical support (levels 3/4);

(c) automotive expert plus ICT (85 % of the workforce): ICT in vehicle repair and sales (levels 2/3), ICT in automotive production (levels 2/3);

(d) ICT user (7 % of the workforce): no specific ICT skill needs defined; general and simple use of existing simple ICT plants.

ICT practitioners and ICT practitioner plus are relevant to the ICT skills framework the. Automotive experts plus ICT are those with a clear orientation towards the tasks within the automotive sector and with sound ICT knowledge and skills (focus: automotive context) (ibid., p. 9). ICT users are not considered in this skills framework nor in the overall synthesis report.

ICT practitioners in the automotive industry can be employed wherever work processes are developed, supported and optimised by ICT. The work itself is, however, not necessarily ICT dominated. The tasks are, in general, oriented to the core business of automotive production and services. In research, development and design departments of automotive production there is a predominance of engineers who are in charge of software and product development (see figure below, ibid., p. 18 et seq.), e.g. automotive software engineers (auto). Within the ICT skills framework these ICT practitioners can be assigned, with their main job roles and tasks, to the work area ICT systems and application development. The demand for ICT practitioners in automotive production must therefore be concentrated on research, development, design, production, assembly, service and maintenance and quality control (ibid., p. 20). In addition, the increasing networking of production underpins the importance of ICT in production and makes programming, configuration, maintenance, diagnosis, and optimisation ICT related tasks to be performed regularly and repeatedly. A major challenge for ICT practitioners is 'to understand and master the interface between the individual steps of the entire production process (including the software) to be able to take decisions and to eliminate uncertainty, sources of error, and software faults' (ibid., p. 40 et seq.).

In the automotive after sales or service sector, two general work areas were identified, namely sales/retail (covering order management, automotive marketing, sales and financial services) and the workshop area (covering standard service, diagnostics, repair, additional installations and configurations and body work) (see figure above and ibid., p. 18 and p. 29 et seq.). In these areas ICT is used for different purposes:

(a) management of vehicle functions (signal registration, signal processing, actuator control, diagnosis);

(b) networking of vehicle systems;

(c) provision of information and communication solutions (audio, video, TV, DAB, telephone, telemetric services).

*Figure 16:    Value-added chain in the automotive industry*



*(see report B, p. 18)*

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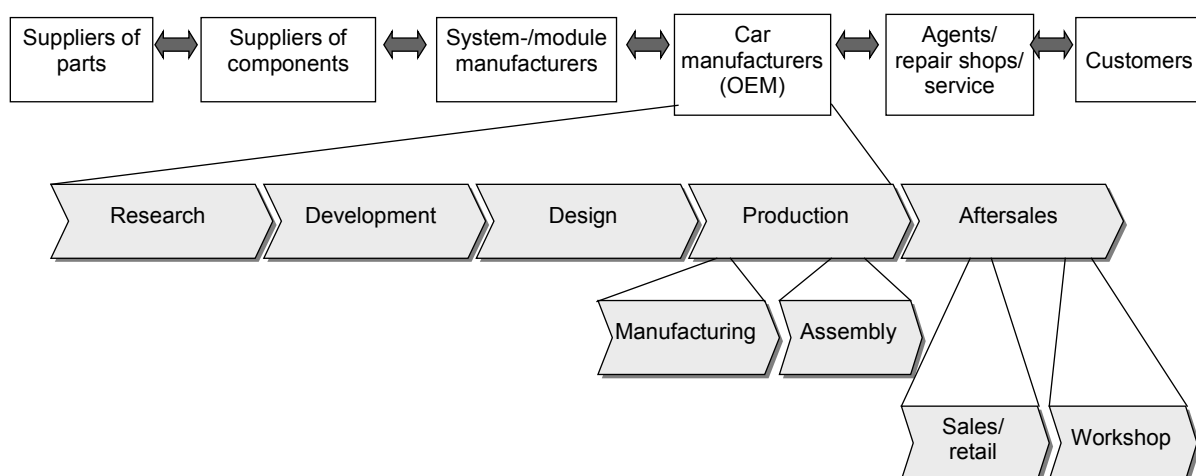
However, it is clearly stated that the development of solutions for these practical cases are typical services rendered by engineers. 'Safety and integration aspects require a sound knowledge of vehicle architecture. This is why computer scientists are rarely involved and the field is dominated by vehicle and electronic engineers and software engineers. Employees without degree level qualifications do not feature in the development of ICT in automobiles.' (ibid., p. 49). An important issue at workshop level is vehicle communication technology (architecture of the vehicle), e.g. for an exchange of data between the vehicle systems/aggregates and the memory for vehicle information, for multimedia applications (infotainment) and assisting the driver, and for the development and configuration of vehicle systems including their diagnosis. Four workshop core tasks could be identified for automotive service (ibid., p. 52):

(a)  check of data bus systems (communication) and the measurement of transfer properties;

(b)  tele-diagnosis (troubleshooting with networked diagnostic systems in coordination with the manufacturer);

(c)  configuration of vehicle communication technology and repair of faults;

(d)  retrofitting of vehicle communication technology.

Another dimension of communication technology is the exchange of communication in the workshop with information providers, manufacturers, parts suppliers, etc. with the aid of computer systems, telecommunication and other installations.

The summaries in the following tables (automotive production as well as motor vehicle repair and sales sector) underpin the variety of work areas and skills at different levels in the automotive sector permeated with ICT. Therefore, a great number of tasks in the automotive industry can only be successfully tackled with the aid of ICT competences. A difference can only be identified at the level of ICT competences, i.e. a degree or a sub-degree level.

*Figure 17:    ICT related tasks, the relevant competences and levels for ICT skill profiles in the automotive production sector*

| ICT related working areas | ICT relevant categories | Competences | Levels 1 to 5 |
|---|---|---|---|
| System automation | Optimised production control<br>Integration of networks<br>Network installation<br>Network functions | Use of PPS<br>PPS optimisation<br>Data bases administration<br><br>Network concepts<br>Network organisation<br>Network standards<br>Troubleshooting | L2<br><br><br><br>L3/4<br>L3 |
| Process quality | CAD/CAM processing<br>Visualisation of processes<br>Data saving | Data transfer<br>Process regulation<br>Fault-risk-analysis<br>Software applications<br>Safety systems | L2/L3<br><br><br>L2/L3<br>L3/L4 |
| Diagnosis and troubleshooting | Diagnosis communication<br>Troubleshooting<br>Ensuring data transfer | Diagnosis interfaces<br>Diagnosis modes<br>Measuring technology<br>Failure codes<br>Expert systems<br>Data transfer, CAN bus, etc. | L2<br><br>L2/L3<br><br><br>L2/L3 |
| Software applications and machine technology | Use of HSC/CNC-CAD/CAM<br>Rapid Prototyping<br>Software adaptations (formats, interfaces) | Machine tools with ICT integration<br>Use of software<br>Use of data bases<br>CAD/CAM transfer of data<br>CAD/CAM adaptation | L2<br><br><br>L 3<br>L2/L3 |
| CAM construction and data bases/data processing | Online use of data<br>CAD/CAM software<br>Data bases: standardised parts, data saving | Online transfers<br>Use/reconfiguration of software<br>Data base integration<br>Data base re-design | L2<br>L3<br>L2/L3<br>L3/L4 |
| Network implementation and software oriented support for production infrastructure | Network programming<br>Interface programming<br>Programming of Internet links | Programming of hard- and software<br>Creation of networks/Internet infrastructure | L4/L5 |

*(see report B, p. 84)*

*Figure 18:* *ICT related tasks, the relevant competences and levels for ICT skill profiles in the motor vehicle repair and sales sector*

| ICT related working areas | ICT relevant categories | Competences | Levels 1 to 5 |
|---|---|---|---|
| Diagnosis | Diagnosis communication Troubleshooting<br><br>Use of networked diagnostic systems/Tele diagnosis | Diagnosis interfaces<br>Diagnosis modes<br>Measuring technology<br>Diagnostic Trouble Codes<br>Expert systems<br>Communication modes in different networked systems (vehicle; with manufacturer) | L2<br><br>L2/L3<br><br><br>L2/L3/L4 |
| Integration of ICT in the vehicle architecture | ICT integration<br><br>Infotainment configuration | Impact of the installation on the entire vehicle system<br>Interfaces<br>programming and software updates | L2/L3<br><br><br>L2/L3 |
| Software applications for the service process | Workshop process systems (WPS)<br><br>Software adaptations (data exchange, interfaces) | Handling workshop/Service tools with ASA interface<br>Use of (web based) software and data bases<br>B2B solutions and their adaptation on WPS | L2<br><br>L2<br><br>L3/L4/L5 |
| Network implementation and software oriented support for workshop management | Networked workshop Knowledge management | Software configuration Programming user oriented hardware support | L4/L5 |

*(see report B, p. 83)*

Looking in detail in the banking and finance industry, report C indicates that ICT skill needs exist in a wide range of fields of activity within the different work areas and at different skill levels. For example, project software architecture/application (bank) can be assigned to ICT systems and application development at levels 3-5M. Furthermore, the report underlines the fact that 'in the banking industry ICT has proven to be most useful and successful in e-business activities and online services. The e-business application can be split into knowledge management, e-learning, collaborative computing and teleworking' (report C, p. 37). However, the proportion of present and also future use of such solutions is not very high.

In Italy, the most widespread skills needs related to ICT are expressed in profiles such as customer care assistant, network assistant, network manager, technical support and web masters. Nevertheless, the profiles with the highest increase in the coming years are e-marketing/e-business manager, ICT assistant, ICT analyst (ibid., p. 40). Therefore, these skills profiles can be assigned to the corresponding ICT work areas and skill levels within the skills framework below. In comparison, in France, the most widespread ICT skills are local and

network administrator, telecommunications technician and web master. In future, an increase in telecommunication technicians and multimedia designers is expected' (ibid., p. 40).

*Figure 19:    Present and future e-business application, (%): Italy and France*
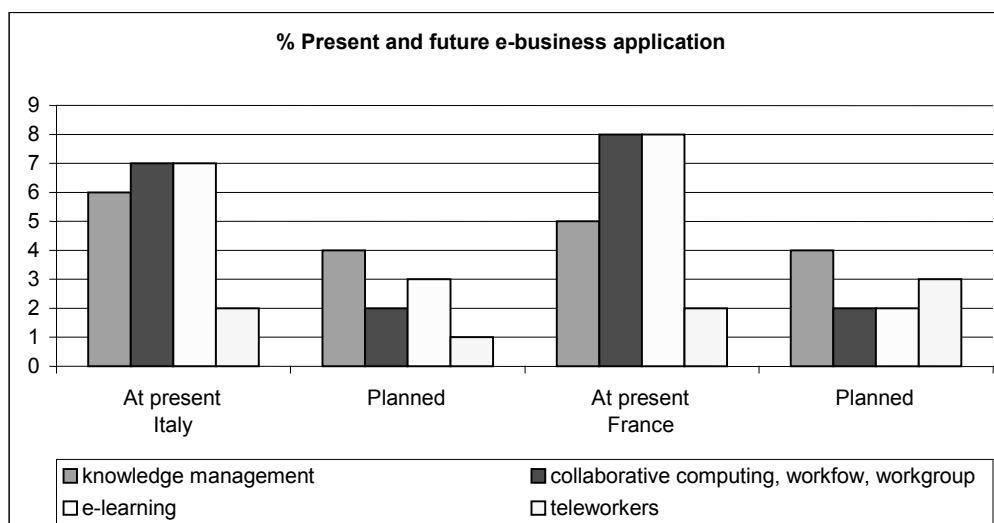


(see report B, p. 37)

For the graphic/media industry the needs of ICT and e-business skills and competences depend on wide spread and high diversity of ICT technologies which are used in the graphic arts and media production processes. Based on the production workflow the intensity of need and use of ICT skills is different in the various fields.

*Figure 20:    Application of IT-ICT skills and knowledge in the specific fields of graphic arts and media management and production*



*(see report D, p. 73)*

An example related to ICT is illustrated in the report to describe this (report D, p. 71):

'Network administration … is a very useful ICT skill for graphic arts and the media since many devices are connected in a digital workflow for production. Scanners, workstations for graphic design, image processing and page layout, proofing printers, image setters and plate setters can be connected in such a workflow. This is an IT-ICT competence and it needs to be included in curricula for graphic arts and media education.'

Therefore the skill needs in network administration can be assigned as a field of activity in the work area ICT support and systems service. The report investigates and compares the cross-relationship between the IT-ICT tasks and the graphic arts and media sectors tasks. Through this analysis effort is given to presenting the identified ICT skills and job profiles/tasks (ibid., p. 73).

Analysis of the three ICT user industry reports indicates consistent outcomes with regard to the major work areas of ICT practitioners. However, some sector-specific aspects need to be considered and aggregated into the detailed ICT skills framework, e.g. specific graphic arts applications, automotive software engineering or banking e-business and ICT analysis.

Together the results of the ICT skill needs analyses can be summarised in the GAHFA ICT skills framework which describes the broad ICT business area in a common sense with a segmentation of ICT work areas, fields of activities and ICT work tasks (see report A, p. 47).

This model approach is based on the assumption that the work areas which were aggregated from the analysis of a variety of ICT business and work processes in the ICT and user industries, can be further segmented in distinguishable fields of activity. These fields of activity in the following step structure a set of ICT work tasks carried out by ICT practitioners at different skills levels and with different (formal) qualifications.

In addition to the detailed ICT skill needs identified in the four Cedefop reports, the following table also assigns – in the GAHFA model – the concrete ICT skill needs at different levels identified by Career Space (CS), the skills framework for the information age (SFIA) in the UK (all levels) and the new German further qualification system for ICT specialists at level 4 (due to its work process orientated approach and implementation called APO). The basic idea behind all frameworks is the same, to structure and identify ICT skill needs, to provide an adequate basis for career planning and development, and the comprehensive skills profiling process.

*Figure 21:   GAHFA model structure of ICT business area with ICT work areas, fields of activities and ICT work tasks including the ICT practitioners who carry out the work tasks*



*(see report A, p. 47)*

Despite slightly different skills indicators, views and approaches, the analyses lead to similar results in terms of structuring the ICT skill needs identified. For instance Career Space identified ICT marketing management, ICT sales management and IT business consultancy at professional skill levels 5 and 6 which can clearly be assigned to the GAHFA work area ICT marketing, consulting and sales. The skills framework for the information age (SFIA) is a UK based model that identified 54 ICT practitioner skills (elements) grouped in subcategories and five ICT work areas (categories) plus an extra area for ICT use with three skills (elements) (see also previous section). The skills (elements) are deployed to seven skill levels of responsibility and accountability exercised by ICT practitioners as assigned in the table below (for further information see SFIA, 2001; see Steedman et al. 2003, p. 63).

The findings from the ICT user industry reports fit into the GAHFA framework, e.g. in the work area ICT systems and application development: project software architecture/application (bank), general software development (media), software development and services (auto) as well as multimedia and web design (auto) and multimedia design (bank). Also sector-specific ICT skill needs summarised in profiles like automotive knowledge management or automotive software engineering can be assigned to a work area as shown below.

As with the work areas and fields of activity, the skills requirements described in ICT work tasks also depend on the concrete content of the ICT business area. For example to 'obtain, analyse and prepare tailored ICT market, product and service information' or to 'contribute to, edit and review an ICT business and project plan' can involve different objects, methods, tools, requirements and regulations depending on the ICT business area. However, there are also, more from a work-oriented view, many similarities that see an ICT work task as being typical and generic in terms of needed skills.

*Figure 22:* Compilation of different European ICT skills frameworks in the work area 'ICT business and project management'

| ICT business area | Work areas | Fields of activity | Skill levels L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|
| ICT business area Skills linked to ... ■ Information systems and applications ■ Communications systems and applications ■ Sector-specific ICT solutions ■ Automotive ■ Banking and financial services ■ Graphic arts and media – ■ Internet applications ■ E-business and e-commerce ■ Data management and databases ■ Networks systems ■ ICT security solutions ■ Business (process) applications ■ Industrial IT systems ■ Embedded systems and control ■ Multimedia applications ■ Consumer electronics ■ ICT training solutions ■ ... All sectors/SMLEs | ICT marketing, consulting and sales | | | | | | |
| | ICT business and project management | ICT management (CS) | | | | x | x |
| | | Contract management (SFIA) | | x | x | x | x |
| | | Procurement (SFIA) | | | | x | x |
| | | ICT project management (CS) | | | | x | x |
| | | Programme management (SFIA) | | | | | x |
| | | Project management (SFIA) | | | | x | x |
| | | Project office (SFIA) | x | x | x | x | |
| | | IT project coordinator (APO) | | | x | | |
| | | Knowledge management systems developer (APO) | | | x | | |
| | | Project and resource planning (GAHFA) | | x | x | x | x |
| | | IS strategy and planning (SFIA) | | | x | x | |
| | | Business continuity planning (SFIA) | | | | | |
| | | Asset management (SFIA) | | | | x | x |
| | | Systems development management (SFIA) | | | | | x |
| | | IS coordination (SFIA) | | | | | x |
| | | ICT management (SFIA) | | | | x | x |
| | | Service delivery management (SFIA) | | | | | x |
| | | Selection and purchasing (GAHFA) | x | x | x | x | x |
| | | Bank e-marketing/e-business management (bank) | | | x | x | |
| | | Order coordination and project support (GAHFA) | x | x | x | x | x |
| | | IT technical writer (APO) | | | x | | |
| | | Project monitoring and quality assurance (GAHFA) | | x | x | x | x |
| | | Automotive knowledge management (auto) | | | x | x | x |
| | | Business risk management (SFIA) | | | | x | x |
| | | Business process improvement (SFIA) | | | x | x | |
| | | Education and training management (SFIA) | | | | x | x |
| | | Development and training (SFIA) | | | | x | x |
| | | IT quality management coordinator (APO) | | | x | | |
| | | Customer support and training (GAHFA) | x | x | x | x | x |
| | | Quality management (SFIA) | | | | x | x |
| | | Quality assurance (SFIA) | | x | x | x | x |
| | | Compliance (SFIA) | | x | x | x | x |
| | | Project finalising and billing (GAHFA) | x | x | x | x | x |
| Integrative work contents and soft skills ■ Behavioural and personal skills ■ Cross section and basic work and technical skills ■ Soft and method skills | ICT systems and application development | | | | | | |
| | ICT integration and administration | | | | | | |
| | ICT infrastructure and installation | | | | | | |
| | ICT support and systems service | | | | | | |

| | | biat Uni Flensburg 2004 | L2 | L3 | L4 | L5 | L6/7 |
|---|---|---|---|---|---|---|---|
| ICT business area | Work areas | Fields of activity | | | | (SFIA levels) Skill levels | |

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*Figure 23    Compilation of different European ICT skills frameworks in the work area 'ICT systems and application development'*

**ICT business area** — Skills linked to ...
- Information systems and applications
- Communications systems and applications
- Sector-specific ICT solutions
- Automotive
- Banking and financial services
- Graphic arts and media
- ...
- Internet applications
- E-business and e-commerce
- Data management and databases
- Networks systems
- ICT security solutions
- Business (process) applications
- Industrial IT systems
- Embedded systems and control
- Multimedia applications
- Consumer electronics
- ICT training solutions
- ...

**All sectors/SMLEs**

Integrative work contents and soft skills
- Behavioural and personal skills
- Cross section and basic work and technical skills
- Soft and method skills

| Work areas | Fields of activity | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|
| ICT marketing, consulting and sales | | | | | | |
| ICT business and project management | | | | | | |
| ICT systems and application development | Analysis and consulting (GAHFA) | x | x | x | x | x |
| | IT analysis (bank) | | | x | x | x |
| | Business analysis (SFIA) | | x | x | x | x |
| | Data analysis (SFIA) | x | x | x | x | |
| | Systems and work planning (GAHFA) | x | x | x | x | x |
| | IT systems analyst (APO) | | | x | | |
| | Design and conception (GAHFA) | | x | x | x | x |
| | Project software architecture / application (bank) | | x | x | x | x |
| | Software architecture and design (CS) | | | | x | x |
| | Systems architecture (SFIA) | | | | | x |
| | Systems design (SFIA) | x | x | x | x | x |
| | Methods and tools (SFIA) | | | x | x | x |
| | Component technician (APO) | | | x | | |
| | Database design (SFIA) | x | x | x | x | x |
| | Technical authority (SFIA) | | | | x | x |
| | Media creation (SFIA) | x | x | x | x | x |
| | Multimedia design (CS) | | | | x | x |
| | Product design (CS) | | | | x | x |
| | IT systems developer (APO) | | | x | | |
| | Research and technology development (CS) | | | | x | x |
| | Programming and implementation (GAHFA) | x | x | x | x | x |
| | Software and application development (CS) | | | | x | x |
| | Programming/software development (SFIA) | x | x | x | x | |
| | General software development (media) | | | x | | |
| | IT software developer (APO) | | | x | | |
| | Database developer (APO) | | | x | | |
| | Software development and services (auto) | x | x | x | x | x |
| | User interface developer (APO) | | | x | | |
| | Multimedia and web design (auto) | x | x | | | |
| | Multimedia design (bank) | | x | x | x | |
| | Multimedia developer (APO) | | | x | | |
| | Graphic/media software development (media) | | | x | | |
| | Automotive software engineering (auto) | | | | x | x |
| | Adaptation, testing and release (GAHFA) | x | x | x | x | x |
| | Systems testing (SFIA) | x | x | x | x | x |
| | IT test coordinator (APO) | | | x | | |
| | IT configuration coordinator (APO) | | | x | | |
| | Configuration management and documentation (GAHFA) | x | x | x | x | |
| | Change control (SFIA) | | x | x | x | x |
| ICT integration and administration | | | | | | |
| ICT infrastructure and installation | | | | | | |
| ICT support and systems service | | | | | | |

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| ICT business area | Work areas | Fields of activity | (SFIA levels) Skill levels |
|---|---|---|---|

*Figure 24:    Compilation of different European ICT skills frameworks in the work area 'ICT infrastructure and installation'*

| ICT business area | Work areas | Fields of activity | Skill levels |||||
|---|---|---|---|---|---|---|---|
| | | | L2 | L3 | L4 | L5 | L6 |
| ICT business area ⇩ Skills linked to ... ■ Information systems and applications ■ Communications systems and applications ■ Sector-specific ICT solutions ■ Automotive ■ Banking and financial services ■ Graphic arts and media .. ■ Internet applications ■ E-business and e-commerce ■ Data management and databases ■ Networks systems ■ ICT security solutions ■ Business (process) applications ■ Industrial IT systems ■ Embedded systems and control ■ Multimedia applications ■ Consumer electronics ■ ICT training solutions **All sectors/SMLEs** ⇩ Integrative work contents and soft skills ■ Behavioural and personal skills ■ Cross section and basic work and technical skills ■ Soft and method skills | ICT marketing, consulting and sales | | | | | | |
| | ICT business and project management | | | | | | |
| | ICT systems and application development | | | | | | |
| | ICT integration and administration | | | | | | |
| | ICT infrastructure and installation | Analysis and consulting (GAHFA) | x | x | x | x | x |
| | | IT security coordinator (APO) | | | x | | |
| | | Systems and work planning (GAHFA) | x | x | x | x | x |
| | | Network developer (APO) | | | x | | |
| | | Network planning (SFIA) | | | | x | x |
| | | Communications network design/network design (auto) | | x | x | | |
| | | Radio frequency (RF) engineering (CS) | | | | x | x |
| | | Digital design (CS) | | | | x | x |
| | | Data communications engineering (CS) | | | | x | x |
| | | Digital signal processing application design (CS) | | | | x | x |
| | | Communications network design (CS) | | | | x | x |
| | | Assembly and installation (GAHFA) | x | x | x | x | |
| | | Systems specialist (CS) | | | | x | x |
| | | Network assistance (bank) | x | | | | |
| | | Network installation (bank) | x | x | | | |
| | | Telecommunications installation/assistance (bank) | x | x | | | |
| | | Security technician (APO) | | | x | | |
| | | Industrial IT systems technician (APO) | | | x | | |
| | | Systems installation/decommissioning (SFIA) | | x | x | x | x |
| | | Set-up, integration and configuration (GAHFA) | x | x | x | x | x |
| | | Configuration management (SFIA) | | x | x | x | x |
| | | Network control (SFIA) | | | | x | x |
| | | Capacity management (SFIA) | | | x | x | x |
| | | Security administration (SFIA) | | x | x | x | |
| | | Network management (bank) | | | x | | |
| | | Telecommunications installation (bank) | x | | | | |
| | | System installation (bank) | | | x | | |
| | | Electronic assembly (bank) | x | | | | |
| | | Check, test and documentation (GAHFA) | x | x | x | x | |
| | | Delivery and instruction (GAHFA) | x | x | x | x | |
| | ICT support and systems service | | | | | | |

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| ICT business area | Work areas | Fields of activity | L2 | L3 | L4 | L5 | L6/7 |
|---|---|---|---|---|---|---|---|
| | | | (SFIA levels) Skill levels ||||

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Together the outcomes indicate ICT skill needs at all different levels. Whereas the Career Space results focus on 'professional' skill levels, the Cedefop reports and the SFIA outcomes underline the fact that all ICT work areas contain skill needs either especially at vocational or at all skill levels, e.g. requirement, product and systems analysis (GAHFA), software development and services (auto), sales support (SFIA), network administration (bank), etc.

Following the developed skill model, the framework also considers skill needs in behavioural and personal skills, cross section and basic work and technical skills, and soft and method skills. Like the ICT business, technology and work (sub-)areas in the left column, these skills, summarised as soft skills, are basically relevant in any ICT work area and field of activity. However, it remains a major challenge to define and contextualise the integrative soft skills needed to perform certain work tasks. Correspondingly there is an interdependence of needed soft skills and skill levels.

## 4.2. Description of ICT work tasks within the skills framework

In addition to the generic ICT work areas and fields of activity, detailed work tasks can be aggregated to a structure of generic ICT work tasks in each field of activity and at different skill levels (see report A, p. 60 et seq.). Each of the fields of activity covers (an open-ended) set of characteristic work tasks to be carried out, by one or two practitioners. The link between these work tasks and skills is based on the assumption that ICT skills can be understood as the requirement to carry out work tasks in a competent, thorough and efficient manner. Just as the work areas and fields of activity are the basis for the overall framework of required ICT skills, these generic ICT work tasks are the basis for the work-oriented description of ICT skill needs in detail, i.e. for the concrete description of ICT skills profiles (see the following sections).

The work tasks listed below cover those described in report A (p. 69 et seq.) and the automotive industry report B (p. 84 et seq.). The work tasks are formulated to cover different ICT practitioners and skill levels. With regard to the challenge of assigning the work tasks to skill levels, report A states (see p. 54 et seq.):

'ICT practitioners of different skill levels work together in teams. Equally, ICT work areas and fields of activities involve work tasks at all skill levels. However, the detailed case study investigations concentrated especially on ICT work tasks at sub-degree skill levels and input from practitioners with job and training profiles at sub-degree skill levels. Because the levels and contents of ICT work tasks are directly connected with the detail of ICT skill needs at sub-degree level, they have a specific importance for training profiles in each ICT work area. In addition, company evaluation of current ICT training profiles is also relevant to determining skill needs.'

*Figure 25:  ICT work tasks at different skill levels – example: ICT business and project management*

| ICT business area | Work areas | Fields of activity | ICT work tasks and skills | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|---|
| ICT business area — Skills linked to ...<br>■ Information systems and applications<br>■ Communications systems and applications<br>■ Sector-specific ICT solutions<br>■ Automotive<br>■ Banking and financial services<br>■ Graphic arts and media<br>...<br>■ Internet and intranet applications<br>■ E-business and e-commerce<br>■ Data management and databases<br>■ Networks systems and solutions<br>■ ICT security solutions<br>■ Business (process) applications<br>■ Industrial IT systems<br>■ Embedded systems and control<br>■ Multimedia applications<br>■ Consumer electronics<br>■ ICT training solutions<br>■ ...<br>All sectors/SMLEs — Overall and integrative work contents and 'soft skills'<br>■ Behavioural and personal skills<br>■ Cross section and basic work and technical skills<br>■ Soft and method skills | ICT business and project management (B) | Project and resource planning (B.1) | Determine and describe project objectives, work packages, milestones, costs, etc. (B.1.1) |  | x | x | x | x |
| | | | Plan and manage human and ICT system resources and maintain project and customer data (B.1.2) |  | x | x | x |  |
| | | | Coordinate and control external project and outsourcing activities (B.1.3) |  |  | x | x | x |
| | | | Redesign of work processes (auto AKM) |  |  | x | x | x |
| | | Selection and purchasing (B.2) | Identify and describe detailed ICT systems needs (B.2.1) |  | x | x | x |  |
| | | | Compare offers of ICT systems and software solutions (B.2.2) | x | x |  |  |  |
| | | | Purchase and provide ICT systems to the specialist teams (B.2.3) |  | x | x | x |  |
| | | Quotation coordination and project support (B.3) | Coordinate ICT work tasks and the work flow and project progress (B.3.1) |  |  | x | x | x |
| | | | Draft and advise overall data and security concepts (B.3.2) |  |  | x | x |  |
| | | | Adapt and use information and communication platforms (B.3.3) | x | x |  |  |  |
| | | | Investigation of communication structures and information flows (auto AKM) |  |  | x | x | x |
| | | | Design of company communication structures (auto AKM) |  |  | x | x | x |
| | | | Development of knowledge data bases (auto AKM) |  |  | x | x | x |
| | | | Development of tele-cooperation platforms (auto AKM) |  |  | x | x | x |
| | | Order coordination and project support (B.4) | Evaluate and control objectives, outcomes, budget etc. of an ICT project or customer order, e.g. target/actual comparison, use of quality management handbook (B.4.1) |  |  | x | x | x |
| | | | Describe and run measures for the evaluation and assurance of quality, e.g. project, system, product service, etc. (B.4.2) |  | x | x | x |  |
| | | | Document the project and order process as well as quality control and technical checks (B.4.3) | x | x |  |  |  |
| | | | Project management for projects for the safeguarding and documentation of information as well as for the optimisation of document structures (document management) and information flows (auto AKM) |  |  | x | x | x |
| | | Customer support and training (B.5) | Instruct and train customers and users on new or adapted ICT systems and applications (B.5.1) | x | x |  |  |  |
| | | | Manage and provide business support and sustain relationships to customers and users (B.5.2) |  |  | x | x | x |
| | | | Develop and realise escalation plans and handle customer complaints (B.5.3) |  | x | x | x |  |
| | | | Selection, coordination, and introduction of content and collaborate management systems by involving the workforce (auto AKM) |  |  | x | x | x |
| | | Project finalising and billing (B.6) | Finally calculate and fix project and service agreement costs (B.6.1) |  | x | x | x | x |
| | | | Prepare and provide project and billing data to the accountancy (B.6.2) | x | x |  |  |  |

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| ICT business area | Work areas | Fields of activity | ICT work tasks and skills | Skill levels |
|---|---|---|---|---|

| | | | | L2 | L3 | L4 | L5 | L8 |
|---|---|---|---|---|---|---|---|---|
| ⇩ **ICT business area** Skills linked to ... ■ Information systems and applications ■ Communications systems and applications ■ Sector-specific ICT solutions ■ Automotive ■ Banking and financial services ■ Graphic arts and media ... ■ Internet and intranet applications ■ E-business and e-commerce ■ Data management and databases ■ Networks systems and solutions ■ ICT security solutions ■ Business (process) applications ■ Industrial IT systems ■ Embedded systems and control ■ Multimedia applications ■ Consumer electronics ■ ICT training solutions ■ ... **All sectors/ SMLEs** ⇩ Overall and integrative work contents and 'soft skills' ■ Behavioural and personal skills ■ Cross section and basic work and technical skills ■ Soft and method skills | ICT systems and application development (C) | Analysis and consulting (C.1) | Investigate and review ICT systems and application requirements of the client and users (C.1.1) | | x | x | x | x |
| | | | Determine and specify concrete hardware and software needs (C.1.2) | x | x | | | |
| | | | Recommend adequate and tailored ICT solutions to the customer (C.1.3) | | x | x | x | |
| | | | Write (parts of) the technical, ICT system and functional specification (C.1.4) | x | x | x | | |
| | | | Investigation of customer requirements and customer service (auto SDaS) | x | x | x | x | x |
| | | | Description and transfer of customer requirements into IT concepts (auto SDaS) | x | x | x | x | x |
| | | | Analysing company needs and customer interests (auto MaWD) | | x | x | | |
| | | | Identifying requirements for a sufficient transfer of company 'products and know-how' to the customer (auto MaWD) | | x | x | | |
| | | Systems- and work planning (C.2) | Manage and specify own work and project priorities using project management tools (C.2.1) | x | x | x | | |
| | | | Accompany, monitor and lead the development process of the ICT solution and ensure progress, quality, configuration management, etc. (C.2.2) | | | x | x | x |
| | | | Test, choose and set up software and systems development tools (C.2.3) | | x | x | x | |
| | | | Coordination with vehicle engineers in Simultaneous Engineering Teams, project management (auto ASE) | | | | x | x |
| | | Design and conception (C.3) | Define and design the ICT systems and software architecture and distribution (e.g. Client/Server, Mainframe, CORBA) considering latest research results (C.3.1) | | | x | x | x |
| | | | Analyse and define objects, frameworks, basic software classes, systems components, interfaces, etc. (C.3.2) | | | x | x | x |
| | | | Create and specify concepts, prototyping, data structures, access, data base models, etc. (C.3.3) | | x | x | x | |
| | | | Design of software architecture for the control of network operations (auto SDaS) | x | x | x | x | x |
| | | | Building prototypes of software products for the use in systems, design of modules, integration and installation of the modules, executing system integration (auto SDaS) | x | x | x | x | x |
| | | | Designing user interfaces and creating prototypes with various multimedia technologies (auto MaWD) | | x | x | | |
| | | | Design of new solutions for the development of vehicles such as Rapid software prototyping, augmented reality, digital mockup (auto ASE) | | | | x | x |
| | | Programming and implementation (C.4) | Determine and describe software units, methods, attributes, modules, I/O-parameters, etc. (C.4.1) | | x | x | x | x |
| | | | Code, adapt and document systems, software and database applications, e.g. in 3GL and with 4GL IDEs, embedded SQL (C.4.2) | x | x | x | x | x |
| | | | Design, develop and implement graphical user interfaces as well as web-based applications (C.4.3) | | x | x | x | x |
| | | | Programming and testing of company-specific software solutions (auto SDaS) | x | x | x | x | x |
| | | | Developing software for the control of the operation of telecommunication networks (auto SDaS) | x | x | x | x | x |
| | | | Development and integration of solutions for vehicle electronics: operating systems for vehicle control units, bus-systems, diagnosis processes and algorithms, advice for diagnosis, development and adaptation of interfaces, development of chips (auto ASE) | | | | x | x |
| | | Software adaptation and testing (C.5) | Develop and coordinate test procedures and cases (C.5.1) | | | x | x | x |
| | | | Run, interpret and document ICT systems and software tests by using various test tools, methods and data (C.5.2) | x | x | x | x | |
| | | | Describe opportunities and undergo bug-fixing, systems upgrading and software adaptation (C.5.3) | | x | x | x | |
| | | | Redesign of traditional products for the use in multimedia systems (auto MaWD) | | x | x | | |
| | | | Programming and set-up of test environments (HIL, SIL) (auto ASE) | | | | x | x |
| | | Configuration management and documentation (C.6) | Write (parts of) the installation and user instructions and ICT systems and application manuals (C.6.1) | | x | x | x | |
| | | | Document, version and register new systems, software and database applications (configuration- and report management) (C.6.2) | | x | x | | |
| | | | Document the work following overall and company standards, e.g. info and help centre, change management (C.6.3) | x | x | x | | |

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| ICT business area | Work areas | Fields of activity | ICT work tasks and skills | Skill levels | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | L2 | L3 | L4 | L5 | L8 |

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*Figure 26:    ICT work tasks at different levels – example: ICT infrastructure and installation*

| ICT business area | Work areas | Fields of activity | ICT work tasks and skills | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|---|
| **ICT business area** Skills linked to … ■ Information systems and applications ■ Communications systems and applications ■ Sector-specific ICT solutions ■ Automotive ■ Banking and financial services ■ Graphic arts and media – ■ Internet and intranet applications ■ E-business and e-commerce ■ Data management and databases ■ Networks systems and solutions ■ ICT security solutions ■ Business (process) applications ■ Industrial IT systems ■ Embedded systems and control ■ Multimedia applications ■ Consumer electronics ■ ICT training solutions ■ … **All sectors/ SMUEs** Overall and integrative work contents and 'soft skills' ■ Behavioural and personal skills ■ Cross section and basic work and technical skills ■ Soft and method skills | **ICT infrastructure and installation (E)** | Analysis and consulting (E.1) | Advise and influence colleagues and customers on new or extended ICT infrastructure solutions (E.1.1) |  | x | x | x | x |
| | | | Determine, specify and describe technical requirements (E.1.2) | x | x | | | |
| | | | Write (parts of) the ICT infrastructure and functional specification (E.1.3) | | x | x | x | |
| | | | Identification of the needs of data transfer between departments (design and construction, work organisation, production) and/or supplier and manufacturer (auto ND) | | x | x | | |
| | | | Working with staff of different departments to analyse their communication requirements and to determine the optimised cost-effective solution, e.g. for the shop-floor, the communication between suppliers and manufacturers, etc. (auto ND) | | x | x | | |
| | | Systems and work planning (E.2) | Receive, assess and forward new customer orders (E.2.1) | x | x | x | | |
| | | | Arrange the time schedule and coordinate work tasks (E.2.2) | | x | x | x | x |
| | | | Ensure, select and use latest ICT product and service information and requirements, also in foreign languages (E.2.3) | x | x | | | |
| | | | Blueprint and determine ICT systems and network solutions and adaptations including security concept (e.g. firewall, encryption, access authorisation) (E.2.4) | | x | x | x | x |
| | | | Order and dispose systems and installation material, tools, documents and manuals (E.2.5) | | x | x | x | |
| | | | Assisting in the specification of suitable hardware architectures as the basis of networks (auto ND) | | x | x | | |
| | | | Developing software architectures for the efficient use of suppliers and manufacturers (auto ND) | | x | x | | |
| | | | Dimensioning the size of networks for production planning, use for production, use for communication between suppliers and manufacturers (auto ND) | | x | x | | |
| | | Assembly and installation (E.3) | Assemble, install and up-grade ICT systems and networks devices and components (E.3.1) | x | x | | | |
| | | | Plan and ensure ergonomics, interoperability, power supply and security of installed ICT infrastructure, applications and data (E.3.2) | | x | x | x | |
| | | | Manual and automatic installation and configuration of operating systems, applications and communication software, etc. (E.3.3) | x | x | | | |
| | | | Decommission and recycle old ICT infrastructure (E.3.4) | x | x | | | |
| | | Setup, integration and configuration (E.4) | Check, evaluate and adapt ICT systems environment and infrastructure regarding design, performance, systems software and interoperability of systems components and interfaces (E.4.1) | | x | x | x | x |
| | | | Plan, test and document new ICT systems and prototypes in test and real operating environments (E.4.2) | | x | x | x | |
| | | | Undertake systems adaptations by parameterising, updating as well as adapt software applications by using macro- and programming languages (E.4.3) | x | x | | | |
| | | | Providing advice and guidance on the use, operation and design of systems or solutions by using specific products (auto ND) | | x | x | | |
| | | | Providing advice, guidance, and support on the use, operation, and design of systems or systems solutions for the use in different applications (auto ND) | | x | x | | |
| | | Check, test and documentation (E.5) | Test and verify requested function of installed and integrated ICT systems based on given criteria and requirements (E.5.1) | x | x | | | |
| | | | Record, back up and archive systems and configuration data (E.5.2) | | x | x | x | |
| | | | Prepare and compile ICT systems and installation documentations (E.5.3) | | x | x | x | |
| | | Delivery, instruction and finalising (E.6) | Coordinate and deliver installed and integrated ICT systems (E.6.1) | x | x | | | |
| | | | Prepare, compile and adapt user and training documents (E.6.2) | | x | x | x | |
| | | | Instruct ICT support staff and users for new ICT infrastructure, applications and functions (E.6.3) | x | x | x | x | |

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| ICT business area | Work areas | Fields of activity | ICT work tasks and skills | L2 | L3 | L4 | L5 | L6 |
|---|---|---|---|---|---|---|---|---|

Based on the developed proposal for a comprehensive European ICT skills framework, it is now of crucial importance to define ICT skills profiles that structure and standardise skill needs. The following sections look at this profiling process by considering the complex findings of the four Cedefop reports as well as taking into account innovative European qualification opportunities based on the fundamental interaction of identified ICT skill needs and future-oriented training programmes and curricula.

# 5. Matching the skills framework to ICT qualifications

There is consensus that a common European (reference) framework for the recognition of skills and qualifications can efficiently support transparency and mobility in European labour markets. Many current vocational education and training (VET) activities in Europe stress the importance (but also the challenge) of creating mutually recognised frameworks of skills, qualifications and certificates. The most relevant overall example is the initiative to create and implement a single framework document, called new Europass (see European e-skill newsletter, p. 13). A precondition, however, for all such common European qualification activities is a clear picture of skill needs summarised in a comprehensive skills framework, both in terms of relevant skill levels and skills profiles, comprehending and differentiating a set of characteristic occupational skills needs and contents in a clearly defined employment and business segment.

The following paragraphs try to illuminate and constitute generic ICT skills profiles for the ICT business area and transfer the findings towards recommendations on the challenging development process of a new European reference framework of ICT qualifications. Based on the intention of this report, the outcomes focus on skills corresponding to vocational levels but taking into account professional skill and degree qualification levels, chiefly based on the results of Career Space. The essence of the work is the ICT skill needs framework described in the previous sections as well as further findings from the four Cedefop reports in terms of ICT skills profiles.

## 5.1. Matching skill needs to ICT job, skills and qualification profiles

The description and delimitation of ICT skill needs in a 'profiling process' is a major challenge, a precondition of which is the description of ICT skill needs within a comprehensive skills framework. The profiling for different skill levels can first be understood as a standardised definition and qualitative description of current ICT skills and profile needs. The profiles cover industry needs for ICT skills and practitioners in ICT and user sectors across Europe, in particular for small and medium size enterprises. Second, because these occupational ICT skills standards ought to decrease the mismatch in regard to existing ICT qualifications, the results can be understood as an important precondition and reference for developing new European ICT curriculum guidelines, especially for vocational sub-degree levels and complementary to the Career Space recommendations for degree level curricula.

To begin, current ICT job titles and ICT qualifications with respect to training profiles in Europe were listed and evaluated at all qualification levels and assigned to the ICT skills

framework. It cannot be ignored that numerous ICT qualifications at all levels exist in Europe following different and historically developed strategies. It was important for the Cedefop reports to analyse and evaluate the current situation and offers in ICT training and qualification programmes, e.g. training objectives, main contents, range of skills and knowledge, etc.

Furthermore in work practice there is an even greater number of ICT job titles and functions, describing the tasks and skills practitioners need to perform in everyday work. Gathering and investigating these job roles is an important indicator for the profiling process within a skills framework. It becomes obvious that the job roles vary in terms of breadth and depth of the areas and tasks associated with the jobs. For instance, in smaller companies the job roles usually cover broader ICT work areas and fields of activity. However, since the job titles chiefly represent work responsibilities of specific companies or ICT business areas, they need to be abstracted and rearranged to overall occupational and skills profiles, considering the empirical findings in terms of ICT skill needs and levels.

*Figure 27:    Map of ICT job titles and qualifications at different levels within the ICT skills framework – Part 1*

| ICT business area | Work areas | Fields of activity | Current ICT job titles/ICT qualifications | | | | |
|---|---|---|---|---|---|---|---|
| | | | L2 | L3 | L4 | L5 / L5B | L6 / L5M |
| **ICT business area**<br>Skills linked to ...<br>■ Information systems and applications<br>■ Communications systems and applications<br>■ Sector-specific ICT solutions<br>■ Internet applications<br>■ E-business and e-commerce<br>■ Data management<br>■ Networks systems<br>■ ICT security solutions<br>■ Business applications<br>■ Industrial IT systems<br>■ Embedded systems<br>■ Multimedia applications<br>■ Consumer electronics<br>■ ICT training solutions<br>**All sectors/ SMLEs** | **ICT marketing, consulting and sales** | Market analysis and benchmarks<br>Advertising and consumer promotion<br>Customer consulting and acquisition<br>Requirement, product and systems analysis<br>Conception and documentation of ICT solutions<br>Quotation processing and contracting | e.g.<br>ICT business assistant<br>Software marketing assistant<br>/<br>Assistant for business informatics (D)<br>Intermediate BTEC call handling (UK) | e.g.<br>Web applications consultant<br>ICT marketing technician<br>ICT sales supporter<br>/<br>Database management - Micro systems (P)<br>IT system support specialist (D) | e.g.<br>ICT sales account manager<br>ICT marketing specialist<br>E-commerce consultant<br>Product manager internet services<br>/<br>Business manager in business informatics (D)<br>Administrator ICT (NL) | e.g.<br>Communications marketing manager<br>Software sales manager<br>Key account manager<br>/<br>Informatics management engineer (P)<br>Business administration informatics (NL) | e.g.<br>Product manager<br>ICT consultant<br>Web content strategist<br>/<br>Informatics and economics (NL)<br>Information and management (P) |
| | **ICT business and project management** | Project and resource planning<br>Selection and purchasing<br>Order coordination and project support<br>Project monitoring and quality assurance<br>Customer support and training<br>Project finalising and billing | e.g.<br>ICT project assistant<br>Office supporter<br>E-commerce production assistant<br>/<br>Commercial assistant for information processing (D) | e.g.<br>Office manager<br>Website coordinator<br>Data warehousing consultant<br>/<br>Information technology officer (D)<br>Managing IT for teleworking (NVQ UK) | e.g.<br>Line manager<br>ICT project manager<br>ICT content manager<br>ICT quality manager<br>/<br>Business manager in data processing/ organisation (D)<br>Managing IT systems (NVQ UK) | e.g.<br>Team manager<br>Product planner<br>Knowledge manager<br>/<br>Directing IS strategy (NVQ UK)<br>Computer science economy (D)<br>IT in business (UK) | e.g.<br>Department manager<br>Master scheduler<br>Manager business development<br>/<br>Business information technology (NL)<br>Health informatics (UK) |

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| ICT business area | Work areas | Fields of activity | Current ICT job titles/ICT qualifications | | | | |
|---|---|---|---|---|---|---|---|
| | | | L2 | L3 | L4 | L5 / L5B | L6 / L5M |

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*Figure 28:* *Map of ICT job titles and qualifications at different levels within the ICT skills framework – Part 2*

| ICT business area | Work areas | Fields of activity | Current ICT job titles/ICT qualifications | | | | |
|---|---|---|---|---|---|---|---|
| | | | L2 | L3 | L4 | L5 / L5B | L6 / L5M |
| ICT business area<br><br>Skills linked to ...<br><br>■ Information systems and applications<br>■ Communications systems and applications<br>■ Sector-specific ICT solutions<br>■ Internet applications<br>■ E-business and e-commerce<br>■ Data management<br>■ Networks systems<br>■ ICT security solutions<br>■ Business applications<br>■ Industrial IT systems<br>■ Embedded systems<br>■ Multimedia applications<br>■ Consumer electronics<br>■ ICT training solutions<br><br>**All sectors/ SMLEs** | ICT systems and application development | Analysis and consulting<br><br>Systems and work planning<br><br>Design and conception<br><br>Programming and implementation<br><br>Adaptation, testing and release<br><br>Configuration management and documentation | e.g.<br>VBA programmer<br>Assistant programmer<br>/<br>Technical assistant for informatics (D)<br>Informatics assistant technician (P)<br>Software development (UK iPRO)<br>Developing IT systems (NVQ UK) | e.g.<br>ICT systems developer<br>Software developer<br>Web designer<br>/<br>Information technology specialist in application development (D)<br>Informatics technician (P)<br>Developing IT Systems (NVQ UK) | e.g.<br>Database developer<br>Multimedia programmer<br>Test analyst<br>/<br>Developer software applications (NL)<br>Informatics applications programmer (P)<br>Developing IT systems (NVQ UK) | e.g.<br>Java software developer<br>Web development manager<br>Software developer<br>Database systems programmer<br>/<br>Informatics (P)<br>Informatics multimedia (D) | e.g.<br>Software architect<br>Multimedia architect<br>Java developer<br>Multimedia network designer<br>/<br>Informatics (P)<br>Computer science/ informatics (D) |
| | ICT integration and administration | Planning and installation<br><br>Systems integration and configuration<br><br>Integration and systems testing, release<br><br>Documentation and delivery<br><br>Presentation, training and instruction<br><br>Systems administration and support | e.g.<br>ICT systems supporter<br>PC administrator<br>/<br>Technical assistant for informatics (D)<br>Data processing assistant (P) | e.g.<br>ICT systems tester<br>ICT systems integrator<br>ERP systems administrator<br>/<br>Information technology specialist in system integration (D)<br>Data processing technician (P)<br>Developing IT Systems (NVQ UK) | e.g.<br>Database administrator<br>ICT security administrator<br>ICT systems administrator<br>/<br>Technician in data processing technology (D)<br>Technical informatics (NL) | e.g.<br>Senior support engineer<br>ICT systems consultant<br>ICT security engineer<br>/<br>Higher informatics (NL) | e.g.<br>ICT systems administrator<br>ICT consultant<br>/<br>Engineering of systems (CZ)<br>Informatics (D) |

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| ICT business area | Work areas | Fields of activity | Current ICT job titles/ICT qualifications | | | | |
|---|---|---|---|---|---|---|---|
| | | | L2 | L3 | L4 | L5 / L5B | L6 / L5M |

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*Figure 29: Map of ICT job titles and qualifications at different levels within the ICT skills framework – Part 3*

| ICT business area | Work areas | Fields of activity | Current ICT job titles/ICT qualifications | | | | |
|---|---|---|---|---|---|---|---|
| | | | L2 | L3 | L4 | L5 / L5B | L6 / L5M |
| **ICT business area** Skills linked to ... ■ Information systems and applications ■ Communications systems and applications ■ Sector-specific ICT solutions ■ Internet applications ■ E-business and e-commerce ■ Data management ■ Networks systems ■ ICT security solutions ■ Business applications ■ Industrial IT systems ■ Embedded systems ■ Multimedia applications ■ Consumer electronics ■ ICT training solutions **All sectors/ SMLEs** ⇩ | **ICT infrastructure and installation** | Analysis and consulting | e.g. Systems operator Networks assistant / Informatics assistant technician (P) ICT systems support (UK iPRO) | e.g. Networks technician Communications technician / IT System electronics (D) Craftsman communications networks (NL) ICT systems support (UK iPRO) | e.g. Interfaces specialist Network designer Network manager / Telecommunications and ICT engineer (NL) Technician in information electronics (D) | e.g. Network engineer Data network designer Hardware design engineer R.F. design engineer / Computer science engineering (D) Communications (L5 UK) | e.g. Network analyst Hardware design engineer R.F. designer / Electrical engineering (NL) Optical electronics (D) Informatics systems engineering (NL) |
| | | Systems and work planning | | | | | |
| | | Assembly and installation | | | | | |
| | | Set-up, integration and configuration | | | | | |
| | | Check, test and documentation | | | | | |
| | | Delivery and instruction | | | | | |
| | **ICT support and systems service** | Service management and systems adoption | e.g. ICT service assistant Customer care assistant Help desk operator / ICT service worker (NL) Operating IT systems (NVQ UK) IT systems support technician (UK ITSST) | e.g. Networks fitter Technical supporter Call centre agent customer care / Network maintenance technician (P) Operating IT systems (NVQ UK) IT systems support professional (UK ITSSP) | e.g. ICT service manager Web master Network management specialist / Master information technology (D) IT services - customer systems support (NVQ UK) | e.g. TC systems tester Disaster recovery specialist Customer support engineer / Telecommunications and electronics (P) Higher electronics expert (NL) | e.g. Service analyst Product support specialist / Technical informatics, computer techniques (TI/TC) (NL) Telecommunications and informatics engineering (P) |
| | | Systems upgrading and optimisation | | | | | |
| | | Systems administration and control | | | | | |
| | | Systems support, helpdesk and training | | | | | |
| | | Systems maintenance and documentation | | | | | |
| | | Error diagnosis and troubleshooting | | | | | |
| ICT business area | Work areas | Fields of activity | L2 | L3 | L4 | L5 / L5B | L6 / L5M |

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The four Cedefop reports and the Career Space initiative recognised, defined and described European ICT skills profiles that reflect the skills and knowledge required to carry out a certain set of occupational ICT work tasks. The profiles were assigned to identified work areas at different skill levels with reference to the GAHFA skills framework. Therefore the complete framework summarises all findings in regard to ICT skills profiles, both from a specific sector point of view as well as overall results from ICT and user industries. For example, the profile automotive knowledge management (auto) needs to be considered for the detailed description of the overall profile ICT content and knowledge management at skill level 4. Other examples are multimedia and web design (auto) and multimedia design (bank) that will be part of the overall profile multimedia design at the skill levels 3, 4 and 5.

This work-oriented way of setting and describing occupational standards through the nomination of ICT skills profiles within the skills framework, provides an open platform for updating, developing and assigning ICT skills profiles and therefore flexibly and prospectively responding to emerging ICT skill needs.

*Figure 30: Map of European ICT skills profiles assigned to ICT work areas within the framework – Part 1*



| ICT business area | Work areas | Fields of activity | ICT skills profiles | | | | |
|---|---|---|---|---|---|---|---|
| | | | L2 | L3 | L4 | L5 | L6 |
| ICT business area<br><br>Skills linked to ...<br><br>■ Information systems and applications<br>■ Communications systems and applications<br>■ Sector-specific ICT solutions<br>■ Automotive industries<br>■ Banking and financial services<br>■ Graphic arts and media<br><br>■ Internet applications<br>■ E-business and e-commerce<br>■ Data management<br>■ Networks systems<br>■ ICT security solutions<br>■ Business applications<br>■ Industrial IT systems<br>■ Embedded systems<br>■ Multimedia applications<br>■ Consumer electronics<br>■ ICT training solutions<br><br>**All sectors/ SMLEs** | **ICT marketing, consulting and sales** | Market analysis and benchmarks | | | | | |
| | | Advertising and consumer promotion | | | | | |
| | | Customer consulting and acquisition | ICT marketing, consulting and sales | ICT marketing, consulting and sales | ICT marketing<br><br>ICT consulting<br><br>ICT sales | ICT marketing management (CS)<br><br>ICT sales management (CS)<br><br>IT business consultancy (CS) | ICT marketing management (CS)<br><br>ICT sales management (CS)<br><br>IT business consultancy (CS) |
| | | Requirement, product and systems analysis | | | | | |
| | | Conception and documentation of ICT solutions | | | | | |
| | | Quotation processing and contracting | | | | | |
| | **ICT business and project management** | Project and resource planning | ICT business and project management | ICT business and project management | ICT business management<br><br>ICT project management<br><br>ICT quality management<br><br>ICT content and knowledge management<br><br>E-business management<br><br>Automotive knowledge management (auto)<br><br>Bank e-marketing/ e-business management (bank) | ICT project management (CS)<br><br>ICT management (CS)<br><br>ICT content and knowledge management<br><br>Automotive knowledge management (auto)<br><br>Bank e-marketing / e-business management (bank) | ICT project management (CS)<br><br>ICT management (CS)<br><br>ICT content and knowledge management<br><br>Automotive knowledge management (auto) |
| | | Selection and purchasing | | | | | |
| | | Order coordination and project support | | | | | |
| | | Project monitoring and quality assurance | | | | | |
| | | Customer support and training | | | | | |
| | | Project finalising and billing | | | | | |
| ICT business area | Work areas | Fields of activity | L2 | L3 | L4 | L5 | L6 |
| | | | ICT skills profiles | | | | |

*Figure 31:    Map of European ICT skills profiles assigned to ICT work areas – Part 2*

| ICT business area | Work areas | Fields of activity | ICT skills profiles | | | | |
|---|---|---|---|---|---|---|---|
| | | | L2 | L3 | L4 | L5 | L6 |
| **ICT business area**<br>Skills linked to ...<br><br>■ Information systems and applications<br>■ Communications systems and applications<br>■ Sector-specific ICT solutions<br>■ Automotive industries<br>■ Banking and financial services<br>■ Graphic arts and media<br>■ Internet applications<br>■ E-business and e-commerce<br>■ Data management<br>■ Networks systems<br>■ ICT security solutions<br>■ Business applications<br>■ Industrial IT systems<br>■ Embedded systems<br>■ Multimedia applications<br>■ Consumer electronics<br>■ ICT training solutions<br>**All sectors/ SMLEs** | **ICT systems and application development** | Analysis and consulting<br><br>Systems and work planning<br><br>Design and conception<br><br>Programming and implementation<br><br>Adaptation, testing and release<br><br>Configuration management and documentation | ICT systems and application development<br><br>Software development and services (auto) | ICT systems and application development<br><br>Database development and administration<br><br>Multimedia design<br><br>Software development and services (auto)<br><br>Multimedia and web design (auto)<br><br>Project software architecture/ application (bank)<br><br>Multimedia design (bank) | ICT systems and application development<br><br>Database development<br><br>Business software development<br><br>Web design<br><br>Multimedia design<br><br>Communication network development<br><br>Software development and services (auto)<br><br>Multimedia and web design (auto)<br><br>IT analysis (bank)<br><br>Project software architecture / application (bank)<br><br>Multimedia design (bank)<br><br>General software development (media)<br><br>Graphic/media software development (media) | Research and technology development (CS)<br><br>Software and application development (CS)<br><br>Software architecture and design (CS)<br><br>Multimedia design (CS)<br><br>Product design (CS)<br><br>Software development and services (Auto)<br><br>Automotive software engineering (auto)<br><br>IT analysis (bank)<br><br>Project software architecture / application (bank)<br><br>Multimedia design (bank) | Research and technology development (CS)<br><br>Software and application development (CS)<br><br>Software architecture and design (CS)<br><br>Multimedia design (CS)<br><br>Product design (CS)<br><br>Software development and services (auto)<br><br>Automotive software engineering (auto)<br><br>IT analysis (bank)<br><br>Project software architecture / application (bank) |
| | **ICT integration and administration** | Planning and installation<br>Systems integration and configuration<br>Integration and systems testing, release<br>Documentation and delivery<br>Presentation, training and instruction<br>Systems administration and support | ICT integration and administration<br><br>ICT systems integration (media) | ICT integration and administration<br><br>ICT systems integration (media) | ICT integration and administration<br><br>Database administration<br><br>ICT testing<br><br>Web system specialist (bank) | Integration and test/ implementation and Test engineering (CS)<br><br>Web system specialist (bank) | Integration and test/ implementation and test engineering (CS)<br><br>Web system specialist (bank) |
| | | | L2 | L3 | L4 | L5 | L6 |

*Figure 32:    Map of European ICT skills profiles assigned to ICT work areas – Part 3*

| ICT business area | Work areas | Fields of activity | ICT skills profiles | | | | |
|---|---|---|---|---|---|---|---|
| | | | L2 | L3 | L4 | L5 | L6 |
| **ICT business area**<br><br>⇩<br><br>Skills linked to …<br><br>■ Information systems and applications<br><br>■ Communications systems and applications<br><br>■ Sector-specific ICT solutions<br><br>■ Automotive industries<br><br>■ Banking and financial services<br><br>■ Graphic arts and media<br><br>■ Internet applications<br><br>■ E-business and e-commerce<br><br>■ Data management<br><br>■ Networks systems<br><br>■ ICT security solutions<br><br>■ Business applications<br><br>■ Industrial IT systems<br><br>■ Embedded systems<br><br>■ Multimedia applications<br><br>■ Consumer electronics<br><br>■ ICT training solutions<br><br>**All sectors/ SMLEs**<br>⇩ | **ICT infrastructure and installation** | Analysis and consulting | ICT infrastructure and installation<br><br>Network installation<br><br>Network assistance (bank)<br><br>Network installation (bank)<br><br>Telecommunications installation/ assistance (bank) | ICT infrastructure and installation<br><br>Network planning and installation<br><br>Communications planning and installation<br><br>Communications network/ network design (auto)<br><br>Network installation (bank)<br><br>Telecommunications installation (bank)<br><br>Telecommunications installation (bank)<br><br>Electronic assembly (bank) | ICT infrastructure and installation<br><br>Network design and installation<br><br>ICT industrial systems design<br><br>ICT consumer electronics design<br><br>ICT security design<br><br>Communications network design/ network design (auto)<br><br>Network management (bank)<br><br>System installation (bank) | Systems specialist (CS)<br><br>Radio frequency (RF) engineering (CS)<br><br>Digital design (CS)<br><br>Data communications engineering (CS)<br><br>Digital signal processing application design (CS)<br><br>Communications network design (CS) | Systems specialist (CS)<br><br>Radio frequency (RF) engineering (CS)<br><br>Digital design (CS)<br><br>Data communications engineering (CS)<br><br>Digital signal processing application design (CS)<br><br>Communications network design (CS) |
| | | Systems and work planning | | | | | |
| | | Assembly and installation | | | | | |
| | | Set-up, integration and configuration | | | | | |
| | | Check, test and documentation | | | | | |
| | | Delivery and Instruction | | | | | |
| | **ICT support and systems service** | Service management and systems adoption | ICT support and systems service<br><br>ICT user support<br><br>Call centre operation (bank)<br><br>Customer care assistance (bank) | ICT support and systems service<br><br>Network administration<br><br>Web administration<br><br>Automotive technical support (auto)<br><br>Call centre operation (bank)<br><br>Web administration (bank)<br><br>Network administration (bank)<br><br>Customer care assistance (bank)<br><br>Technical support (bank)<br><br>Network administration (media) | ICT support and systems service<br><br>Network administration<br><br>Database administration<br><br>ICT training<br><br>ICT operation<br><br>Automotive technical supporter (auto)<br><br>Web administration (bank)<br><br>Network administration (bank)<br><br>Network administration (bank)<br><br>Technical support (bank)<br><br>Network administration (media) | Technical support (CS)<br><br>Network administration (bank)<br><br>Technical support (bank) | Technical support (CS) |
| | | Systems upgrading and optimisation | | | | | |
| | | Systems administration and control | | | | | |
| | | Systems support, helpdesk and training | | | | | |
| | | Systems maintenance and documentation | | | | | |
| | | Error diagnosis and troubleshooting | | | | | |
| | | | L2 | L3 | L4 | L5 | L6 |
| ICT business area | Work areas | Fields of activity | ICT skills profiles | | | | |

## 5.2.   Description and maintenance of generic ICT skills profiles

The final version of the ICT skills framework covers all those ICT skills profiles that offer a clear work, task and level description and have a delimitation to other skills profiles. The specification of ICT skills profiles is based on a work-oriented analysis of all described ICT skills profiles covered by the reports and studies. Essential to this profiling work are the identified ICT work areas and fields of activity of the GAHFA skill model. Thus, for this final profiling process, decisions had to be made that cover all ICT skill needs at different levels of the ICT and ICT user industries. The complete ICT skills framework including the results of the Career Space work consists of the following number of profiles:

(a)   eight generic ICT skills profiles at skill level 2;

(b)   12 generic ICT skills profiles at skill level 3;

(c)   27 generic ICT skills profiles at skill level 4;

(d)   20 generic ICT skills profiles each at skill levels 5 and 6 (mainly Career Space (CS) results plus two exemplary ICT skills profiles from the automotive report).

One major result of the profiling process is that the ICT skills profiles at levels 2 and 3 cover broader technical skill sets than those of levels 4, 5 and 6. Therefore, ICT practitioners working at level 2 or 3 are not so specialised that their skills profile can cover a complete work area, e.g. ICT marketing, consulting and sales or ICT business and project management. In the work areas ICT systems and application development, ICT infrastructure and installation and ICT support and systems service, further differentiation has been identified, e.g. in database development and administration or multimedia design. However, a far clearer specialisation of the decisive technical ICT skills takes place at skill level 4, leading to a total of 27 generic ICT skills profiles, as in the differentiation of the three profiles ICT marketing, ICT consulting and ICT sales.

The complete skills framework contains a list of ICT business (sub-)areas to which the skills profiles refer depending on criteria such as sector, ICT business area, products and services. This means that technical skills, for instance in ICT systems and application development, always have a crosslink to one of the ICT business areas such as information systems and applications, communications systems and applications, Internet and intranet applications, etc. Other profiles, such as database development and administration or network planning and installation, are already more closely linked to a concrete business area. Furthermore, each skills profile covers certain soft skills depending on the work area and skills level.

*Figure 33:    European ICT (reference) skills framework with all generic ICT skills profiles
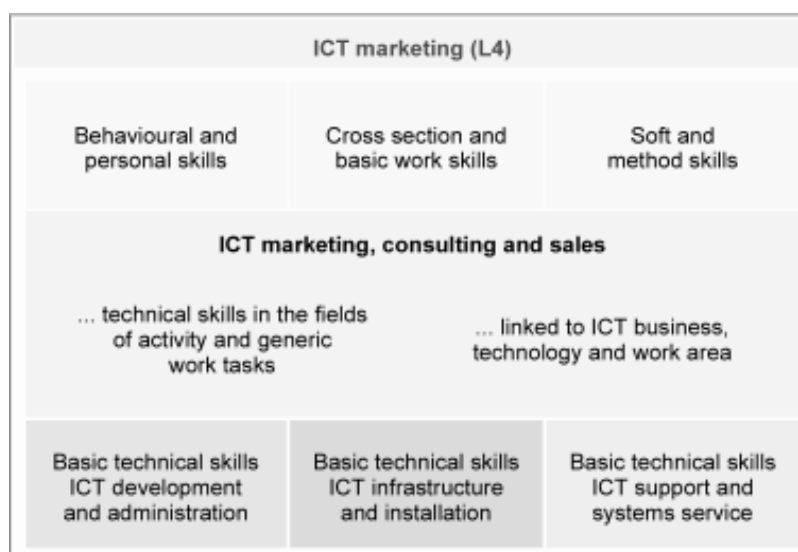(CS; Career Space)*

Based on the general ICT skills model introduced in Section 3.3., the skills profiles can be described in more detail. Thereafter four skill categories were defined. The primary part of a skills profile is the 'technical skills kernel' related to the fields of activity and generic ICT work tasks linked to the ICT business, technology and work area specific to the company business areas and sector (see for each profile below).

To meet the work requirements and skill needs in these generic ICT work areas demands complementary basic behavioural and personal skills, according to the concrete work tasks and the skill level. ICT practitioners need some overall understanding of ICT business and work processes as a whole, so basic technical skills are required in all work areas of the ICT business area. Therefore, each ICT skills profile covers also cross work area ICT skills expressed by the other groups of generic ICT work areas. These basic technical skills ensure overall ICT business and work process competences in ICT practitioners and also depend on the concrete work requirements and the skill level.

The following examples of generic ICT skills profiles are described in more detail subsequently:

(a)   ICT marketing at skill level 4;

(b)   ICT content and knowledge management at skill level 4;

(c)   ICT systems and application development at skill level 4;

(d)   ICT systems and application development at skill level 3;

(e)   ICT systems and application development at skill level 2;

(f)   ICT integration and administration at skill level 3;

(g)   ICT infrastructure and installation at skill level 2;

(h)   ICT support and systems service at skill level 3.


*Figure 34:    Generic ICT skills profile: ICT marketing at skill level 4*

In accordance with the underlying skill model, as well as the description of the generic ICT skills profiles of Career Space, the skills profiles below provide a comprehensive description of the following:

(i)    the title and level of the generic ICT skills profile;

(j)    examples of job titles and existing qualifications in European countries associated with the skills profile;

(k)    a work and profile description;

(l)    a list of complementary soft skills;

(m)   technical ICT skills in the fields of activity and generic work tasks linked to the ICT business, technology and work area;

(n)    the cross work area technical basic ICT skills complementary to the technical ICT skills;

(o)    a career roadmap and future work opportunities.

*Figure 35:    Generic ICT skills profile: ICT marketing at skill level 4 (in detail)*

**1. Generic ICT skills profile**

ICT marketing (L4)

**2. Examples of job titles and qualifications (country)**

- ICT marketing specialist
- ICT commerce specialist
- Manager in business informatics (D)
- E-marketing developer (D)

**3. Work and profile description**

'ICT marketing, consulting and sales' is a comprehensive work area covering commercial and consultancy activities with special focus on information and communications technology (ICT) projects, products and services. At first sight this generic ICT work area seems to apply to the ICT industry only, but for instance structural changes in companies of the ICT user industries (keyword: profit centre organisation) lead to a strengthened consideration of such work areas. Increasingly 'internal' customers of ICT departments (e.g. in banks, insurance companies, industry departments like accounting, production, etc.) have the same requirements as external customers have of their ICT suppliers in terms of the provision of advice and guidance on how to support their business processes through the effective use of ICT products and services. Therefore although this work area covers mainly work processes of the ICT industry, it partly also covers those of ICT user industries.

The successful marketing of ICT products and services requires fundamental analyses of external and internal market and customer needs. The most important step, however, is to translate these requirements into services and products that answer specific customer needs while providing benefits to the company or department at the same time. Common goals of more business and technical orientated ICT practitioners is a clear description of the business requirements within the 'technical specification' of the ICT solution to be developed. This combination of business and technical tasks asks for specific skills and justifies the elaboration and delimitation of the two generic ICT work areas and corresponding skills profiles at different skill levels.

ICT marketing activities (in conjunction with ICT sales) guarantee the work flow success from the very first steps like 'ICT market analysis and -benchmarks' to the 'conception and documentation of ICT solutions'. Within these different phases of activity and responsibilities ICT marketing practitioners closely collaborate with internal and external ICT experts, providers and customers in order to ensure a solid market position of the company's ICT solutions and services.

**4. Soft skills**

| Behavioural and personal skills | Cross section and basic work skills | Soft and method skills |
|---|---|---|
| - Flexibility<br>- Stress resistant and emotion<br>- Responsibility<br>- Managing risks<br>- Decision making<br>- Negotiation<br>- Influence and persuasiveness<br>- Professional attitude | - Quality awareness<br>- Commercial and market awareness<br>- Entrepreneurship<br>- Customer orientation and relationship<br>- Company and business organisation<br>- Work and project organisation<br>- Work safety and health protection<br>- Labour law and data privacy<br>- Environmental and resource awareness | - Communication<br>- Languages and culture<br>- Collaboration and interaction<br>- Teamwork and mentoring<br>- Conflict and consensus<br>- Creative and innovation<br>- Problem analysis and solving<br>- Strategy, conception and planning<br>- Documentation and presentation |

**5. ICT marketing skills**

| ... in regard to the fields of activity and generic work tasks | ... linked to the ICT business and technology areas |
|---|---|
| - Market analysis and -benchmarks<br>  o Obtain, analyse and prepare tailored ICT market, product and service information<br>  o Contribute to, edit and review an ICT business and project plan<br>- Advertising and consumer promotion<br>  o Establish, describe and present ICT marketing and sales objectives and strategies (e.g. strategic planning, e-marketing and e-sales, network marketing and sales, direct marketing and sales)<br>  o Organise, coordinate and carry out ICT marketing and sales campaigns, e.g. fair exhibitions, company and product brochures, advertising texts<br>- Customer consulting and acquisition<br>  o Receive, assess and forward customer inquiries<br>  o Analyse and evaluate ICT systems and applications demand of customers<br>  o Meet customers and colleagues and present tailored ICT solutions<br>- Requirement, product and systems analysis<br>  o Investigate ICT business processes and determine requirement specifications<br>  o Coordinate, carry out and review financial and cost-benefit analyses<br>- Conception and documentation of ICT solutions<br>  o Formulate overall data base structures using various data models<br>  o Prepare and administer product- and project specific documentations and manuals | - Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems, etc.)<br>- Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data, etc.)<br><br>- Sector-specific ICT solutions (automotive industry, financing and banking, graphic/media industry, health, etc.)<br>- Internet and intranet systems and applications (web design, service providing, etc.)<br>- E-business and e-commerce solutions (B2B, B2C, etc.)<br>- Data management and database solutions (process databases, backup and recovery systems, etc.)<br>- Networks systems and solutions (LAN, ATM, etc.)<br>- ICT security solutions (antivirus, firewall, VPN, etc.)<br>- Business (process) systems and applications (CRM, ERP, etc.)<br>- Industrial IT systems (industrial and process automation, etc.)<br>- Embedded systems and control (diagnostics, monitoring, etc.)<br><br>- Multimedia systems and applications (video, simulations, etc.)<br>- Consumer and entertainment electronics (computer games, etc.)<br>- ICT training solutions (customer seminars, blended learning, etc.)<br>- ... |

**6. Cross work area/basic technical ICT skills**

| ICT development and administration | ICT infrastructure and installation | ICT support and systems service |
|---|---|---|
| - Differentiate and describe the architecture of ICT systems and software solutions (e.g. Client-Server, Mainframes, Web Services)<br>- Differentiate technologies of ICT systems and software design (e.g. machine-intimate, object-orientation, 4GL, 3GL)<br>- Describe ICT systems and software requirements (e.g. systems software, application software, communication software, specific applications, databases, security systems)<br>- Adapt databases (e.g. mainly SQL in MS Access, SQL-Server, MySQL) | - Provide, install and up-grade basic ICT systems (e.g. PCs, printers, servers, operating systems, drivers, communications systems)<br>- Differentiate and describe important interface and bus systems (e.g. RS-232, RS-485, ISA, PCI/AGP, SCSI, USB)<br>- Differentiate and describe ICT infrastructure and network structures and technologies (e.g. LAN, WLAN, ATM, Ethernet, Token Ring, ISDN)<br>- Arrange and run the delivery of ICT systems and infrastructure solutions | - Calculate and monitor standard ICT service and support activities (e.g. hotlines, user help desk, internet and intranet forum)<br>- Describe support, service and communication channels (e.g. customers, business partners, suppliers, colleagues)<br>- Up-date and optimise basic ICT systems (e.g. hardware, operating systems, drivers, firmware)<br>- Undergo simple troubleshooting and maintenance procedures (e.g. for PCs, printers, databases, networks, communications systems, standard software applications) |

**7. Career roadmap and future opportunities**

Due to the rapid developments in technologies, methods and process organisation, practitioners working in 'ICT marketing' must be aware of the need for lifelong learning (LLL) both in terms of more informatics and technology subjects, but chiefly economic technical aspects like market developments and trends. Based on some years work and project experience in ICT marketing next stage of a career in the work area 'ICT marketing, consulting and sales' is described in the relevant ICT skill profiles at degree level 5, e.g. Career Space. This role for instance involves more responsible consulting and strategic work, e.g. marketing and sales strategies, product management, external product promotion.

*Figure 36:    Generic ICT skills profile: ICT content and knowledge management*

**1. Generic ICT skills profile**

ICT content and knowledge management (L4)

**2. Examples of job titles and qualifications (country)**

- Automotive knowledge manager
- Intranet knowledge manager
- Business manager in business informatics (D)
- Information management (CZ)

**3. Work and profile description**

'ICT content and knowledge management' covers the design and development of technical solutions to support business processes in an organisation based on ICT knowledge management systems. As user and customer specific solution developers the ICT practitioners carrying out this work arrange the solutions in cooperation with the user department (or company) and the ICT developers (e.g. software developers).

For instance, automotive knowledge manager deal with the key know-how of a company (manufacturer or repair workshop) and process this information with the aid of databases. A transparent documentation is the challenged to be tackled. The most important tasks are the compilation of process oriented data, an access-friendly data processing and the safeguarding of a flawless information flow.

**4. Soft skills**

| Behavioural and personal skills | Cross section and basic work skills | Soft and method skills |
| --- | --- | --- |
| - Flexibility<br>- Stress resistant and emotion<br>- Responsibility<br>- Managing risks<br>- Decision making<br>- Negotiation<br>- Influence and persuasiveness<br>- Professional attitude | - Quality awareness<br>- Commercial and market awareness<br>- Entrepreneurship<br>- Customer orientation and relationship<br>- Company and business organisation<br>- Work and project organisation<br>- Work safety and health protection<br>- Labour law and data privacy<br>- Environmental and resource awareness | - Communication<br>- Languages and culture<br>- Collaboration and interaction<br>- Teamwork and mentoring<br>- Conflict and consensus<br>- Creative and innovation<br>- Problem analysis and solving<br>- Strategy, conception and planning<br>- Documentation and presentation |

**5. ICT content and knowledge management skills**

| ... in regard to the fields of activity and generic work tasks | ... linked to the ICT business and technology areas |
| --- | --- |
| - Project and resource planning<br>  ○ Determine and describe project objectives, work packages, milestones, costs, etc.<br>  ○ Re-design of work processes<br>- Selection and purchasing<br>  ○ Purchase and provide ICT systems to the specialist teams<br>- Quotation coordination and project support<br>  ○ Coordinate ICT work tasks and the work flow and project progress<br>  ○ Investigation of communication structures and information flows<br>  ○ Design of company communication structures<br>  ○ Development of knowledge data bases<br>  ○ Development of tele-cooperation platforms<br>- Order coordination and project support<br>  ○ Describe and run measures for the evaluation and assurance of quality, e.g. project, system, product service, etc.<br>  ○ Project management for projects for the safeguarding and documentation of information as well as for the optimisation of document structures (document management) and information flows<br>- Customer support and training<br>  ○ Manage and provide business support and sustain relationships to customers and users<br>  ○ Selection, coordination and introduction of content and collaborate management systems by involving the workforce<br>- Project finalising and billing<br>  ○ Finally calculate and fix project and service agreement costs | - Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems, etc.)<br>- Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data, etc.)<br><br>- Sector-specific ICT solutions (automotive industry, financing and banking, graphic/media industry, health, etc.)<br>- Internet and intranet systems and applications (web design, service providing, etc.)<br>- E-business and e-commerce solutions (B2B, B2C, etc.)<br>- Data management and database solutions (process databases, backup and recovery systems, etc.)<br>- Networks systems and solutions (LAN, ATM, etc.)<br>- ICT security solutions (antivirus, firewall, VPN, etc.)<br>- Business (process) systems and applications (CRM, ERP, etc.)<br>- Industrial IT systems (industrial and process automation, etc.)<br>- Embedded systems and control (diagnostics, monitoring, etc.)<br><br>- Multimedia systems and applications (video, simulations, etc.)<br>- Consumer and entertainment electronics (computer games, etc.)<br>- ICT training solutions (customer seminars, blended learning, etc.)<br>- ... |

**6. Cross work area/basic technical ICT skills**

| ICT development and administration | ICT infrastructure and installation | ICT support and systems service |
| --- | --- | --- |
| - Differentiate and describe the architecture of ICT systems and software solutions (e.g. client-server, mainframes, web services)<br>- Differentiate technologies of ICT systems and software design (e.g. machine-intimate, object-orientation, 4GL, 3GL)<br>- Describe ICT systems and software requirements (e.g. systems software, application software, communication software, specific applications, databases, security systems)<br>- Adapt databases (e.g. mainly SQL in MS Access, SQL-Server, MySQL) | - Provide, install and up-grade basic ICT systems (e.g. PCs, printers, servers, operating systems, drivers, communications systems)<br>- Differentiate and describe important interface and bus systems (e.g. RS-232, RS-485, ISA, PCI/AGP, SCSI, USB)<br>- Differentiate and describe ICT infrastructure and network structures and technologies (e.g. LAN, WLAN, ATM, Ethernet, Token Ring, ISDN)<br>- Arrange and run the delivery of ICT systems and infrastructure solutions | - Calculate and monitor standard ICT service and support activities (e.g. hotlines, user help desk, internet and intranet forum)<br>- Describe support, service and communication channels (e.g. customers, business partners, suppliers, colleagues)<br>- Up-date and optimise basic ICT systems (e.g. hardware, operating systems, drivers, firmware)<br>- Undergo simple troubleshooting and maintenance procedures (e.g. for PCs, printers, databases, networks, communications systems, standard software applications) |

**7. Career roadmap and future opportunities**

Due to the rapid developments and changes in technologies, methods and process organisation, 'ICT content and knowledge management' practitioners must be aware of the need for lifelong learning (LLL) both in terms of primary ICT technical subjects as well as overall aspects like ICT business process and market developments and trends.

*Figure 37:*    *Generic ICT skills profile in ICT systems and application development at skill levels 4, 3 and 2*

*Figure 38:  Generic ICT skills profiles: ICT systems and application development levels 4, 3 and 2*

**1. Generic ICT skills profile**

ICT systems and application development (L4)

**2. Examples of job titles and qualifications (country)**

- Database developer
- Software developer
- Test analyst

- Technician in data processing technology (D)
- Developer software applications (NL)
- Informatics applications programmer (P)

**3. Work and profile description**

'ICT systems and application development' is a comprehensive work area covering far more than just mere individual programming or coding. In this work area informatics practitioners work in systems and software development teams that design, realise, update, test, integrate and maintain individual, enterprise, customer, sector-specific and standard applications using existing modelling and engineering methods, development tools and languages, (O).D.B.M.S. (object-orientated) database management system), etc. Depending on the real ICT business area the work can cover also embedded systems solutions, specific telecommunications applications, multimedia and internet applications, etc. The work tasks are carried out based on comprehensive analyses and descriptions of what is needed by the market, a specific sector or a specific customer. Informatics practitioners at this skill level take over responsible parts in this work, usually as self-organised team members. In practise permanent contacts to the project and team manager and ICT business and technical practitioners within or without the company are important, e.g. ICT consultants, ICT infrastructure practitioners, research groups, etc. In the daily work processes the transfer of the technical and business requirements to be clearly defined in the 'technical specification' into a consistent 'data processing specification' is crucial for the final success of ICT systems and application development as well as the final integration and deployment process. Primary criteria for the software solutions are reliability and usability. Furthermore the work as part of a team often runs under time constraints and must be constantly well communicated, reported and documented.

**4. Soft skills**

| Behavioural and personal skills | Cross section and basic work skills | Soft and method skills |
|---|---|---|
| - Flexibility<br>- Stress resistant and emotion<br>- Responsibility<br>- Managing risks<br>- Decision making<br>- Negotiation<br>- Influence and persuasiveness<br>- Professional attitude | - Quality awareness<br>- Commercial and market awareness<br>- Entrepreneurship<br>- Customer orientation and relationship<br>- Company and business organisation<br>- Work and project organisation<br>- Work safety and health protection<br>- Labour law and data privacy<br>- Environmental and resource awareness | - Communication<br>- Languages and culture<br>- Collaboration and interaction<br>- Teamwork and mentoring<br>- Conflict and consensus<br>- Creative and innovation<br>- Problem analysis and solving<br>- Strategy, conception and planning<br>- Documentation and presentation |

**5. ICT systems and application development skills**

| ... in regard to the fields of activity and generic work tasks | ... linked to the ICT business and technology areas |
|---|---|
| - Analysis and consulting<br>  o Investigate and review ICT systems and application requirements of the client and users<br>  o Recommend an adequate and tailored ICT solution to the customer<br>  o Write (parts of) the technical, ICT system and functional specification<br>- Systems- and work planning<br>  o Manage and specify own work and project priorities using project management tools<br>  o Accompany, monitor and lead the development process of the ICT solution and ensure progress, quality, configuration management, etc.<br>  o Test, choose and set up software and systems development tools<br>- Design and conception<br>  o Define and design the ICT systems and software architecture and distribution (e.g. client-server, mainframe, CORBA) considering latest research results<br>  o Analyse and define objects, frameworks, basic software classes, systems components, interfaces, etc.<br>- Programming and implementation<br>  o Determine and describe software units, methods, attributes, modules, I/O-parameters, etc.<br>  o Code, adapt and document systems, software and database applications, e.g. in 3GL and with 4GL IDEs, embedded SQL<br>  o Design, develop and implement graphical user interfaces as well as web-based applications<br>- Software adaptation and testing<br>  o Develop and coordinate test procedures and cases<br>  o Run, interpret and document ICT systems and software tests by using various test tools, methods and data<br>  o Describe opportunities and undergo bug-fixing, systems upgrading and software adaptation<br>- Configuration management and documentation<br>  o Write (parts of) the installation and user instructions and ICT systems and application manuals<br>  o Document, version and register new systems, software and database applications (configuration and report management)<br>  o Document the work following overall and company standards, e.g. info and help centre, change management | - Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems, etc.)<br>- Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data, etc.)<br><br>- Sector-specific ICT solutions (automotive industry, financing and banking, graphic/media industry, health, etc.)<br>- Internet and intranet systems and applications (web design, service providing, etc.)<br>- E-business and e-commerce solutions (B2B, B2C, etc.)<br>- Data management and database solutions (process databases, backup and recovery systems, etc.)<br>- Networks systems and solutions (LAN, ATM, etc.)<br>- ICT security solutions (antivirus, firewall, VPN, etc.)<br>- Business (process) systems and applications (CRM, ERP, etc.)<br>- Industrial IT systems (industrial and process automation, etc.)<br>- Embedded systems and control (diagnostics, monitoring, etc.)<br><br>- Multimedia systems and applications (video, simulations, etc.)<br>- Consumer and entertainment electronics (computer games, etc.)<br>- ICT training solutions (customer seminars, blended learning, etc.)<br>- ... |

**6. Cross work area/basic technical ICT skills**

| ICT commerce and business | ICT infrastructure and installation | ICT support and systems service |
|---|---|---|
| - Compare standard and specific ICT solutions (e.g. performance, business areas, architecture, efficiency, profitability)<br>- Describe the impact of innovative ICT developments (e.g. hardware, software, internet, services)<br>- Collaborate within customers quotations, consulting, contracting and project processing<br>- Self-responsible and project related support of customers and users<br>- Provide project data for the invoicing and accountancy | - Provide, install and up-grade basic ICT systems (e.g. PCs, printers, servers, operating systems, drivers, communications systems)<br>- Differentiate and describe important interface and bus systems (e.g. RS-232, RS-485, ISA, PCI/AGP, SCSI, USB)<br>- Differentiate and describe ICT infrastructure and network structures and technologies (e.g. LAN, WLAN, ATM, Ethernet, Token Ring, ISDN)<br>- Provide and connect basic communications and telephone systems (e.g. analogue, modems, ISDN, DSL) | - Calculate and monitor standard ICT service and support activities (e.g. hotlines, user help desk, internet and intranet forum)<br>- Describe support and communication channels (e.g. customers, business partners, suppliers, colleagues)<br>- Up-date and optimise basic ICT systems (e.g. hardware, operating systems, drivers, firmware)<br>- Undergo simple troubleshooting and maintenance procedures (e.g. for PCs, printers, databases, networks, communications systems, standard software applications) |

**7. Career roadmap and future opportunities**

Due to the rapid developments and changes in technologies, methods and process organisation, practitioners in 'ICT systems and application development' must be aware of the need for lifelong learning (LLL) both in terms of primary informatics and technology subjects as well as overall aspects like ICT business process and market developments and trends. Based on some years work and project experience at this skill level next stage of a career in the work area 'ICT systems and application development' is described in the ICT skill profiles at skill level 5. This role, on the one hand, involves more self organised and responsible project management and commercial work and, on the other hand, the design, development and support of more complex and specific applications, e.g. in the fields of internet and e-business solutions, GUI design and development or configuration and test management.

## 1. Generic ICT skills profile

ICT systems and application development (L3)

## 2. Examples of job titles and qualifications (country)

- Software developer
- ICT systems developer
- Information technology specialist in application development (D)
- Informatics technician (P)

## 3. Work and profile description

'ICT systems and application development' is a comprehensive work area covering far more than just mere individual programming or coding. In this work area informatics practitioners work in systems and software development teams that design, realise, update, test, integrate and maintain individual, enterprise, customer, sector-specific and standard applications using existing modelling and engineering methods, development tools and languages, (O)D.B.M.S. (object-orientated) database management system), etc. Depending on the real ICT business area the work can cover also embedded systems solutions, specific telecommunications applications, multimedia and internet applications, etc. The work tasks are carried out based on comprehensive analyses and descriptions of what is needed by the market, a specific sector or a specific customer. Informatics practitioners at this skill level take over responsible parts in this work, usually as self-organised team members. In practise permanent contacts to the project and team manager and ICT business and technical practitioners within or without the company are important, e.g. ICT consultants, ICT infrastructure practitioners, research groups, etc. In the daily work processes the transfer of the technical and business requirements to be clearly defined in the 'technical specification' into a consistent 'data processing specification' is crucial for the final success of ICT systems and application development as well as the final integration and deployment process. Primary criteria for the software solutions are reliability and usability. Furthermore the work as part of a team often runs under time constraints and must be constantly well communicated, reported and documented.

## 4. Soft skills

| Behavioural and personal skills | Cross section and basic work skills | Soft and method skills |
|---|---|---|
| - Flexibility | - Quality awareness | - Communication |
| - Self learning | - Commercial and market awareness | - Languages and culture |
| - Motivation and commitment | - Entrepreneurship | - Collaboration and interaction |
| - Stress resistant and emotion | - Customer orientation and relationship | - Teamwork |
| - Responsibility | - Company and business organisation | - Creative and innovation |
| - Decision making | - Work organisation | - Analytical and reasoning |
| - Initiative and attention | - Work safety and health protection | - Problem analysis and solving |
| - Professional attitude | - Labour law and data privacy | - Context and causal connection thinking |
| | - Environmental and resource awareness | - Documentation and presentation |

## 5. ICT systems and application development skills

### ... in regard to the fields of activity and generic work tasks

- Analysis and consulting
  - Investigate and review ICT systems and application requirements of the client and users
  - Determine and specify concrete hardware and software needs
  - Recommend an adequate and tailored ICT solution to the customer
  - Write (parts of) the technical, ICT system and functional specification
- Systems- and work planning
  - Manage and specify own work and project priorities using project management tools
  - Test, choose and set up software and systems development tools
- Design and conception
  - Create and specify concepts, prototyping, data structures, access, data base models, etc.
- Programming and implementation
  - Determine and describe software units, methods, attributes, modules, I/O-parameters, etc.
  - Code, adapt and document systems, software and database applications, e.g. in 3GL and with 4GL IDEs, embedded SQL
  - Design, develop and implement graphical user interfaces as well as web-based applications
- Software adaptation and testing
  - Run, interpret and document ICT systems and software tests by using various test tools, methods and data
  - Describe opportunities and undergo bug-fixing, systems upgrading and software adaptation
- Configuration management and documentation
  - Write (parts of) the installation and user instructions and ICT systems and application manuals
  - Document, version and register new systems, software and database applications (configuration- and report management)
  - Document the work following overall and company standards, e.g. info and help centre, change management

### ... linked to the ICT business and technology areas

- Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems, etc.)
- Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data, etc.)
- Sector-specific ICT solutions (automotive industry, financing and banking, graphic/media industry, health, etc.)
- Internet and intranet systems and applications (web design, service providing, etc.)
- E-business and e-commerce solutions (B2B, B2C, etc.)
- Data management and database solutions (process databases, backup and recovery systems, etc.)
- Networks systems and solutions (LAN, ATM, etc.)
- ICT security solutions (antivirus, firewall, VPN, etc.)
- Business (process) systems and applications (CRM, ERP, etc.)
- Industrial IT systems (industrial and process automation, etc.)
- Embedded systems and control (diagnostics, monitoring, etc.)
- Multimedia systems and applications (video, simulations, etc.)
- Consumer and entertainment electronics (computer games, etc.)
- ICT training solutions (customer seminars, blended learning, etc.)
- ...

## 6. Cross work area/basic technical ICT skills

| ICT commerce and business | ICT infrastructure and installation | ICT support and systems service |
|---|---|---|
| - Compare standard and specific ICT solutions (e.g. performance, business areas, architecture, efficiency, profitability) | - Provide, install and up-grade basic ICT systems (e.g. PCs, printers, servers, operating systems, drivers, communications systems) | - Calculate and monitor standard ICT service and support activities (e.g. hotlines, user help desk, internet and intranet forum) |
| - Describe the impact of innovative ICT developments (e.g. hardware, software, internet, services) | - Differentiate and describe important interface and bus systems (e.g. RS-232, RS-485, ISA, PCI/AGP, SCSI, USB) | - Describe support and communication channels (e.g. customers, business partners, suppliers, colleagues) |
| - Collaborate within customers quotations, consulting, contracting and project processing | - Differentiate and describe ICT infrastructure and network structures and technologies (e.g. LAN, WLAN, ATM, Ethernet, Token Ring, ISDN) | - Up-date and optimise basic ICT systems (e.g. hardware, operating systems, drivers, firmware) |
| - Self-responsible and project related support of customers and users | - Provide and connect basic communications and telephone systems (e.g. analogue, modems, ISDN, DSL) | - Undergo simple troubleshooting and maintenance procedures (e.g. for PCs, printers, databases, networks, communications systems, standard software applications) |
| - Provide project data for the invoicing and accountancy | | |

## 7. Career roadmap and future opportunities

Due to the rapid developments and changes in technologies, methods and process organisation, practitioners in 'ICT systems and application development' must be aware of the need for lifelong learning (LLL) both in terms of primary informatics and technology subjects as well as overall aspects like ICT business process and market developments and trends. Based on some years work and project experience at this skill level next stage of a career in the work area 'ICT systems and application development' is described in the ICT skill profiles at skill level 4. This role, on the one hand, involves more self organised and responsible project management and commercial work and, on the other hand, the design, development and support of more complex and specific applications, e.g. in the fields of internet and e-business solutions, GUI design and development or configuration and test management.

## 1. Generic ICT skills profile

ICT systems and application development (L2)

## 2. Examples of job titles and qualifications (country)

- VBA programmer
- ICT applications tester

- Technical assistant for informatics (D)
- Data processing assistant (P)

## 3. Work and profile description

'ICT systems and application development' is a comprehensive work area covering far more than just mere individual programming or coding. In this work area informatics practitioners work in systems and software development teams that design, realise, update, test, integrate and maintain individual, enterprise, customer, sector-specific and standard applications using various development tools and languages, (O).D.B.M.S. (object-orientated) database management system), etc. Depending on the real ICT business area the work can cover also embedded systems solutions, specific telecommunications applications, multimedia and internet applications, etc.

The work tasks are carried out based on comprehensive analyses and descriptions of what is needed by the market, a specific sector or a specific customer. Informatics practitioners at this skill level take over smaller parts in this work, usually as team members. In practise permanent contacts to the colleagues in the team are important. The work must be constantly well communicated, reported and documented.

## 4. Soft skills

| Behavioural and personal skills | Cross section and basic work skills | Soft and method skills |
|---|---|---|
| ■ Flexibility<br>■ Self learning<br>■ Motivation and commitment<br>■ Initiative and attention<br>■ Professional attitude | ■ Quality awareness<br>■ Customer orientation and relationship<br>■ Company and business organisation<br>■ Work safety and health protection<br>■ Labour law and data privacy<br>■ Environmental and resource awareness | ■ Communication<br>■ Languages and culture<br>■ Collaboration and interaction<br>■ Teamwork<br>■ Problem analysis and solving<br>■ Documentation and presentation |

## 5. ICT systems and application development skills

| ... in regard to the fields of activity and generic work tasks | ... linked to the ICT business and technology areas |
|---|---|
| ■ Analysis and consulting<br>  ○ Determine and specify concrete hardware and software needs<br>  ○ Write (parts of) the technical, ICT system and functional specification<br>■ Systems- and work planning<br>  ○ Manage and specify own work and project priorities using project management tools<br>■ Programming and implementation<br>  ○ Code, adapt and document systems, software and database applications, e.g. in 3GL and with 4GL IDEs, embedded SQL<br>■ Software adaptation and testing<br>  ○ Run, interpret and document ICT systems and software tests by using various test tools, methods and data<br>■ Configuration management and documentation<br>  ○ Document the work following overall and company standards, e.g. info and help centre, change management | ■ Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems, etc.)<br>■ Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data, etc.)<br><br>■ Sector-specific ICT solutions (automotive industry, financing and banking, graphic/media industry, health, etc.)<br>■ Internet and intranet systems and applications (web design, service providing, etc.)<br>■ E-business and e-commerce solutions (B2B, B2C, etc.)<br>■ Data management and database solutions (process databases, backup and recovery systems, etc.)<br>■ Networks systems and solutions (LAN, ATM, etc.)<br>■ ICT security solutions (antivirus, firewall, VPN, etc.)<br>■ Business (process) systems and applications (CRM, ERP, etc.)<br>■ Industrial IT systems (industrial and process automation, etc.)<br>■ Embedded systems and control (diagnostics, monitoring, etc.)<br><br>■ Multimedia systems and applications (video, simulations, etc.)<br>■ Consumer and entertainment electronics (computer games, etc.)<br>■ ICT training solutions (customer seminars, blended learning, etc.)<br>■ ... |

## 6. Cross work area/basic technical ICT skills

| ICT commerce and business | ICT infrastructure and installation | ICT support and systems service |
|---|---|---|
| ■ Compare standard and specific ICT solutions (e.g. performance, business areas, architecture, efficiency, profitability)<br>■ Collaborate within customers quotations, consulting, contracting and project processing<br>■ Provide project data for the invoicing and accountancy | ■ Provide, install and up-grade basic ICT systems (e.g. PCs, printers, servers, operating systems, drivers, communications systems)<br>■ Differentiate and describe important interface and bus systems (e.g. RS-232, RS-485, ISA, PCI/AGP, SCSI, USB)<br>■ Provide and connect basic communications and telephone systems (e.g. analogue, modems, ISDN, DSL) | ■ Up-date and optimise basic ICT systems (e.g. hardware, operating systems, drivers, firmware)<br>■ Undergo simple troubleshooting and maintenance procedures (e.g. for PCs, printers, databases, networks, communications systems, standard software applications) |

## 7. Career roadmap and future opportunities

Due to the rapid developments and changes in technologies, methods and process organisation, practitioners in 'ICT systems and application development' must be aware of the need for lifelong learning (LLL) both in terms of primary informatics and technology subjects as well as overall aspects like ICT business process and market developments and trends. Based on some years work and project experience at this skill level next stage of a career in the work area 'ICT systems and application development' is described in the ICT skill profiles at skill level 3. This role, on the one hand, involves more self organised and commercial work and, on the other hand, the design, development and support of more complex and specific applications, e.g. in the fields of internet and e-business solutions, GUI design and development or configuration and test management.

*Figure 39:*     *Generic ICT skills profile: ICT integration and administration at skill level 3*

**1. Generic ICT skills profile**

ICT integration and administration (L3)

**2. Examples of job titles and qualifications (country)**

- ICT systems integrator
- Database supporter
- Information technology specialist in system integration (D)
- Informatics technician (P)

**3. Work and profile description**

'ICT integration and administration' covers first of all the final integration and deployment process of ICT systems and software development processes. Primary criteria for a smooth integration process are reliability and usability.

The work as part of a team often runs under time constraints and must be constantly well communicated, reported and documented. Eventually, the customer and its users often need applied (helpdesk) support, training and instructions. As part of the (continuous and often contracted) technical support systems and applications are optimised and up-graded and troubleshooting need to coordinated and problems resolved.

**4. Soft skills**

| Behavioural and personal skills | Cross section and basic work skills | Soft and method skills |
|---|---|---|
| - Flexibility<br>- Self learning<br>- Motivation and commitment<br>- Stress resistant and emotion<br>- Responsibility<br>- Decision making<br>- Initiative and attention<br>- Professional attitude | - Quality awareness<br>- Commercial and market awareness<br>- Entrepreneurship<br>- Customer orientation and relationship<br>- Company and business organisation<br>- Work organisation<br>- Work safety and health protection<br>- Labour law and data privacy<br>- Environmental and resource awareness | - Communication<br>- Languages and culture<br>- Collaboration and interaction<br>- Teamwork<br>- Creative and innovation<br>- Analytical and reasoning<br>- Problem analysis and solving<br>- Context and causal connection thinking<br>- Documentation and presentation |

**5. ICT integration and administration skills**

| ... in regard to the fields of activity and generic work tasks | ... linked to the ICT business and technology areas |
|---|---|
| - Planning and installation<br>  ○ Assemble and test ICT systems, e.g. hardware, operating system, drivers<br>  ○ Clarify and describe hardware and software requirements for the installation and integration of ICT systems and applications<br>  ○ Manual and automatic installation and adaptation of operating systems, data bases and application software<br>- Systems integration and configuration<br>  ○ Control compatibility between devices and ICT systems<br>  ○ Check and adapt installation and configuration parameters to new and real circumstances<br>  ○ Implement communication software and ensuring data mining and exchange<br>  ○ Plan and set up systems parameters and user administration<br>- Integration and systems testing, release<br>  ○ Coordinate, run and evaluate integrated tests of ICT systems and applications based on defined test cases<br>  ○ Coordinate and undergo systems adaptations based on a test protocol and issue release<br>- Documentation and delivery<br>  ○ Document systems specifications, test results and work tasks and provide them according to the arrangements (e.g. in the Intranet)<br>  ○ Coordinate, run and document systems delivery according to company and customer requirements<br>- Presentation, training and instruction<br>  ○ Prepare and run systems and application related presentations<br>  ○ Elaborate and edit training and instruction material<br>  ○ Run and evaluate training measures using multimedia systems<br>- Systems administration and support<br>  ○ Optimise and actualise ICT systems, e.g. hardware, operating system, libraries<br>  ○ Arrange and guarantee ICT system and software security and data backup and restore<br>  ○ Manage and run software distribution, remote configuration, data archiving, retrieving and reorganisation<br>  ○ Interpret, remove and document ICT systems and software bugs and coordinate external support | - Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems, etc.)<br>- Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data, etc.)<br><br>- Sector-specific ICT solutions (automotive industry, financing and banking, graphic/media industry, health, etc.)<br>- Internet and intranet systems and applications (web design, service providing, etc.)<br>- E-business and e-commerce solutions (B2B, B2C, etc.)<br>- Data management and database solutions (process databases, backup and recovery systems, etc.)<br>- Networks systems and solutions (LAN, ATM, etc.)<br>- ICT security solutions (antivirus, firewall, VPN, etc.)<br>- Business (process) systems and applications (CRM, ERP, etc.)<br>- Industrial IT systems (industrial and process automation, etc.)<br>- Embedded systems and control (diagnostics, monitoring, etc.)<br><br>- Multimedia systems and applications (video, simulations, etc.)<br>- Consumer and entertainment electronics (computer games, etc.)<br>- ICT training solutions (customer seminars, blended learning, etc.)<br>- ... |

**6. Cross work area/basic technical ICT skills**

| ICT commerce and business | ICT infrastructure and installation | ICT support and systems service |
|---|---|---|
| - Compare standard and specific ICT solutions (e.g. performance, business areas, architecture, efficiency, profitability)<br>- Describe the impact of innovative ICT developments (e.g. hardware, software, internet, services)<br>- Collaborate within customers quotations, consulting, contracting and project processing<br>- Self-responsible and project related support of customers and users<br>- Provide project data for the invoicing and accountancy | - Provide, install and up-grade basic ICT systems (e.g. PCs, printers, servers, operating systems, drivers, communications systems)<br>- Differentiate and describe important interface and bus systems (e.g. RS-232, RS-485, ISA, PCI/AGP, SCSI, USB)<br>- Differentiate and describe ICT infrastructure and network structures and technologies (e.g. LAN, WLAN, ATM, Ethernet, Token Ring, ISDN)<br>- Provide and connect basic communications and telephone systems (e.g. analogue, modems, ISDN, DSL) | - Calculate and monitor standard ICT service and support activities (e.g. hotlines, user help desk, internet and intranet forum)<br>- Describe support and communication channels (e.g. customers, business partners, suppliers, colleagues)<br>- Up-date and optimise basic ICT systems (e.g. hardware, operating systems, drivers, firmware)<br>- Undergo simple troubleshooting and maintenance procedures (e.g. for PCs, printers, databases, networks, communications systems, standard software applications) |

**7. Career roadmap and future opportunities**

Due to the rapid developments and changes in technologies, methods and process organisation, practitioners in 'ICT integration and administration' must be aware of the need for lifelong learning (LLL) both in terms of primary informatics and technology subjects as well as overall aspects like ICT business process and market developments and trends. Based on some years work and project experience next stage of a career in the work area 'ICT integration and administration' is described in the ICT skill profiles skill level 4. This role, on the one hand, involves more self organised and responsible project management and commercial work and, on the other hand, the design, development and support of more complex and specific applications, e.g. in the fields of internet and e-business solutions, GUI design and development or configuration and test management.

*Figure 40: Generic ICT skills profile: ICT infrastructure and installation at skill level 2*

| 1. Generic ICT skills profile |
| --- |
| ICT infrastructure and installation (L2) |

**2. Examples of job titles and qualifications (country)**

- Systems operator
- Network installer
- Informatics assistant technician (P)
- Information and communications technology assistant (D)

**3. Work and profile description**

'ICT infrastructure and installation' work covers the planning, integration, modification and installation of the wide range of different ICT systems, devices, telecommunications, networks, etc., summarised as ICT infrastructure. The work is carried out based on problem orientated analyses and descriptions of what type and level of ICT infrastructure is needed by the market, a specific sector or (internal or external) customer. ICT practitioners use these information for the description of what is needed in concrete cases. For this contacts to customers, project managers and ICT business and systems development practitioners within or without the company can partly be important, but may not in any case be carried out at this level. However, for the realisation and integration of ICT infrastructure solutions like networks or telecommunications they need to consider aspects like reliability, cost effectiveness, upgradeability, etc. The integration of standard solutions (e.g. software applications, wireless network and telecommunication solutions, web based infrastructure) is part of this work. The work, sometimes as part of a team, must be constantly well communicated and documented. Eventually, the customer and its users often need applied support, training and instructions.

**4. Soft skills**

| Behavioural and personal skills | Cross section and basic work skills | Soft and method skills |
| --- | --- | --- |
| <ul><li>Flexibility</li><li>Self learning</li><li>Motivation and commitment</li><li>Initiative and attention</li><li>Professional attitude</li></ul> | <ul><li>Quality awareness</li><li>Customer orientation and relationship</li><li>Company and business organisation</li><li>Work safety and health protection</li><li>Labour law and data privacy</li><li>Environmental and resource awareness</li></ul> | <ul><li>Communication</li><li>Languages and culture</li><li>Collaboration and interaction</li><li>Teamwork</li><li>Problem analysis and solving</li><li>Documentation and presentation</li></ul> |

**5. ICT infrastructure and installation skills**

| ... in regard to the fields of activity and generic work tasks | ... linked to the ICT business and technology areas |
| --- | --- |
| <ul><li>Analysis and consulting<ul><li>Determine, specify and describe technical requirements</li></ul></li><li>Systems- and work planning<ul><li>Receive, assess and forward new customer orders</li><li>Ensure, select and use latest ICT product and service information and requirements, also in foreign languages</li></ul></li><li>Assembly and installation<ul><li>Assemble, install and up-grade ICT systems and networks devices and components</li><li>Manual and automatic installation and configuration of operating systems, applications and communication software, etc.</li><li>Decommission and recycle old ICT infrastructure</li></ul></li><li>Setup, integration and configuration<ul><li>Undertake systems adaptations by parameterising, updating as well as adapt software applications by using macro- and programming languages</li></ul></li><li>Check, test and documentation<ul><li>Test and verify requested function of installed and integrated ICT systems based on given criteria and requirements</li></ul></li><li>Delivery, instruction and finalising<ul><li>Coordinate and deliver installed and integrated ICT systems</li><li>Instruct ICT support staff and users for new ICT infrastructure, applications and functions</li></ul></li></ul> | <ul><li>Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems, etc.)</li><li>Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data, etc.)</li><li>Sector-specific ICT solutions (automotive industry, financing and banking, graphic/media industry, health, etc.)</li><li>Internet and intranet systems and applications (web design, service providing, etc.)</li><li>E-business and e-commerce solutions (B2B, B2C, etc.)</li><li>Data management and database solutions (process databases, backup and recovery systems, etc.)</li><li>Networks systems and solutions (LAN, ATM, etc.)</li><li>ICT security solutions (antivirus, firewall, VPN, etc.)</li><li>Business (process) systems and applications (CRM, ERP, etc.)</li><li>Industrial IT systems (industrial and process automation, etc.)</li><li>Embedded systems and control (diagnostics, monitoring, etc.)</li><li>Multimedia systems and applications (video, simulations, etc.)</li><li>Consumer and entertainment electronics (computer games, etc.)</li><li>ICT training solutions (customer seminars, blended learning, etc.)</li><li>...</li></ul> |

**6. Cross work area/basic technical ICT skills**

| ICT commerce and business | ICT development and administration | ICT support and systems service |
| --- | --- | --- |
| <ul><li>Compare standard and specific ICT solutions (e.g. performance, business areas, architecture, efficiency, profitability)</li><li>Collaborate within customers quotations, consulting, contracting and project processing</li><li>Provide project data for the invoicing and accountancy</li></ul> | <ul><li>Describe ICT systems and software requirements (e.g. systems software, application software, communication software, specific applications, databases, security systems)</li><li>Modify, configure and administrate basic software and web applications (e.g. algorithms, data structures, I/O parameters, e.g. VB, JavaScript, ABAP, HTML, XML)</li></ul> | <ul><li>Up-date and optimise basic ICT systems (e.g. hardware, operating systems, drivers, firmware)</li><li>Undergo simple troubleshooting and maintenance procedures (e.g. for PCs, printers, databases, networks, communications systems, standard software applications)</li></ul> |

**7. Career roadmap and future opportunities**

Due to the rapid developments and changes in technologies, methods and process organisation, practitioners working in the area of 'ICT infrastructure and installation' must be aware of the need for lifelong learning (LLL) both in terms of primary ICT and technology subjects as well as overall aspects like ICT business process and market developments. Next stage of a career in the work area 'ICT infrastructure and installation' is described in the ICT skill profiles at skill level 3. This role, on the one hand, involves more self organised and responsible project work and, on the other hand, the integration of more specific ICT infrastructures and systems, e.g. in the fields of printing systems, mobile communications systems, audio and video systems, ICT security systems.

*Figure 41:    Generic ICT skills profile: ICT support and systems service at skill level 3*

**1. Generic ICT skills profile**

ICT support and systems service (L3)

**2. Examples of job titles and qualifications (country)**

- Networks fitter
- ICT service technician
- Network (PCs) maintenance technicians (P)
- IT system electronics (D)

**3. Work and profile description**

'ICT support and systems service' primarily concerns the analysis, troubleshooting and fixing of ICT infrastructure, systems and application problems. In principle this work covers a wide range of different ICT technologies and services and correspondingly the use of different soft- and hardware based expert and diagnosis tools, depending on the level of service and support. In order to narrow the faults down to the concrete technical problem, ICT service practitioners need to communicate well with customers, users and colleagues. As part of the service and maintenance the ICT practitioners must be able to propose possibilities of optimising and upgrading existing ICT systems.

**4. Soft skills**

| Behavioural and personal skills | Cross section and basic work skills | Soft and method skills |
|---|---|---|
| - Flexibility<br>- Self learning<br>- Motivation and commitment<br>- Stress resistant and emotion<br>- Responsibility<br>- Decision making<br>- Initiative and attention<br>- Professional attitude | - Quality awareness<br>- Commercial and market awareness<br>- Entrepreneurship<br>- Customer orientation and relationship<br>- Company and business organisation<br>- Work organisation<br>- Work safety and health protection<br>- Labour law and data privacy<br>- Environmental and resource awareness | - Communication<br>- Languages and culture<br>- Collaboration and interaction<br>- Teamwork<br>- Creative and innovation<br>- Analytical and reasoning<br>- Problem analysis and solving<br>- Context and causal connection thinking<br>- Documentation and presentation |

**5. ICT support and systems service skills**

| ... in regard to the fields of activity and generic work tasks | ... linked to the ICT business and technology areas |
|---|---|
| - Service management and systems implementation<br>  ○ Analyse and optimise the integration of ICT service and escalation concepts and platforms within the overall company- and process structure using various methods and sources<br>  ○ Receive, interpret and confirm customer ICT service orders<br>  ○ Check and assess service level agreements and advise colleagues and customers on ICT service possibilities<br>  ○ Suggest potential ICT service and maintenance improvements of the company<br>  ○ Participate at the integration and implementation of new ICT systems and applications<br>- Systems upgrading and optimisation<br>  ○ Upgrade and modify ICT infrastructure and systems, e.g. new systems software, drivers, firmware, etc.<br>  ○ Recommend, present and setup new and upgraded ICT applications, e.g. office products, database systems<br>- Systems administration and control<br>  ○ Maintain ICT systems and infrastructure regarding up-to-dateness, data- and systems security, user administration, etc.<br>  ○ Permanently run and document ICT systems- and process control<br>- Systems support, helpdesk and training<br>  ○ Provide, update and administer ICT system- and user information and resources, e.g. manuals, support documents, patch<br>  ○ Support and advice customers and users within company support and helpdesk tasks and follow up complaints<br>  ○ Instruct ICT support staff and users on new systems, safety, security, application changes, potential problems, etc.<br>- Systems maintenance and documentation<br>  ○ Maintain ICT systems and infrastructure, e.g. PCs, networks, TC systems, print- and copy systems<br>  ○ Report and document service work tasks following overall and company standards, e.g. working hours, material, resources, problems<br>- Error diagnosis and troubleshooting<br>  ○ Ensure, select and use latest ICT product and service information and manuals, also in foreign languages<br>  ○ Narrow and interpret ICT systems and infrastructure problems<br>  ○ Select and run test and diagnosis systems and software tools<br>  ○ Remove ICT systems errors and ensure safety and security of systems and data, e.g. repair and change hardware, configure systems components and software | - Information systems, applications and services (IT) (PCs, storages, servers, systems software, operating systems, etc.)<br>- Communications systems, applications and services (CT) (fixed and wireless networks, mobile systems, voice, data, etc.)<br><br>- Sector-specific ICT solutions (automotive industry, financing and banking, graphic/media industry, health, etc.)<br>- Internet and intranet systems and applications (web design, service providing, etc.)<br>- E-business and e-commerce solutions (B2B, B2C, etc.)<br>- Data management and database solutions (process databases, backup and recovery systems, etc.)<br>- Networks systems and solutions (LAN, ATM, etc.)<br>- ICT security solutions (antivirus, firewall, VPN, etc.)<br>- Business (process) systems and applications (CRM, ERP, etc.)<br>- Industrial IT systems (industrial and process automation, etc.)<br>- Embedded systems and control (diagnostics, monitoring, etc.)<br><br>- Multimedia systems and applications (video, simulations, etc.)<br>- Consumer and entertainment electronics (computer games, etc.)<br>- ICT training solutions (customer seminars, blended learning, etc.)<br>- ... |

**6. Cross work area/basic technical ICT skills**

| ICT commerce and business | ICT development and administration | ICT infrastructure and installation |
|---|---|---|
| - Compare standard and specific ICT solutions (e.g. performance, business areas, architecture, efficiency, profitability)<br>- Describe the impact of innovative ICT developments (e.g. hardware, software, practitioners, internet, services)<br>- Collaborate within customers quotations, consulting, contracting and project processing<br>- Self-responsible and project related support of customers and users<br>- Provide project data for the invoicing and accountancy | - Differentiate technologies of ICT systems and software design (e.g. machine-intimate, object-orientation, 4GL, 3GL)<br>- Describe ICT systems and software requirements (e.g. systems software, application software, communication software, specific applications, databases, security systems)<br>- Modify, configure and administrate basic software and web applications (e.g. algorithms, data structures, I/O parameters, e.g. VB, JavaScript, ABAP, HTML, XML)<br>- Adapt databases (e.g. mainly SQL in MS Access, SQL-Server, MySQL) | - Provide, install and up-grade basic ICT systems (e.g. PCs, printers, servers, operating systems, drivers, communications systems)<br>- Differentiate and describe important interface and bus systems (e.g. RS-232, RS-485, ISA, PCI/AGP, SCSI, USB)<br>- Differentiate and describe ICT infrastructure and network structures and technologies (e.g. LAN, WLAN, ATM, Ethernet, Token Ring, ISDN)<br>- Provide and connect basic communications and telephone systems (e.g. analogue, modems, ISDN, DSL) |

**7. Career roadmap and future opportunities**

Due to the rapid developments and changes in technologies, methods and process organisation, ICT practitioners in 'ICT support and systems service' must be aware of the need for lifelong learning (LLL) both in terms of primary ICT service and technology subjects as well as overall aspects like ICT business process and market developments and trends. Based on some years work and project experience at this level next stage of a career in the work area 'ICT support and systems service' is described in the ICT skills profiles at skill level 4. This role, on the one hand, involves more self organised and responsible project management and commercial work and, on the other hand, the service and maintenance of more specific ICT systems, e.g. in the fields of ICT systems and network administration, mobile systems helpdesk and support, ICT application and user training, ICT troubleshooting and recovery.

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## 5.3.    Towards a European framework of ICT qualifications

The Bruges-Copenhagen Process, like the Bologna Process for higher education (HE), aims to increase cooperation in vocational education and training (VET). One major precondition for better cooperation and enhanced mobility of practitioners is recognition of qualifications combined with the transfer of training credits of different countries throughout Europe. However, national education and qualification strategies and structures in Europe still differ, often considerably. This is due to the fact that vocational education and training systems - like education systems as a whole – dynamically develop and change within each national socio-economic and historical context. The European Communities have considered this fact under the principle of subsidiarity, meaning each member state has control over its own educational policy yet participates in common European action in this field. Thus national qualification frameworks have been developed in various countries designed to provide nationally recognised, consistent standards and qualifications as well as recognition and credit for all learning activities, both at degree and sub-degree vocational levels. Nevertheless, the Bruges-Copenhagen Process tries to stress the importance of moving towards cooperative and mutually recognised European VET activities rather than just focusing on national education policies. Correspondingly, the proposition and maintenance of European (reference) ICT skills and qualification frameworks will support policy decisions for setting targets on common ICT training and skills development, e.g. to promote the definition of coherent ICT skills and qualification profiles in order to anticipate employment requirements in both quantitative and qualitative terms.

European labour markets take little account of national employment and qualification objectives. More open and global labour markets need corresponding employment and qualification strategies characterised by an adequately qualified and flexible workforce, both from an occupational and geographical point of view: 'ICT businesses are increasingly international in scope and structure. The globalisation of ICT affects business management, research and development fields and the shop floor level, and because of the internationalisation of so many aspects, ICT work today is impossible for instance without competence in the English language' (report A).

A European ICT skills framework has been developed and described representing the broad and concrete skill needs of concerned industries. It remains a European challenge to create and further detail ideas leading to a comprehensive European ICT qualifications framework (EQF – ICT), in terms of tailored qualification profiles/descriptors at adequately defined qualification levels and with transparent learning outcomes/standards including meaningful certificates of acquired ICT skills. The major objectives of such a reference framework are, on the one hand, to provide the labour market with transparent information on qualified ICT practitioners and, on the other hand, to improve the qualification-employment transfer of individuals. However, adequate qualification (and education) covers more than just adaptation to the ostensible needs of the industry, especially when we talk about flexible individuals in open labour markets. Nevertheless, identified industry skill needs constitute the most important orientation for determining tailored qualifications.

It is stated in report A that many companies support the objective of common European standards for ICT qualifications and curricula; more than 50 % of the companies state that European standardisation of ICT training profiles is urgently necessary. The higher the level of qualification, the higher is the proportion of companies stating that such European initiatives are needed. For higher education degrees, between 60 and 80 % of the companies stress the importance of European standardisation of ICT qualification profiles. For VET profiles at level 3 and 2, the proportion is slightly lower and 50 % of the companies prefer national standards of ICT training and qualification. The authors state that one primary reason for this appraisal can probably be seen in a lack of mutual European trust concerning strategies and concepts of a common way to European skills, training and curriculum frameworks. However, maintaining national standards does not necessarily mean that common European vocational qualification concepts and frameworks should not be taken into account for national and regional action (cf. report A, p. 84 et seq.).

*Figure 42:    Company evaluation of a European standardisation of ICT training profiles*
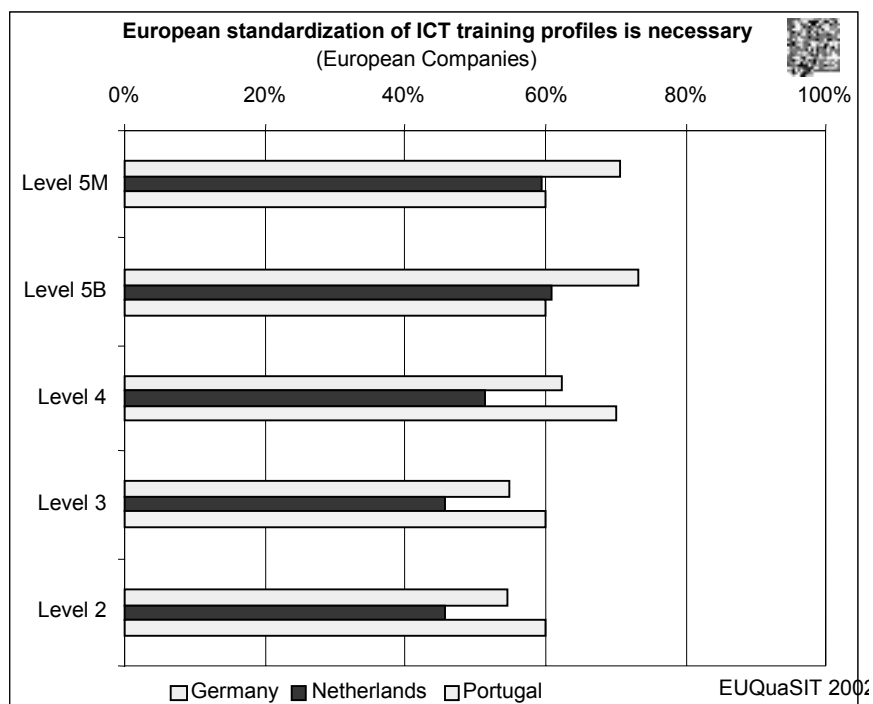


As comprehensively described in report A (p. 83), existing ICT qualifications and curricula at sub-degree and VET levels illustrate differences between European countries with regard to the qualification levels, the number of ICT qualifications at each level and the main content of ICT qualifications. However, the authors state that 'there are many similarities in specific goals, contents and methods. This is equally the case with outcomes and ICT qualifications,

given the fact that ICT practitioners in Germany or the Netherlands are able, after training, to carry out the same work tasks in a comparable manner' (ibid.).

The following table indicates the interaction between the ICT skill needs expressed and described in the generic European ICT skills profiles on the left hand side and ICT qualifications on the right hand side. To establish a European (reference) ICT qualification framework, the matching of ICT qualifications with ICT skill profiles at different levels is a vital process. All qualification and training systems in Europe (and therefore the study and training suppliers) need a reference by which they can appraise and evaluate their qualification programme offers and curricula. The generic ICT skills profiles constituting the skills framework provide the basic reference, with other criteria, for determining and describing adequate ICT qualifications. However, and this is stated in the reports, we need good criteria and an adequate structural approach to clarify the relationships between needed ICT practitioner skills and qualifications, and also for profiling of qualifications, their occupational delimitation avoiding unnecessary overlap and their qualifications outcomes (cf. report A, p. 85). In other words, the ICT qualifications and outcomes must match the ICT skill needs, if not in the short term then at least in the medium term.

### 5.3.1. Define qualification and learning outcomes

The outputs of the qualification process are VET qualifications with competences that qualify individuals for professional activities mainly in a specific ICT work area but also beyond. Therefore both the qualification level and profile must be relevant to the labour market skill requirements. The qualification should be described as a set of competences (knowledge, skills) e.g. within a set of qualification and learning modules (M.1, M.2 ...) required to exercise the occupational tasks, rather than just listing the knowledge to be acquired in the qualification process. The skill needs as defined in each generic ICT skills profile can be generally understood and described as a reference for defining outcomes of the ICT qualification profiles (see figure below). The definition of more work-oriented qualification outcomes permits an adequate credit system based on activity and work-oriented assessment and quality assurance arrangements. As in real working life, the qualification framework provides a clear orientation concerning learners' career prospects, whether at work or with a training provider. Therefore, positive impact can also be expected in lifelong learning activities and their recognition.

According to this approach, a skills profile in ICT marketing management can have its equivalent in an ICT qualification at level 5M Master of Science in ICT marketing management. Another profiling possibility is the clustering of ICT generic skills profiles (see CSC/Cedefop, 2001b, p. 39 et seq.). An example is the skills profile communications network design that could be assigned to a cluster IT networks for instance as a first cycle (FCD) or bachelor degree respectively (see ibid.). For the qualifications at sub-degree vocational levels, the table indicates three different vocational degrees, namely specialist (Level 4), technician (Level 3) and assistant (Level 2) (see report A). These terms define the level of qualifications

based on the idea of a simple level combination of ICT skills and qualifications. The concrete name of the qualification indicates either a one-to-one equivalence or at least a close correspondence to the work area and skills profile, e.g. specialist in ICT project management (VET level 4), technician in ICT systems and application development (VET level 3) or assistant in ICT infrastructure and installation (VET level 2).

*Figure 43:    European framework of ICT skills profiles and VET and HE qualifications (Generic ICT skills profiles of Career Space)*
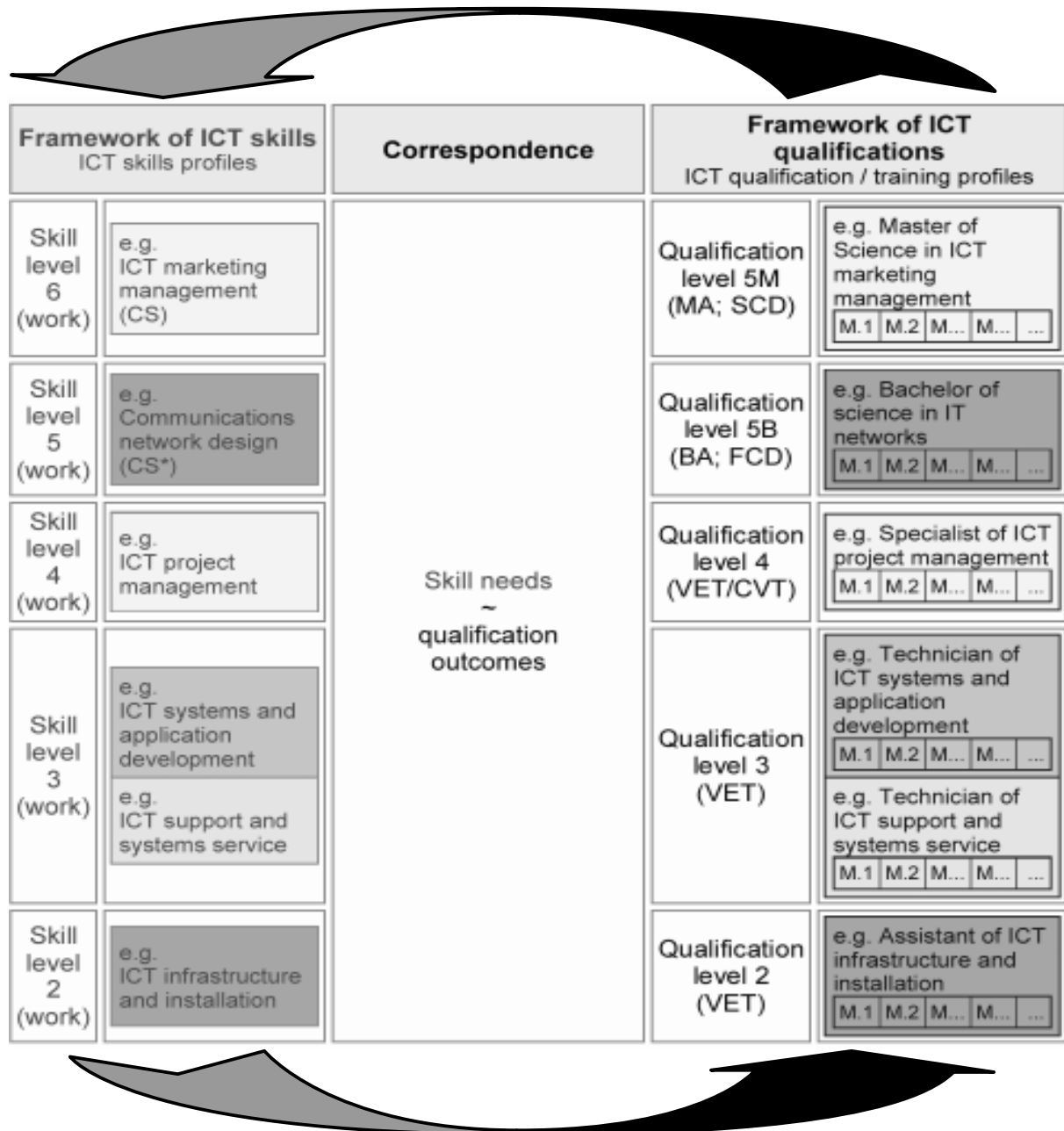
The following tables, illustrating vocational levels 3 and 2, indicate a close transfer of ICT skills to qualification profiles, covering all defined skills profiles. Such a close link between required skills and qualifications, which reflects most clearly the didactical change in defining and profiling ICT qualifications, was proposed in reports A and B. Therefore, the framework of ICT qualifications contains profiles such as:

(a)   Specialist profiles in ICT marketing, ICT consulting and sales, etc.;

(b)   Technician profiles in ICT systems and application development, communications systems installation, etc.;

(c)   Assistant profiles in ICT business and sales, ICT infrastructure and installation, ICT support and systems service, etc.

*Figure 44:    European framework of ICT skills profiles and VET qualifications at level 3*
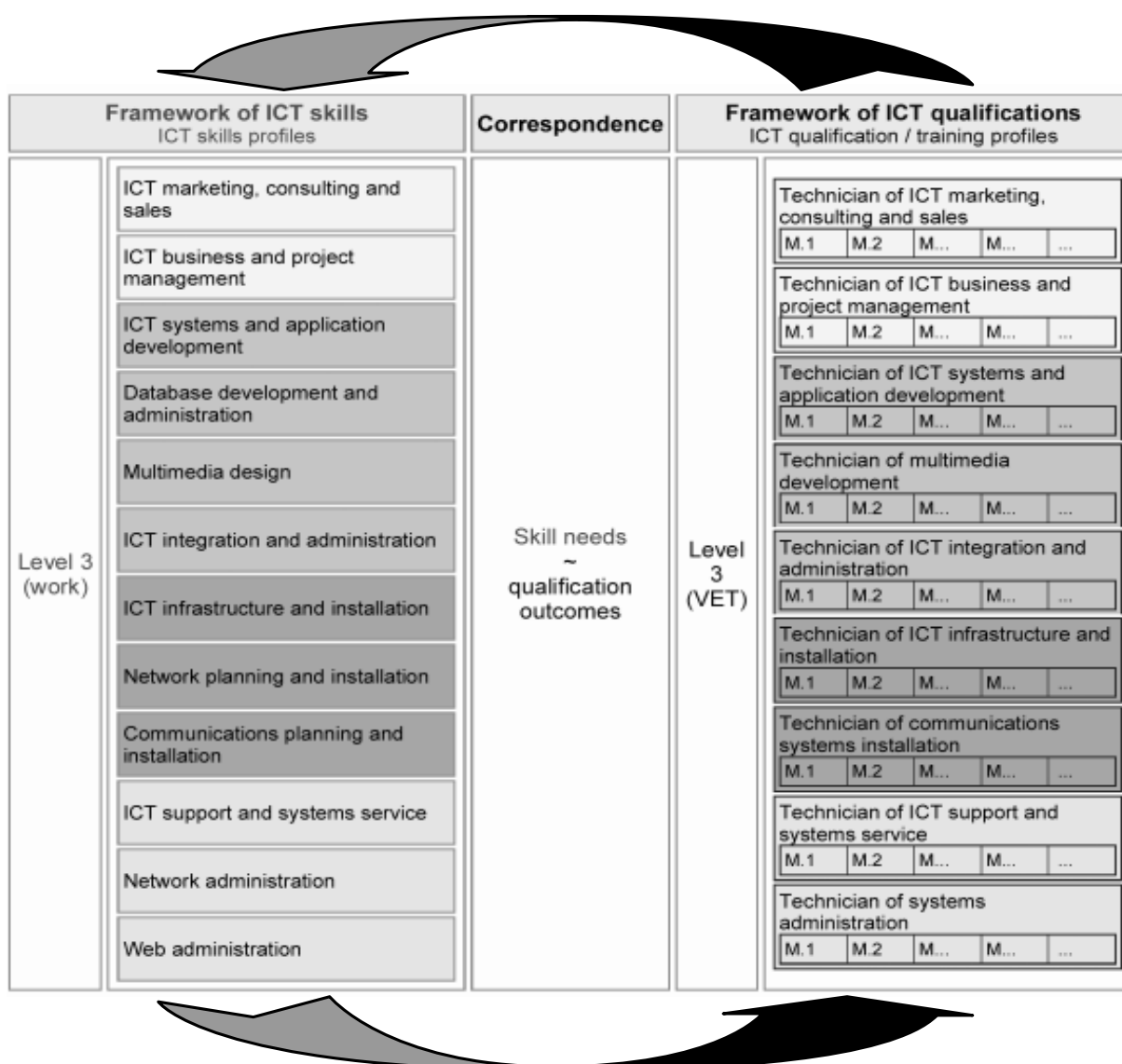
In practice, and based on the principle of subsidiarity, EU member states and regional stakeholders are free to adjust and orient their qualifications to this (reference) framework of ICT qualification profiles. However, to promote international and European transparency in VET policies and actively contribute to a European VET area by 2010 (Copenhagen Declaration, p. 2) the framework of ICT qualifications provides a concrete base for harmonising European VET activities in a specific vocational field. In this context it is important to mention that qualification frameworks need to be specifically developed for certain business, work, skills and qualification areas, in this case ICT. Therefore this work-oriented framework can have a pilot characteristic for similar activities in other domains.

*Figure 45: European framework of ICT skills profiles and VET qualifications at level 2*
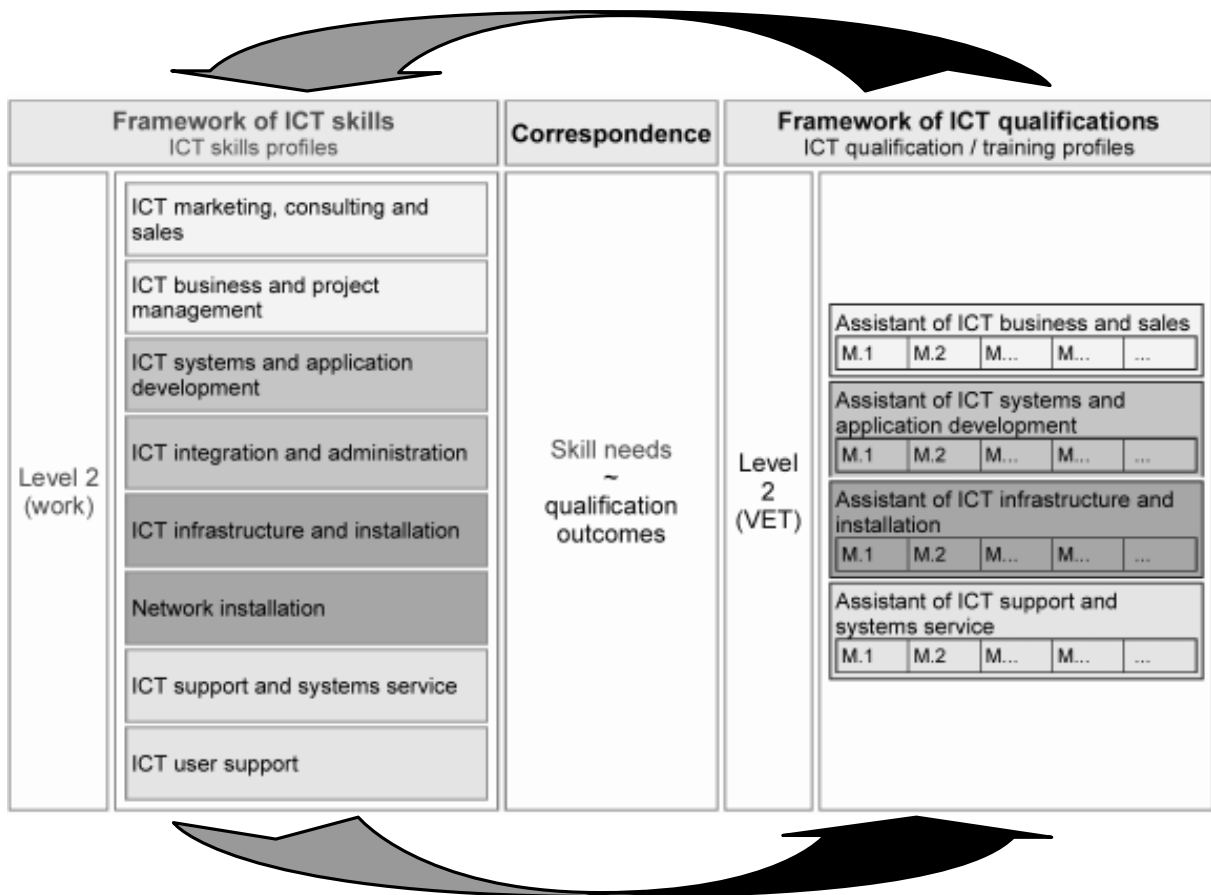


The following table summarises the complete European (reference) framework of ICT qualifications for all work areas and sub-degree qualification levels. Only one ICT qualification profile example is indicated at degree level for each work area. Further recommendations for these levels are presented in the Career Space publication *Curriculum development guidelines* (see CSC/Cedefop, 2001b).

*Figure 46:   European ICT (reference) framework with all ICT qualifications at sub-degree (VET) levels and some examples at degree (HE) levels*

| ICT education area | Training areas | European framework of ICT qualifications | | | | |
|---|---|---|---|---|---|---|
| | | sub-degree (VET) qualifications | | | degree (HE) qualifications | |
| | | L2 | L3 | L4 | L5B | L5M |
| Qualification linked to ...<br><br>■ Information systems and applications<br>■ Communications systems and applications<br>■ Sector-specific ICT solutions<br>■ Automotive industries<br>■ Banking and financial services<br>■ Graphic arts and media<br>■ Internet applications<br>■ E-business and e-commerce<br>■ Data management<br>■ Networks systems<br>■ ICT security solutions<br>■ Business applications<br>■ Industrial IT systems<br>■ Embedded systems<br>■ Multimedia applications<br>■ Consumer electronics<br>■ ICT training solutions | ICT marketing, consulting and sales | | Technician of ICT marketing, consulting and sales | Specialist of ICT marketing<br><br>Specialist of ICT consulting and sales | e.g. Bachelor of Science in Business Informatics<br><br>... | e.g. Master of Science in ICT marketing management<br><br>... |
| | ICT business and project management | Assistant of ICT business and sales | Technician of ICT business and project management | Specialist of ICT project management<br><br>Specialist of ICT quality management<br><br>Specialist of ICT content and knowledge management | e.g. Bachelor of Science in ICT project management<br><br>... | e.g. Master of Science in ICT management<br><br>... |
| | ICT systems and application development | Assistant of ICT systems development and administration | Technician of ICT systems and application development<br><br>Technician of multimedia development | Specialist of database development<br><br>Specialist of business software development<br><br>Specialist of multimedia and web design | e.g. Bachelor of Science in informatics<br><br>... | e.g. Master of Science in multimedia informatics<br><br>... |
| | ICT integration and administration | | Technician of ICT integration and administration | Specialist of database administration<br><br>Specialist of ICT testing | e.g. Bachelor of Science in integration and test<br><br>... | e.g. Master of Science in implementation and test engineering<br><br>... |
| | ICT infrastructure and installation | Assistant of ICT infrastructure and installation | Technician of ICT infrastructure and installation<br><br>Technician of communications systems installation | Specialist of network planning and installation<br><br>Specialist of ICT communication systems planning<br><br>Specialist of ICT security design | e.g. Bachelor of Science in IT networks<br><br>... | e.g. Master of Science in data communications engineering<br><br>... |
| | ICT support and systems service | Assistant of ICT support and systems service | Technician of ICT support and systems service<br><br>Technician of ICT systems administration | Specialist of ICT support<br><br>Specialist of network administration<br><br>Specialist of ICT training | e.g. Bachelor of Science in technical support<br><br>... | e.g. Master of Science in technical support<br><br>... |
| ICT education area | Training areas | L2 | L3 | L4 | L5B | L5M |
| | | European framework of ICT qualifications | | | | |

The ICT qualification framework above presents a solution with five eligible levels, from qualification levels 2-5M. As comprehensively described in Section 3 certain level frameworks exist either referring more to (occupation) skills (e.g. ISCO 88) or to (professional) qualifications (e.g. the new directive of the European Parliament and of the Council on the recognition of professional qualifications, EC, 2004). Taking these two level frameworks as an alternative basis for the ICT qualification framework also starting with level 2/B, there are only three qualification levels to be considered (see Figure below).

*Figure 47: Framework of common description, separation and correspondence of skill and qualification levels (based on ISCO-88 and EC 2004)*
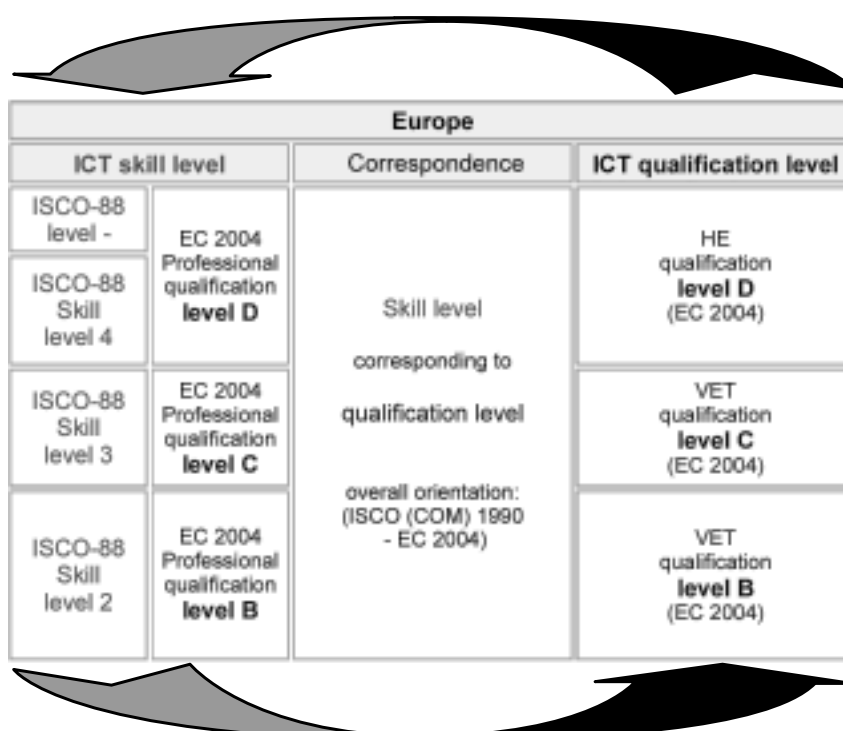


The transfer of these alternative level descriptions into the ICT qualification framework suggests two sub-degree (vocational) levels B and C and one degree level D. Therefore, there would be only one instead of two degree levels. For sub-degree (VET) qualifications there are only two levels instead of three:

- ICT qualification level C (specialist );

- ICT qualification level B (technician).

The advantages of such a structure are simpler delimitation of levels and more room for interpretation. A clear disadvantage is the high entrance level B (technician instead of assistant), reducing the career possibilities in ICT for weaker school leavers.

*Figure 48:* *European ICT (reference) qualification framework with all generic ICT qualification profiles at three levels*

| ICT education area | Training areas | European framework of ICT qualifications | | |
|---|---|---|---|---|
| | | sub-degree (VET) qualifications | | degree (HE) qualifications |
| | | Level B | Level C | Level D |
| Qualification linked to ...<br><br>■ Information systems and applications<br>■ Communications systems and applications<br>■ Sector-specific ICT solutions<br>■ Automotive industries<br>■ Banking and financial services<br>■ Graphic arts and media<br>■ Internet applications<br>■ E-business and e-commerce<br>■ Data management<br>■ Networks systems<br>■ ICT security solutions<br>■ Business applications<br>■ Industrial IT systems<br>■ Embedded systems<br>■ Multimedia applications<br>■ Consumer electronics<br>■ ICT training solutions | ICT marketing, consulting and sales | Technician of ICT marketing, consulting and sales | Specialist of ICT marketing<br><br>Specialist of ICT consulting and sales | e.g. Bachelor of Science in business informatics<br><br>e.g. Master of Science in ICT marketing management |
| | ICT business and project management | Technician of ICT business and project management | Specialist of ICT project management<br><br>Specialist of ICT quality management<br><br>Specialist of ICT content and knowledge management | e.g. Bachelor of Science in ICT project management<br><br>e.g. Master of Science in ICT management |
| | ICT systems and application development | Technician of ICT systems and application development<br><br>Technician of multimedia development | Specialist of database development<br><br>Specialist of business software development<br><br>Specialist of multimedia and web design | e.g. Bachelor of Science in informatics<br><br>e.g. Master of Science in multimedia informatics |
| | ICT integration and administration | Technician of ICT integration and administration | Specialist of database administration<br><br>Specialist of ICT testing | e.g. Bachelor of Science in integration and test<br><br>e.g. Master of Science in implementation and test engineering |
| | ICT infrastructure and installation | Technician of ICT infrastructure and installation<br><br>Technician of communications systems installation | Specialist of network planning and installation<br><br>Specialist of ICT communication systems planning<br><br>Specialist of ICT security design | e.g. Bachelor of Science in IT networks<br><br>e.g. Master of Science in data communications engineering |
| | ICT support and systems service | Technician of ICT support and systems service<br><br>Technician of ICT systems administration | Specialist of ICT support<br><br>Specialist of network administration<br><br>Specialist of ICT training | e.g. Bachelor of Science in technical support<br><br>e.g. Master of Science in technical support |
| ICT education area | Training areas | Level B | Level C | Level D |
| | | European framework of ICT qualifications | | |

The definition of a European framework of ICT qualifications, based on a close link to ICT skills profiles reflecting the skill needs in business and work, is important for all curriculum decisions and with regard to qualification outcomes, e.g. in terms of developing and reviewing

curricula and learning modules. However, the following section will stress the fact that it deliberately remains an open question how national and regional bodies and institutions act in describing ICT qualification outcomes and training and learning processes at different levels and institutional structures to satisfy ICT skills needs. The (reference) framework offers to assist European countries and institutions to maintain their ICT skills and qualification profiles in a current form by considering and linking them to their curriculum review and development processes.

# 6. Guidelines and recommendations for ICT curriculum development

## 6.1. Accrediting qualifications within a European framework

Employers and students need to be assured that the programmes being offered by vocational providers address the skills and knowledge required and, as appropriate, can attest to the competence of the individual achieving the qualification. This project is concerned with practitioner qualifications, which primarily, aim to prepare people for work as an ICT practitioner in industry. Practitioners may be involved, for example, in installing and maintaining hardware/equipment and/or writing software, as opposed to user qualifications aimed at people seeking to develop their skills in the use of ICT. The aims of this work are to:

- create the basis for a coherent framework for skills in information and communications technology (ICT) and offer guidance on the curricula content which meets the needs of the industry such curricula serve;

- ensure that through such guidance, accredited qualifications have common features and meet with specifications set out within the curricula guidelines.

This project is contributing to the establishment of a meta-framework for ICT skills and qualifications within the European Union, which meet four priority areas to ensure that:

(a)  all qualifications in ICT include a range of appropriate generic, non-technical skills and knowledge (behavioural skills);

(b)  the content of such qualifications is underpinned by a common set of specifications;

(c)  qualifications include opportunities for work-based learning or work-related assessment

(d)  guidance is provided where it is required to facilitate links between 'vendor awards' and such qualifications.

(e)  that the resulting, agreed framework is based upon the needs of employers and it indicates the route towards:

(i)   rationalisation of existing provision;

(ii)  the introduction of a common nomenclature for the content and title of qualifications;

(iii) the identification of enhanced progression opportunities and mobility across and within the European Union.

### 6.1.1. Progression routes between qualifications and employment

Vocational qualifications should aim to provide students with the knowledge and understanding, together with the appropriate vocational and personal skills, necessary for them to be ready for work.

### 6.1.2. Profiling students for vocational qualifications

Given that vocational qualifications should aim to ensure that students are work-ready for a role as an ICT practitioner, it is likely that their take-up profile will include individuals of all ages. While 16 to 19/21 year olds might make up the majority of students, in line with current intakes to tertiary colleges (post-16 institutions), vocational qualification also offers a route into work within ICT for more mature students and should encourage lifelong learning, be they:

- HE graduates seeking to enhance their employability;

- mature students seeking a career change or 'upskilling'.

This view of vocational qualifications complements the Commission's policy for lifelong learning, as individuals may progress into a vocational qualification at any age and at the level appropriate to them.

Feedback from employers and training providers has indicated that levels 2 and 3 are often those of greatest interest. Level 3, in particular, is often valued highly as the entry level into work for ICT practitioners, as it addresses the practitioner skills most relevant for work-readiness. Potential implications of these views, and how these might be addressed within a (reference) vocational qualification framework, are explored in the next section.

## 6.2. Transferability, mobility and equivalence

The Copenhagen Declaration includes a statement on:

'Investigating how transparency, comparability, transferability and recognition of competences and/or qualifications, between different countries and at different levels, could be promoted by developing reference levels, common principles for certification, and common measures, including a credit transfer system for vocational education and training.'

This report does not seek to solve or offer solutions to the challenges set within the declaration. However, it does offer some guidelines, which may contribute to the debate and hence assist in the movement towards a common system.

The levels described in this report relate to those delineated by the two frameworks (*biat* and SFIA), which serve as the basis for the common, 'meta-framework' outlined. They too, reflect

the sub-degree qualifications framework used in England. Cedefop, the organisation leading the debate and work towards meeting the requirements of the Declaration, in its First report of the technical working group for credit transfer in VET raises the following key issues:

(a)  the definition of qualification and zones of mutual trust;

(b)  the issues of assessment;

(c)  unitisation and modularisation;

(d)  the issue of certification.

The issue of definition is one of the most challenging and the word qualification is perhaps foremost amongst these. The working groups states:

[The word] '… qualification can be considered as a sum of courses made up of units and modules and consequently a certain number of credits. Another approach sees qualification or vocational programmes as the result of the student learning activities, which are based on modules, corresponding to areas and competences of working life. A third group sees qualifications as certificates or diplomas or other evidence linked to the delivery and assessment of training received. The discussion on qualifications is closely linked to the ongoing work on qualification frameworks.'

The paper then goes on to say:

'Qualifications systems include all activities that result in the delivery or recognition of all types of learning. These systems include legal frameworks, curricula, institutional arrangements, quality assurance processes, assessment and awarding processes, skills recognition and other mechanisms that may refer to the labour market and/or education and training.

A qualifications framework is an instrument for the classification and definition of qualifications according to a set of criteria for levels of learning and/or skills. This set of criteria may be implicit in the qualifications descriptors themselves or made explicit in the form of a set of levels descriptors. The scope of frameworks may be comprehensive of all learning achievements and pathways, or may be confined to a particular sector or area, e.g. higher education, initial education or adult education and continuing training. Some frameworks may be based in legislation whereas others are based on consensus with links to regulations. All qualifications frameworks, however, establish a basis for information on quality, accessibility, linkages and public or labour market recognition of qualifications within a country and internationally'.

The guidelines described below recognise these issues and their commonality across all subject/work areas; they are expressed as a guide to content and are expressed in terms of learning outcomes. This should enable their use independent of system or terminology, allowing an interpretation suitable to the country of origin. It is for others to address the issues

outlined above: however, in designing theses guidelines these challenges have been foremost in our minds.

For ICT practitioners working within the ICT Industry itself, or in a user sector, three career paths essentially underpin their career progression. These are not necessarily determined or agreed from the outset but a person entering the industry may have some idea of where they would like to see themselves going.

The three-career paths generally have a set of generic behavioural skills, some common to them all. Each path, however, will have some which, while desirable in the other paths, are not essential. Each, in turn, will, have important and essential skills of its own. The three paths are described in the figures below.

*Figure 49:     Cross profile career paths*
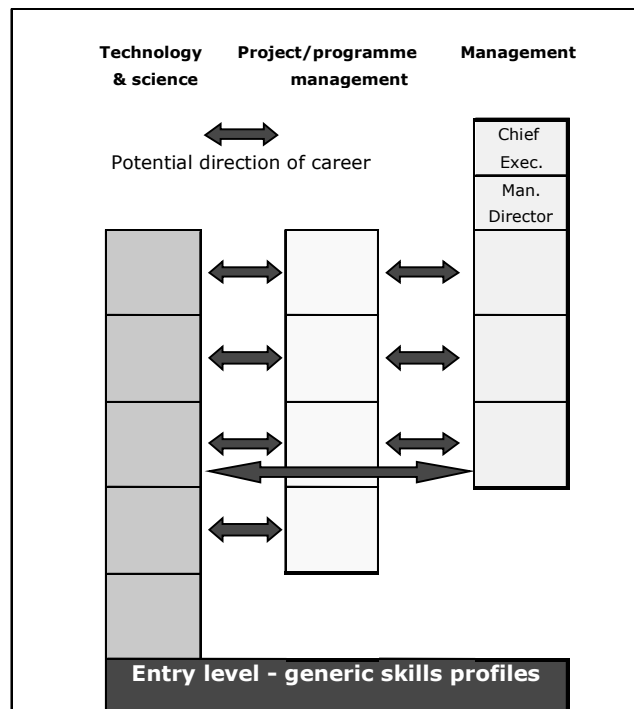


### 6.2.1.   Technology and science

Technologists and scientists apply their technical knowledge and skills to create and operate global information and communication systems, or design systems to enhance the capability of their sectors' products. Technical capabilities are at the heart of these roles and skills profiles describe what these are and the levels at which they are required.

While such a career path requires strong technical capability, a range of specific transferable skills are needed:

(a)  analytical;

(b)  attention to detail;

(c)  problem solving;

(d)  technical orientation;

(e)  creativity.

In addition they demand:

(a)  team work;

(b)  professional attitude;

(c)  business awareness;

(d)  relationships;

(e)  flexibility and self learning;

(f)  customer orientation.


### 6.2.2.    Project management

Involvement in project management offers the opportunity to work on assignments, some of which in larger companies may be multi-million EUR assignments, and contribute to all the stages of a project life cycle, from the initial bidding to the successful delivery of the programme.

Project managers lead the control, storage and delivery of technology projects providing clients, internal and external, with solutions that transform their business or facilitate the achievement of a particular project.

The range of skills needed in this career path include:

(a)  business awareness;

(b)  planning and organisation;

(c)  leadership;

(d)  problem solving;

(e)  persuasiveness;

(f)  flexibility and self learning.

In addition they demand, professional attitude, analytical skills and creativity.

### 6.2.3. Management

Business managers are essential to the everyday running of the company. They are an integral part of all teams and contribute directly to the businesses success.

Such management covers a significant range of responsibilities but there are common features to any role within this career path. These include managing client relationships, utilising ICT solutions to solve or enhance business processes, maximising developing solutions for ICT systems, and creating and presenting solution proposals to clients.

The range of skills to be demonstrated in this career path include:

(a)  business awareness;

(b)  decision making;

(c)  strategy and planning;

(d)  managing risk;

(e)  leadership;

(f)  initiative;

(g)  communication.

In addition they demand:

(a)  persuasiveness;

(b)  customer orientation;

(c)  commitment to excellence;

(d)  planning and organisation.

A career path for a high flyer may, therefore, pursue the following route. The model allows for career paths of all types to be drawn and reflects the opportunities available within a range of industries.

*Figure 50:    Example career path*
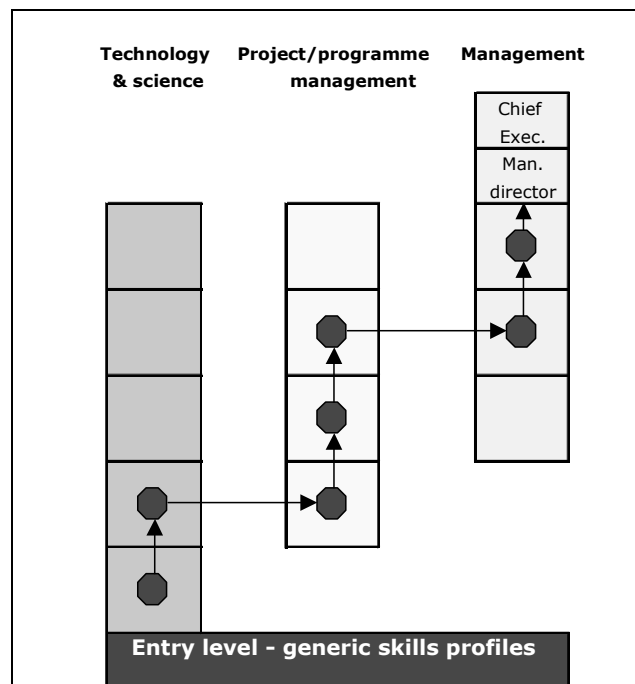


## 6.3.    Agreeing a model for ICT curriculum guidelines

There is no one single way to design the best ICT curriculum agreeable to all tertiary educational institutions. The cultural and educational diversity within the European Union should be used to give competitive advantage to this region, with each country using the strengths of their own vocational education system to find its own best solution while learning from the practice of others.

The content of curricula is always a key issue for discussion at any level within education. Fundamentally, at the vocational level, two key questions need to be addressed in considering a solution, allowing the demand side needs to be consulted:

- what generic and/or context specific competencies do graduates of vocational programmes need within industry?

- what knowledge and understanding underpins that competence.

Since they have to deal with opportunities and problems in their daily activities, the question about competence can be answered easily by employers. They are often clear about what technical, professional and personal competences are needed to be successful in business. Within the UK, for example, the national occupational standards, which delineate the competences required in vocational qualifications, are determined through a functional analysis involving employers.

Career Space, in its *Curriculum guidelines at first and second cycle degree level* states:

'A wide breadth of technical skills are needed by all employees, while singular in-depth skills are needed for people working in particular specialised areas. The ability to take a systems perspective is required. Communicating effectively with others in different fields is a necessary attribute. Working in multi-disciplinary multi-cultural project teams is a way of life. The ability to take initiatives and create system solutions or solve problems is fundamental.'

Specialised knowledge can only be deployed if it is built on the foundation of a solid broad general understanding. This fact is often neglected. Identifying this foundation is fundamental to effective vocational teaching.

The guidelines described require vocational qualifications, at all levels to address those areas of skills and knowledge common to all ICT practitioners. These include, as a minimum, the generic (technical) skills, work-readiness (behavioural) skills plus any foundation knowledge (mathematics, physics, etc) particular to ICT.

It is important to recognise and agree that the purpose of vocational education and training is not merely to train an individual in specific technical skills but to be seen as a form of all round education which develops technical as well as social and behavioural skills, and which instils ethics and values. It is vital that it shows a learning pathway into higher education and offers the opportunity to expand the individual's horizons. A fundamental component of such a process also needs to assist the learner's meta-cognitive capabilities, developing a sense of responsibility for themselves and for their own development. These latter skills are perhaps as important as technical ones and certainly act as a differentiator in recruitment of individuals by companies. These behavioural skills also need to be developed, not exclusive to the technical learning programme but integral to it.

The identified structures and contents of the skill needs and generic work area oriented ICT skills profiles are relevant to ICT curriculum development and VET programmes. As seen with the ICT skills profiles and the profiles at each level, the skill structure of all profiles is basically identical with three main skill fields:

(a) behavioural and personal skills, cross section and basic work skills, soft and method skills;

(b) ICT practitioner skills (kernel work area oriented profile skills);

(c) cross work area ICT skills (complementary to kernel work area).

Following this delineation of skills, and also qualification outcomes with structure and contents of ICT training profiles, the basis of ICT curriculum development can be described in a common curriculum model as a qualification framework of work area oriented ICT curriculum for all sub-degree levels.

This curriculum model illustrates a framework of three main qualification and content fields that depend on level for the breadth and depth of their qualifications. Each qualification field

also shows the qualification and content structure in detail, which includes, from didactic consideration of practitioner needs, a recommendation of the (quantitative) curriculum extent, e.g. ICT practitioner qualifications cover 70 % of the curriculum.

*Figure 51:    Qualification framework of the work area orientated ICT curricula for all sub-degree levels*
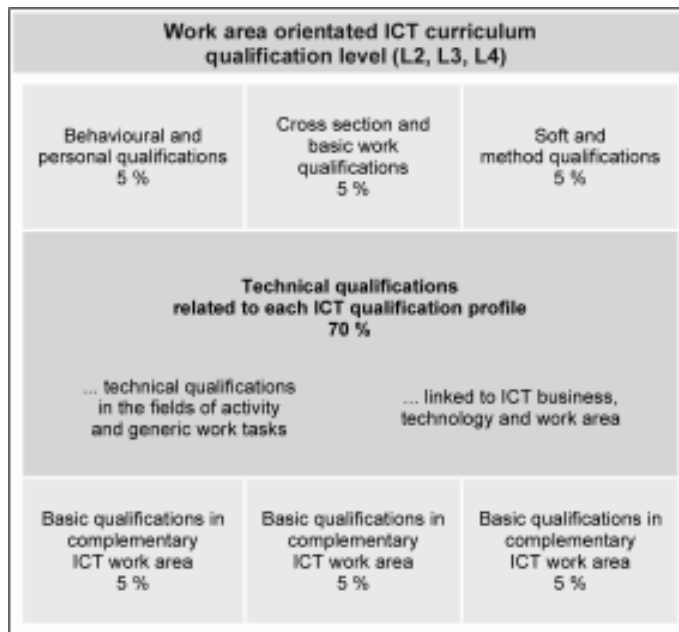


### 6.3.1.    Sector specific results

Some guidance is also offered in respect of the contextualising or situating the content to reflect the requirements of various user sectors of ICT practitioners, see diagram (1). It is realised from the work of phase 3 of the Career Space Consortium that the generic skills of ICT practitioners in any sector do not vary; however, it is agreed that such skills will become contextualised into the situation in which they are practiced and that sectors such as automotive will apply and evolve these skills to their own practices. The guidelines seek to take this into account and are reflected in the emphasis placed on advising on situational learning.

A diagrammatic representation of such contextualisation can be seen in diagram (1) drawn form the work of Spoettl et al. at the University of Flensburg, which seeks to reflect this issue.

In this diagram the ICT practitioner profiles (taken from the generic skill profiles of Career Space) reflect a development of generic skills at least up to level 3 or 4, or level 5 for software developers.

*Figure 52: Generic structure of ICT skill profiles in the automotive industry*
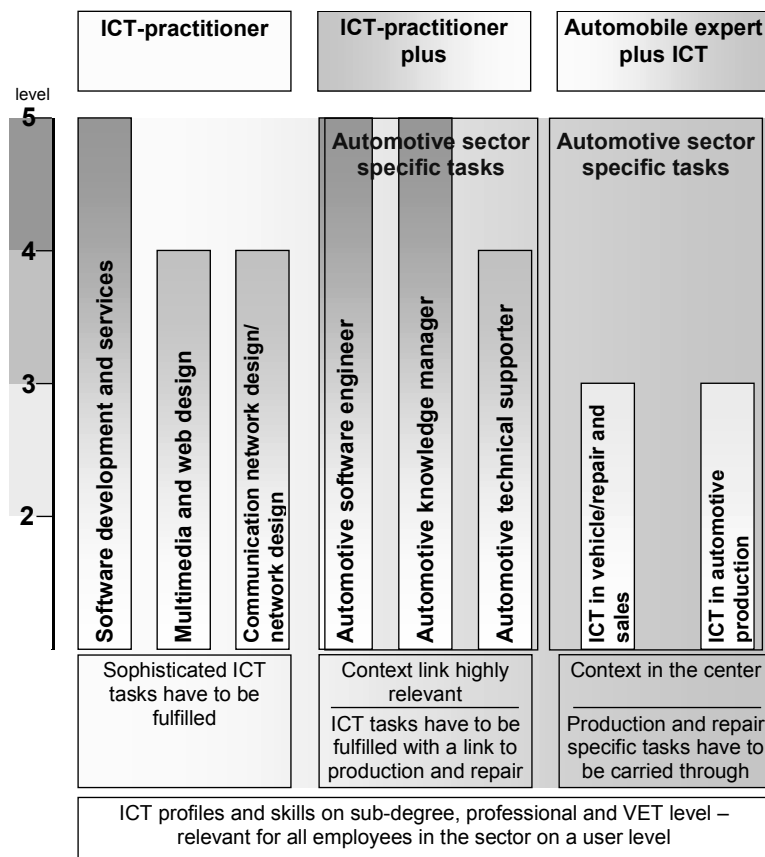


*(see report B)*

ICT practitioners plus reflects a link to sector specific requirements as well as ICT oriented skills. Only then can the ICT practitioner plus (sector specific practitioner) use those skills in such a way, which produces solutions attractive for the sector.

The ICT profiles of the automotive expert plus ICT further reflect the contextualisation of the practitioner skills into sector specific areas, in this case vehicle sales and repair. Such a process can be delineated in the following diagram, where the learning construct for the sector is achieved through the interaction of the three separate but complementary learning requirements:

(a) sector specific general skills;

(b) general ICT practitioner skills;

(c) sector situated ICT practitioner skills.

The learning construct requires all three components to be present to enable the alignment of the individual's development within the context envisaged. In this case it reflects the automotive sector but is equally applicable to any other sector.

*Figure 53: Three separate but complementary learning requirements*
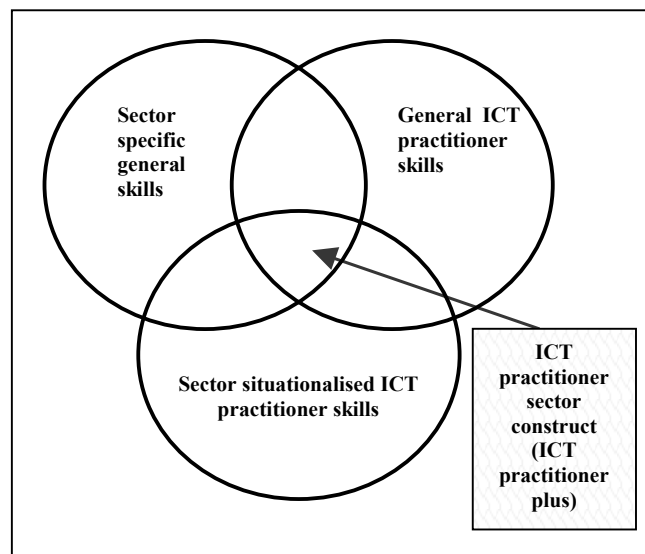


Figure 58 describes the acquisition process in linear format where general skills are acquired at a school or college and then situated in the work and training undertaken afterwards. However, each of the constructs in a vocational pathway may be combined and taught in a fully integrated way. Such a model is reflected in, for example, the modern apprenticeship programme operated in the United Kingdom or within the German *Fachhochschule*. However, in both these cases the process is not designed, and neither should it be, to prepare a student for a specific job but for a vocation, a career pathway within a specific sector, in this case ICT. The learning process should enable the individual to perform the many tasks associated with the vocational area in such a way that they can be subsequently employed in various companies after its completion.

*Figure 54: Acquisition process in linear format*
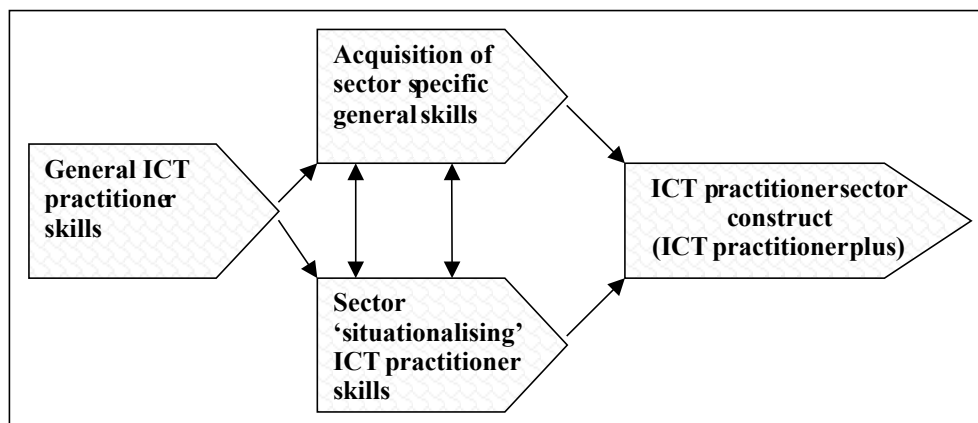
It is important as it was already mentioned above to recognise and agree that the purpose of vocational education is not merely intended to train an individual in technical specific skills but to be seen as a form of all-round education which develops technical as well as social and behavioural skills and which instils ethics and values. It is vital that it shows a learning pathway into higher education and offers the opportunity to expand the individual's horizons. A fundamental component of such a process also needs to assist the learner's meta-cognitive capabilities developing a sense of responsibility for themselves and for their own development.

These latter skills are, perhaps, as important as the technical and certainly act as a differentiator in recruitment of individuals by companies. These behavioural skills need also to be developed not exclusive to the technical learning programme but integral to it. Panel 1, taken from the curriculum guidelines of Career Space (2000), explains this concept.

Examination of the reports for banking and finance and media/graphics indicates a similar situation. It can be argued that for young people considering a career in the ICT Industry who may later migrate into a sector industry as a practitioner, a general, non-contextualised course of study is the most appropriate, providing a body of knowledge which opens up rather than closes down opportunity.

The meta-framework described within this document describes overarching skill profiles. These can be used to delineate a framework of curricula guidelines, which can be used in any European Union country, and within their individual systems, to align content of programmes of study to a common format which supports and encourages mobility of skills through such initiatives as ECVET and Europass. It is also hoped that it provides a basis which allows for the use of frameworks already in use and which does not compromise their potential or capacity for use in these contexts.

The guidelines are further predicated on a diagram, which originates in the First report of the working group supporting

*PANEL 1*
*NOTE ON SITUATIONAL LEARNING*
*THE EXPLICIT ACQUISITION OF BEHAVIOURAL SKILLS*
by Peter Revill,

Member of Career Space Curriculum Development Group
One of the most fundamental concepts in learning is transfer, i.e., the ability to apply something learned in one situation to another setting. Transfer of learning can be defined operationally as improved performance on one task as a result of knowledge acquired on a previous task. This could apply to any type of skill (e.g., analytical, communication, problem solving, leadership, etc.).

Historically, methods of didactic education, often an integral part of higher education delivery, assume a separation between knowing and doing, treating knowledge as something integral and self-sufficient, theoretically independent of the situations in which it is learned and used. On the other hand, more experiential teaching methods use direct debriefing opportunities designed to help the student 'Situationalize' and recognise, the many aspects of learning taking place. These methods are particularly useful with regard to the softer or behavioural skills.

To reinforce the idea that behavioural concepts are both situated and progressively developed through activity, the idea that they are abstract, implicit and self-contained should be abandoned. Instead, it may be more useful to consider behavioural skills as being a set of tools. Such tools in this context can only be fully understood through use, and using them entails changing the user's view of the world. If behavioural skills are thought of in this way they can be used to distinguish between the 'mere acquisition of inert concepts and the development of useful, robust knowledge' (Whitehead, 1929).

It is possible to acquire a tool but be unable to use it because either its acquisition has not been recognised by the learner or she/he is unable to transfer the learning from one situation to another. Students who are given the opportunity to use behavioural skills in a context oriented environment and where opportunities exist for the emerging learning to be made explicit and recognised by the learner build a richer understanding of themselves and their abilities and increase their own self confidence to perform the myriad tasks expected of them by potential employers. Lifelong learning is a process of working in 'situations'. Guided reflection assisted by the teacher, but undertaken by the learner about the activities integral to that 'situation' will help recognition of the learning-taking place.

the Cedefop virtual community for credit transfer in VET. It illustrates curricula for vocational education made up from a range of modules. The module within our model has then been deconstructed to illustrate a range of components, which act as guides to course structure. The main technical components of the module(s) are described in terms of learning outcomes rather than as curriculum content, the former offering greater flexibility for course design and delivery. The modules, for our purposes, reflect the basic components of the meta-framework, proposed within this document.

*Figure 55: Draft scheme illustrating the relationships between the basic components of a credit system in VET*
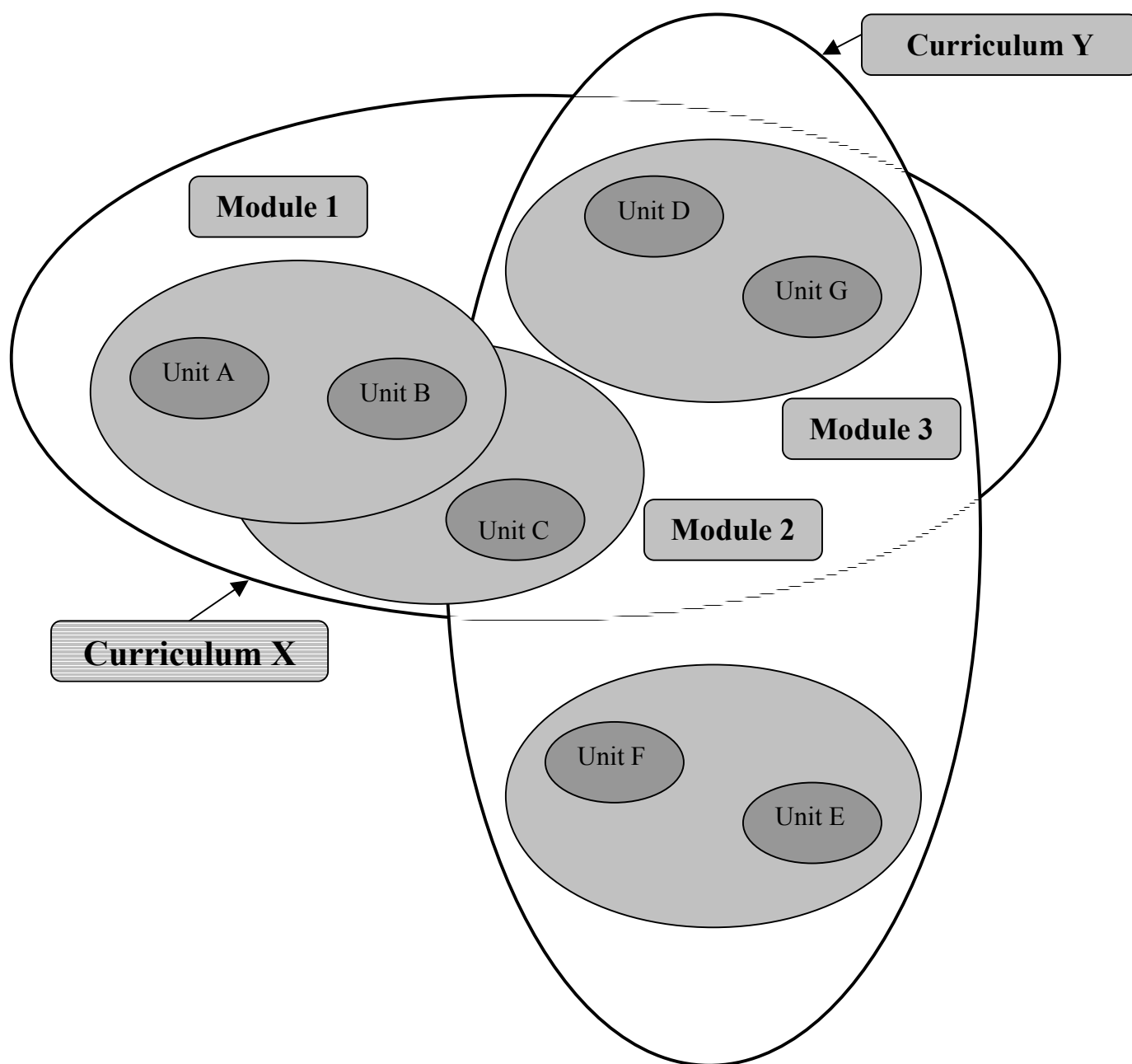
The curricula need a structure and definition of learning sections which are defined as work area oriented ICT learning modules. This name and structure have been chosen because the qualifications and contents of each learning section are geared to the description of the work areas; also each learning section – like a module – is part of a didactic module set that constitutes each ICT training programme. The module structure and sets show the following

level variants, including a recommendation for valuing ICT vocational training programmes in terms of credit points (CP).

*Table 6:        Sets of work area oriented ICT learning modules*

| ICT assistant curriculum (L2, 12 CP) | ICT technician curriculum (L3, 36 CP) | ICT specialist curriculum (L4, 24 CP) |
|---|---|---|
| -     set of assistant basic modules<br>-     set of assistant modules<br>-     set of assistant elective modules | -     set of technician basic modules<br>-     set of technician modules<br>-     set of technician elective modules<br>-     set of technician add-on modules | -     set of specialist modules<br>-     set of specialist elective modules<br>-     set of specialist add-on modules |

These sets of learning modules can be defined in more detail for the ICT assistant curricula at level 2, the ICT technician curricula at level 3 (as shown in the figures below) and the ICT specialist curricula at level 4.

*Figure 56:    Examples for ICT technician curricula at level 3*



### 6.3.2.    Outcomes definitions

The aim of ICT vocational education is to produce a skilled worker with sub-degree ICT qualifications and abilities that qualify him or her to work in different areas and fields of activity and to carry a range of ICT work tasks. The ICT training profiles and curriculum development guidelines emphasise the importance of qualification levels and profiles meeting the needs of the different ICT work area and labour market requirements. The sub-degree ICT qualifications and the structure and definitions of the ICT training profiles have already been described in such a way that outcomes definitions have strong relevance to the needed skills and profiles within the ICT and user sectors.

Correspondingly, the outcomes as sets of qualifications defined by the generic work area oriented ICT skills profiles are the basis for developing the curricula of ICT training profiles, rather than simply a knowledge list of subjects, scientific disciplines and technology areas. To adjust the outcomes continuously and keep the curricula up to date, in order to increase the

employability of skilled ICT workers, skill needs within the ICT and user sectors should also be evaluated continuously, e.g. through surveys and company case studies. Understanding curriculum development, therefore, is a continuing process. However, curricula outcomes have to be defined precisely in each case and specifically for the modules as the relevant basis for aspects such as entry requirements, assessment and certification. For example, the qualifications and contents structure of the defined outcomes of a technician in ICT systems and application development at level 3 can be described as follows.

*Figure 57:    Qualifications and contents structure of defined outcomes of the 'informatics technician' at sub-degree level 3*
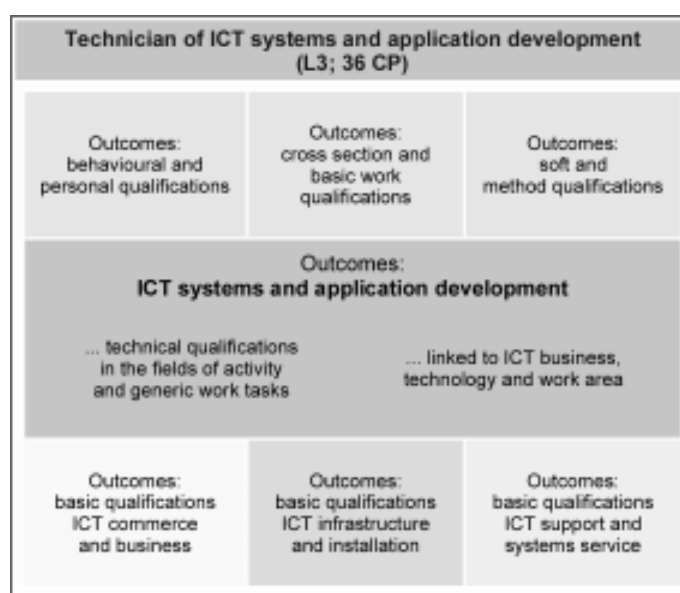


It is imperative that behavioural skills are encouraged and developed within the context of the learning programme and not taught separately. In developing such skills, the guidelines offer learning outcomes that should be striven for, again offering flexibility in their mode of delivery and inclusion within any programme of study.

The detail of defined outcomes for one learning module for this position is as follows:

*Figure 58:    Defined outcomes of one work area oriented ICT technician elective module*



### 6.3.3.    Assessment and certification

The outcomes of the ICT training profiles at sub-degree levels 2, 3 and 4, in combination with the duration of the relevant ICT vocational training programme, are one basis for setting up entry requirements. Another orientation is given by the three models with a hierarchic structure and combination of the two and three years ICT vocational training programmes (see Section 2.3.). Vocational education and training normally starts at sub-degree levels 2 or 3 where entry requirements are education and qualifications in general, which trainees have acquired through secondary education up to the age of 16. ICT vocational training programmes at level 4 normally build on a programme at level 3. Therefore, the entry requirements of VET level 4 can be described by the outcomes of the ICT training profiles at sub-degree level 3.

Other possibilities of entry and intergradation can be open, using the recommendations of valuing and assessment as well as corresponding certification of the ICT training profiles and modules outcomes. The recommended outcomes value in terms of credit points (CP) of the ICT assistant curricula is 12 CP, of the ICT technician curricula 36 CP and of the ICT specialist curricula 24 CP. The outcomes value of the modules differs depending on profile

level and learning module duration (see example above). With certificates for the profiles and modules according to the credit points and based on examinations, there are various options of mutual recognition between profiles and outcomes respectively, as well as to establish individual entry requirements. For example certification for ICT assistant outcomes can be recognised with 12 CP for profiles at level 3, while ICT technician outcomes can be recognised with 36 CP for the profiles at level 4.

As a new intergradation between the sub-degree and degree level, the certification for ICT specialist outcomes (which include the ICT technician outcomes) can be recognised with 60 CP (36 CP + 24 CP) for profiles at a first cycle degree, e.g. BA level (=180 CP). Other mutual recognition, such as valuing non-formal prior learning by external exam or product and vendor specific certifications in the broad ICT business areas, are also possibly more effective on an outcomes basis.

### 6.3.4. Links to 'vendor awards'

It is recommended that where a vendor (or vendor neutral) award can be demonstrated as meeting the specification requirements, either as a whole or in part, for one or more component parts within the guidelines framework, then the vendor award should be allowed to form a contributory element of a relevant vocational qualification.

It is recommended, therefore, that this consideration be extended to allow such inclusion of vendor awards where they:

- address the required specification of technical, component parts contributing towards a full vocational qualification;

- fulfil the appropriate accreditation criteria.

While it is recognised that vendor awards often do not allow for assessment of work-based competence, they can be sought after by employers as they often attest to product-based competence. The opportunity to use appropriate vendor awards in contributing to vocational qualifications would assist in ensuring the relevance of such qualifications.

### 6.3.5. Conclusions

The cycle of knowledge creation, distribution, learning and utilisation is becoming shorter. This in turn leads to a need for continuous qualification of the workforce and update of the learning content, lifelong learning. While this practice should have its roots in school education, the upskilling aspect should become embedded within the tertiary phase of education as the individual matures.

The guidelines offered here should promote and encourage the development of curricula within vocational education programmes, which meet the needs of all stakeholders, but in

particularly the learner. They should be viewed as a challenge to forward educational thinkers who, in designing the programmes of study, will see this as an exciting challenge to consider realistic learning objectives and a teaching methodology, a pedagogy, which supports the learning style of all learners.

These curricula should meet the needs of traditional full-time learners as well as non-traditional learners such as part-timers and mature students. The structure proposed should also lend itself to the needs of learners who require short sharp inputs of learning as a means of upskilling in a rapidly changing and dynamic technological environment.

In order to meet all these requirements, ICT curricula need a flexible structure on a modular basis so that they can be easily adapted to different target groups, different skills profile needs and the rapid pace of change. It is hoped that the modular structure described here will facilitate this.

No curriculum is perfect nor can it prepare students for all activities. However, if taught in a contextual and integrated way, the tools developed within the individual should facilitate the transfer of learning more effectively.

The guidelines described here should provide curriculum developers with a common platform to level 4, which has the potential to integrate with the recommendations of the Career Space guidelines for higher education, to provide a more fluid pathway. More importantly, this platform should provide a level of commonality, which promotes and encourages mobility while respecting the uniqueness of national systems.

# 7. Implementation issues and recommendations

This section identifies the implementation issues that have emerged during this synthesis study, either from the subsidiary reports or from discussions in meetings and between the team members. The scope of this project does not embrace solving these issues or their investigation to any depth, except in the case of a common skills dictionary where a brief exploration has been carried out and is described.

The issues start with compatibility of certification, competence and accreditation. This is, in part illustrated by the graphic arts and media report:

'A major priority for the sector is to work on the development of a system for evaluation and certification of competence at European level, contributing to the transparency of occupational standards' (report D, p. 13 et seq.).

Qualifications as a general recognition of achievement (transferability of achievement) are also important and dealt with in the same report:

'Also desirable to standardise the recognition by employers of certificates and diplomas awarded to workers. Evidence shows that at present acceptance is not uniform across Europe' (ibid.).

Credit transfer systems and Europass and standardisation and comparability of the graduations (output standards) are covered:

'Similarly it is desirable for a more standardised acceptance of certificates and diplomas as acceptable entry to further vocational training. There needs to be a general standardisation of curriculum content and output standards for each level of competence. And thereby overcome the apparent lack of trust between EU partners in module content, associated competence level and of overall qualification and curriculum frameworks' (ibid.).

Other issues include:

(a) financing and updating the equipment of educational institutions;

(b) preparation and common use of teaching materials (possible role of SCORM);

(c) common use of training institutions for initial and further training;

(d) vendor qualifications;

(e) further training of trainers, instructors and teachers;

(f) common skills dictionary or glossary/typology.

## 7.1.  What is currently being done?

Across Europe there is current activity on a number of these issues. 'Under the principle of subsidiarity every Member State of the European Union still retains full responsibility for the content of teaching and the organisation of its own education and training system. However, people increasingly need to be able to follow more individualised learning and work pathways which may take them between different levels of education and training, different occupations and sectors, as well as between countries (see The Copenhagen Declaration, Nov. 2002). Corresponding actions have been trying to tackle aspects such as mobility, exchanges, transparency and recognition of qualifications, definition and use of reference levels and qualification system structures, cooperation in areas of accreditation/ certification and the validation of non-formal prior learning. Recent developments include the Europass-Training developed by the EU or Cedefop activities such as the network of reference and expertise, the establishment of virtual communities and the service to the social partners and the social dialogue (for more details see on http://www.Cedefop.gr)' (report A, p. 107).

On the issues of enhancing mobility:

'One of the major preconditions for mobility certainly is to set up frameworks that improve transparency in European employment and training strategies and action. The 'European Commission's Action Plan for skills and mobility' thus highlights three fundamental challenges (see CEC, 2002c, p. 4):

(a)  Firstly, there is the challenge of inadequate occupational mobility, showing up the need to adapt education and training systems more effectively to the labour market, to boost lifelong learning and skills acquisition (particularly skills in information and communication technologies – ICT), and to improve systems to recognise qualifications and competences.

(b)  Secondly, low levels of geographic mobility within and between Member States suggest that the benefits of the internal market are not yet fully explored, for example in terms of dealing with skills bottlenecks or labour market imbalances. Many obstacles to mobility still exist, including deficiencies in language skills, etc.

(c)  Finally, deficiencies in access to and the quality of information on mobility and individual sectors deter many people from considering a job move or particular career choice'

(Report A, p. 107).


## 7.2.  Common skills dictionary: job titles and structure levels

Titles of positions held by individuals within organisations or structures are both important and emotive. They are important from the point of view of the holder in that they confer a 'level' of operation on that individual and position them in the overall organisational

structure. Clearly from the individual's point of view the better the title or label the more senior they are, or appear to be, in the work environment, to customers and the external business environment and to their peers and the social groups within which they live.

Some titles were historically established and, with the passage of time, there has been a progressive expansion of their meaning and resistance to use of terms that are considered inappropriate, through fashion or political (small 'p') reasons. An example of this in the UK is the almost derogatory inferences of the title 'secretary', to the extent that in many structures the title is being eliminated. The title 'engineer' has evolved over time to embrace a vast diversity of jobs over a very wide range of levels, from vocationally-oriented to those requiring first cycle degree and superior qualifications for entry. Sometimes such titles are augmented by an additional word such as 'professional' or 'chartered' to denote a more advanced level within the engineering scale. Incremental development of titles, for whatever reason, leads to change that can be helpful yet sometimes unhelpful, in that the accepted meaning of a title moves away from its traditional origins to a more liberal and, in some cases, reduced value meaning (for example in 'engineer' in the UK). To turn the clock back is unrealistic.

An additional complexity arises through the different meaning associated with titles within different cultures and nationalities.

The objective of this short section is not to provide answers, because this is a complex and emotive area, but to provide some basic information that can be used for discussion purposes and, perhaps, provoke some debate as a lead in to the (possible) establishment of a common set of nomenclature across Europe.

## 7.3. How can job titles be formulated?

There are four initial ways in which the title describing a job can be formulated. They are by reference to:

(a)  the inputs to the job function;

(b)  the output expectations of the job function;

(c)  the value added by the job function;

(d)  the process that is undertaken by the job holder.

This list is not implied to be exhaustive. Many of the current titles are based on words that are functional nouns, as is illustrated below where the Oxford English dictionary definitions of words are shown.

The profiles framework in this report, see Section 5.1., is used as a source of job titles. In the framework and map of European ICT work areas and generic ICT skills profiles at different levels diagram, example job titles are given for a range of different work areas and across the

spectrum of levels (L2 to L6). Table 7 below shows an extract from this table, taking the key word(s) within each job title that are indicative of level. For example, for the job profile ICT business assistant, the word assistant is the one extracted as indicative of level, ICT business being indicative of context.

*Table 7:      Key word extraction from skills framework*

| L2 | Assistant, supporter, programmer, troubleshooter |
|----|--------------------------------------------------|
| L3 | Technician, developer, specialist, coordinator, programmer, fitter, operator |
| L4 | Manager, specialist, consultant, administrator, supporter, programmer, analyst, designer, operator, master |
| L5 | Manager, engineer, planner, producer, programmer, support engineer, tester, specialist |
| L6 | Manager, consultant, strategist, analyst, scheduler, architect, engineer |

Table 7 immediately shows a problem. Although in different ICT business areas, the same generic title is used for jobs at different levels, some across a wide range of different levels; for example, manager is used from L4 up to L6. Below are the Oxford English dictionary definitions (the relevant parts of) for the extracted words in Table 7.

---

**Administrator**

'One who administers; one who manages, carries on, or directs the affairs of any establishment or institution; a steward, manager, or acting governor.

One who has the faculty of managing or organising.'

**Analyst**

One who is skilled at analyzing data.

**Architect**

'One who designs and frames any complex structure; esp. the Creator; one who arranges elementary materials on a comprehensive plan.

One who so plans, devises, contrives, or constructs, as to achieve a desired result (especially when the result may be viewed figuratively as an edifice); a builder-up.'

**Assistant**

'One who is present, a bystander; one who takes part in an assembly.

One who gives help to a person, or aids in the execution of a purpose; a helper, an auxiliary; a promoter; also, a means of help, an aid.'

**Consultant**

'A person qualified to give professional advice or services, e.g. in problems of management or design; an adviser;'

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**Coordinator**

'A person or thing that coordinates'

**Designer**

'One who originates a plan or plans.

One who makes an artistic design or plan of construction; a draughtsman; spec. one whose business is to invent or prepare designs or patterns for the manufacturer or constructor.'

**Developer**

'He who or that which develops.'

**Engineer**

'One who contrives, designs, or invents; an author, designer (const. of)'

**Fitter**

'One who or that which fits'

**Manager**

'One who manages (something specified); the wielder (of a weapon), the person who wages (a war); the conductor (of an affair). Now rare in general sense

Chiefly with qualifying adj.: One skilled in managing affairs, money, etc.

One whose office it is to manage a business establishment or a public institution.'

**Master**

'gen. One having direction or control over the action of another or others; a director, leader, chief, commander; a ruler, governor. Obs.

One who employs another in his service: correlative with servant, man; also with apprentice, where the original sense is that of branch.

One who has the power to control, use, or dispose of something at will.

Originally, a workman who is qualified by training and experience to teach apprentices and to carry on his trade on his own account.'

**Operator**

'One who does or effects something; a worker, an agent; a maker, producer, creator.

One who performs the practical or mechanical operations belonging to any process, business, or scientific investigation; a person professionally or officially engaged in doing this; spec. a secret-service agent.'

**Programmer**

'One who programmes, in various senses, as: a. (s.v. Programme v.) b. One who devises a course of programmed instruction. c. One who plans or chooses programmes for broadcasting. d. One who arranges something according to a programme.

One who writes computer programs.'

**Scheduler**

'One who draws up a schedule or arranges activities in accordance with one.'

**Specialist**

'In general use, one who specially or exclusively studies one subject or one particular branch of a subject.'

**Strategist**

'One versed in strategy.'

**Supporter**

'One who or that which supports.

One who sides with, backs up, assists, or countenances a person, cause, etc.

One who keeps a person or thing from failing, giving way, or perishing; a sustainer, maintainer.'

**Technician**

'A person conversant with the technicalities of a particular subject.

One skilled in the technique or mechanical part of an art, as music or painting.

A person qualified in the practical application of one of the sciences or mechanical arts; now esp., a person whose job is to carry out practical work in a laboratory or to give assistance with technical equipment.'

**Tester**

'One who tests or proves, or whose business is to test the quality or condition of anything; a device for testing.'

**Troubleshooter**

'A person who traces and corrects faults in machinery and equipment (orig. spec. on a telegraph or telephone line).

One who specializes in removing or solving difficulties; esp. a mediator in diplomatic or industrial affairs.'

The definitions also imply level in that master is at a higher level than people doing the work, for example support engineer or tester. In Table 8, master is L4 whereas support engineer and tester are both at the higher L5 level. The accepted meaning of titles clearly differs from, or has incrementally been developed away from, what might be considered the formal definition of the meaning of the words.

## 7.4.　Job title structures

*biat*

A second source of general job titles is the *ICT practitioner skills and training solutions at sub-degree vocational level in Europe* report by *biat*. In this report, level 2 is consistently given the (extracted) term assistant, level 3 technician and level 4 specialist.

**APO-ICT**

The German APO-ICT skill matrix, developed by the *Bundesinstitut fur Berufsbildung* (BiBB), continuing education system map shows three generic levels with strategic professionals comprising IT system engineer and IT business engineer at master of engineering level (second cycle degree level), operative professionals comprising IT engineer, IT manager, IT consultant and IT commercial manager at the bachelor of engineering (first cycle degree level) and 29 specialist occupations, which include technicians, software, solution, coordinators, mediators and administrators. This model is primarily a hierarchy of qualifications but makes strong reference to titles as is illustrated by the following extract from the report.

'The overwhelming majority (29/35) of the APO-ICT occupational profiles fall into the category identified as "Specialists" in the BiBB model. This level requires a completed apprenticeship followed by at least three or four years of experience of which one year would be spent on the job obtaining the recognised further qualification needed in order to be recognised as competent at that level. Further career opportunities are open to "specialists". If they are successful in examinations which test working competence they can be recognised as competent at the "operative professional" level, considered equivalent to a university first degree. The final stage in the further qualification process now being put in place requires a

pass in additional work-process oriented examinations and this level, "strategic professional" is recognised as being equivalent to a post-graduate Master qualification.'

**SFIA**

The skills framework for the information age (SFIA) of the UK is a model that identifies 57 skill areas which can be deployed at one or more of seven levels. These levels are:

*Table 8:      SFIA level descriptors*

| Level 7 | Set strategy, inspire, mobilise |
|---------|--------------------------------|
| Level 6 | Initiate, influence            |
| Level 5 | Ensure, advise                 |
| Level 4 | Enable                         |
| Level 3 | Apply                          |
| Level 2 | Assist                         |
| Level 1 | Follow                         |

The Oxford English dictionary definitions of the SFIA terms are:

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**Inspire**

'To influence, animate, or actuate (a person) with a feeling, idea, impulse, etc.'

**Mobilise**

'To render (an individual or group of individuals) active or capable of action.

To assemble, organise, and utilize (resources, etc.) for a particular purpose; to press into service; to adduce in support.

**Initiate**

'To begin, commence, enter upon; to introduce, set going, give rise to, originate, 'start' (a course of action, practice, etc.).'

**Influence**

'To affect the condition of, to have an effect on.'

**Ensure**

'To make (a person) mentally sure; to convince, render confident.

To pledge one's credit to (a person); to tell (a person) confidently that (something is true).'

**Advise**

'To offer counsel, as one of a consulting body; to give advice.'

**Enable**

'To impart to (a person or agent) power necessary or adequate for a given object; to make competent or capable.'

**Apply**

'To administer to, to bring (a thing) to bear upon, in order to produce an effect.'

**Assist**

'To help, aid: a person in doing something or an action, process, or result.'

**Follow**

'To go or come after (a person or other object in motion); to move behind in the same direction.'

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It is perhaps obvious that there is a significant difference between the SFIA level descriptor terms and those of all the other sets described in this section. The SFIA terms are all verb terms whereas all the others are nouns or adverbs. The SFIA level descriptors are descriptions of the function or expectations of the job whereas the others are descriptions of the job itself. This is a parallel to the process versus function debate between the GAHFA and SFIA frameworks.

If the objective is ultimately to establish a set of titles that reflect level and are acceptable to all parties then the titles need to be contiguous and recognise the possibility of progression. In the UK, the term technician has traditionally been used to describe a person with vocational and sub-degree qualifications while engineer and professional engineer titles are used to describe persons within the same business sector, who have degrees or above. Engineers and professional engineers rarely aspired to become technicians, however some technicians do aspire to become engineers and professional engineers. Any set of titles implying level must take into account personal development and progression.

In summary, it seems there is a choice of approach to producing a set of level descriptors. The choice is akin to a 'process' or 'functional' view. If the functional view is chosen, then titles describing the job must be designed. The evidence above suggests that such a list will be difficult as some current systems have overlaps, grammatical inconsistencies and illogicalities.

The alternative is to take the process view in which the level is described more in terms of the expectations of an individual who is at that level. In such an approach the titles given can be secondary to the expectations and hence local and national needs can be catered for.

## 7.5.    Evaluation and sustainability

The challenge for means, programmes and actions, both at European and national level, is a preferably broad acceptance of the (reference) frameworks for ICT skills and qualifications. This requires the opinion of as many stakeholders as possible and coordination of corresponding activities. The idea to engage CEN/ISSS in cooperation with Cedefop is a good example of bringing together important European and national VET stakeholders and researchers in ICT to promote such ICT skills and qualifications framework approaches. At the same time, the implementation and evaluation of the new ICT qualification structures and guidelines need to be promoted, best within a scope of comprehensive European pilot projects.

All the activities must focus on two aspects. First is an accepted definition and description of skill and qualification levels (perhaps not only specific to ICT). Some current approaches such as ISCO 88 (COM) have been presented (see Section 3 and in the Annex) and, with additional outcomes of the investigated and summarised Cedefop reports as well as other studies like SFIA and Career Space, summarised and transferred to the recommended European ICT skills and qualifications level structure. Second, the ICT skill needs contextualised through the

description of ICT skills profiles within the GAHFA model structure must be evaluated and kept up to date. This would cover the skill and practitioner needs of ICT industries, as well as the ICT practitioner skill needs of user industries and enterprises of all sizes.

Therefore, both the level approach and the ICT skills needs identified and described in the overall European ICT skills (reference) framework need to be continuously evaluated to ensure currency. One important approach is the evaluation of the results against actual company and work practice needs. This could be done by means of online questionnaires as indicated below. The results of such work and skills analyses would constitute the basis for adapting ICT skills profiles, both in terms of the overall structure as well as the contents.

*Figure 59:    Draft for a questionnaire to analyse industry's ICT skill needs in the GAHFA structure*

The second part of the evaluation would concern the implementation of the new ICT qualifications and curriculum structures. Major challenges are the implementation of the work-oriented qualifications and curricula as well as the modular concept with a corresponding credit points system for VET. The aim is to improve European recognition of the ICT qualification standards and certificates to provide greater transparency and mobility across Europe for skilled workers. The implementation process needs to go along with an open and networked discussion as well as recommendations for tailored ICT and didactic qualification concepts for teachers and trainers.

Skills assessment and quality control need to be subject of evaluation. This includes permanent matching, valuing and accreditation of sector, vendor or product specific ICT certifications as well as prior non-formal learning activities.

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# 9. Annex 1: Cedefop/ICT skills workshop participants

Castelli, Alex; Bloom Consulting, Parma (alexcastelli@hotmail.com)

Dixon, Mathew; London (MD@iisfairfield.demon.co.uk)

Dolan, Dudley; Trinity College, Dublin (dudley.dolan@cs.tcd.ie)

Holmes, Brian; DG Education and Culture, European Commission, Brussels (brian.holmes@cec.eu.int)

Lueders, Hugo; CompTIA/EsCC, Bruessel (hlueders@comptia.org)

Meristö, Tarja; IAMSR/Åbo Akademi University, Turku (tarja.meristo@abo.fi)

Müller, Karlheinz; ZVEI, Frankfurt/Main (mueller.zwingenberg@t-online.de)

Niitamo, Veli-Pekka; Nokia, Espoo (veli-pekka.niitamo@nokia.com)

Petersen, Willi; BIAT, University of Flensburg (awpetersen@biat.uni-flensburg.de)

Pfisterer, Stephan; BITCom, Berlin (s.pfisterer@bitkom.org)

Politis, Anastasios; EGIN, Pireas (politisresearch@techlink.gr)

Power, Alan; IBM, Portsmouth (powera@uk.ibm.com)

Revill, Peter; Department for Trade and Industry, London (peter.revill@dti.gsi.gov.uk)

Richier, Andre; DG Entreprise, European Commission Brussels (andre.richier@cec.eu.int)

Rohde, Gerhard; replaced by Jacqueline Straccia, UNI-Europa, Genf (jacqueline.straccia@union-network.org)

Sellin, Burkart; Cedefop Principal Administrator, Workshop Moderator, (bs@cedefop.eu.int)

van den Berghe, Luc; CEN/ISSS, Information Society Standardization System, Brussels (luc.vandenberghe@cenorm.be)

Ward, Tony; University of York (aew@ohm.york.ac.uk)

Wehmeyer, Carsten; biat, University of Flensburg (wehmeyer@biat.uni-flensburg.de)

Ziegler, Elmar; Siemens Technik Akademie, München (elmar.ziegler@sta.siemens.de)

# 10. Annex 2: Comparison and transfer of skill and qualification level frameworks

The table below indicates correspondence between the ISCO 88 skill levels and the latest EU Directive on recognising professional qualifications at different levels (EC 2004, Article 11), and between ISCED 97 education levels and training qualification levels within the EU Directive. ISCO 88 divides into five skill levels (including an open level at the top), whereas the new EC 2004 directive divides into four professional qualification levels from level A to D. However, ISCO 88 and EC 2004 levels are easily comparable, e.g. the skill level 3 of ISCO 88 corresponds to professional qualification level C of EC 2004.

*Figure 60:    Comparison of approaches for common description, separation and correspondence of skill, qualification and education levels*



The table does not consider education level 1 of the ISCED 97 education and qualification levels since level 1 only covers primary education and is not relevant for HE and VET qualifications. Therefore, the ISCED 97 education and qualification levels in the table below begin with level 2, comparable to VET qualification level A of EC 2004.

The comparison of the international and European level frameworks used in this report is given in the following table. The new ICT skill and qualification frameworks are each five-level structures with three sub-degree/VET levels and two degree/HE levels. Compared to the skill and professional level structure of ISCO 88 and EC 2004, the new ICT level structure is differentiated more for both the 'degree' and 'sub-degree' levels.

*Figure 61:* *Comparison of approaches for ICT and common description, separation and correspondence of skill, qualification and education levels*

| ICT occupation skill level | | | | ICT education and qualification level | | |
|---|---|---|---|---|---|---|
| ISCO-88 skill level --- | EC 2004 professional qualification level D | ICT skill level 6 (work) | Occupation skill level corresponding to HE qualification level | ICT qualification HE level 5M (MA/SCD) | HE qualification level D (EC 2004) | ISCED-97 education Level 6 |
| ISCO-88 skill level 4 | | ICT skill level 5 (work) | | ICT qualification HE level 5B (BA/FCD) | | ISCED-97 education Level 5 |
| ISCO-88 skill level 3 | EC 2004 professional qualification level C | ICT skill level 4 (work) | Occupation skill level corresponding to VET qualification level | ICT qualification VET level 4 (Specialist) | VET qualification level C (EC 2004) | ISCED-97 education Level 4 |
| ISCO-88 skill level 2 | EC 2004 professional qualification level B | ICT skill level 3 (work) | | ICT qualification VET level 3 (Technician) | VET qualification level B (EC 2004) | ISCED-97 education Level 3 |
| | | ICT skill level 2 (work) | | ICT qualification VET level 2 (Assistant) | | |