

Modernisation of the IT occupations in the age of 4.0



HENRIK SCHWARZ
Research Associate in the
“Electrical, IT and Scientific
Occupations” Division at BIBB



STEPHANIE CONEIN
Dr., Research Associate in the
“Electrical, IT and Scientific
Occupations” Division at BIBB



HERBERT TUTSCHNER
Head of the “Electrical, IT
and Scientific Occupations”
Division at BIBB

BIBB has been investigating whether the four dual IT occupations, which have remained unchanged since 1997, need to be modernised. Against the background of the increasing digitalisation of the world of work, the aims of this process were to identify current and foreseeable requirements for skilled IT staff and to draw up proposals for the future shaping of the IT occupations. This article presents selected outcomes of the investigation and uses this to arrive at conclusions with regard to a possible rearrangement of IT occupations.

Training in the IT occupations

The four dual IT occupations (cf. Table 1) met with considerable demand from trade and industry when they were introduced in 1997. This popularity has been retained down to the present day. Over the past few years, the number of newly concluded training contracts has been around 15,000 annually and has most recently risen to 16,000. Since the launch of the IT occupations, around 250,000 skilled IT staff have been trained for work at manufacturing and applications companies offering products and services in the field of information and communication technology. The IT occupations were a reaction to the boom of the 1980s, which was brought about by the standardisation of hardware and software and allowed new, cost-effective and individually deployable information and communications technology (ICT) to penetrate all sectors of trade and industry. The flexible structure of the IT training occupa-

tions resulting from these lines of development was able to meet the differing requirements of IT manufacturers and applications companies (cf. Table 1).

The training occupation of information technology specialist, which offers two specialisms, has increasingly become a sought-after core brand within the IT occupations in recent years. The numbers of trainees entering this occupation more than compensate for the tendency towards a decline in the other three occupations. Between 2015 and 2016, the figures for newly concluded training contracts for the occupation of information technology specialist increased once more by 1,000 to reach a level of over 12,000 (cf. Figure 1).

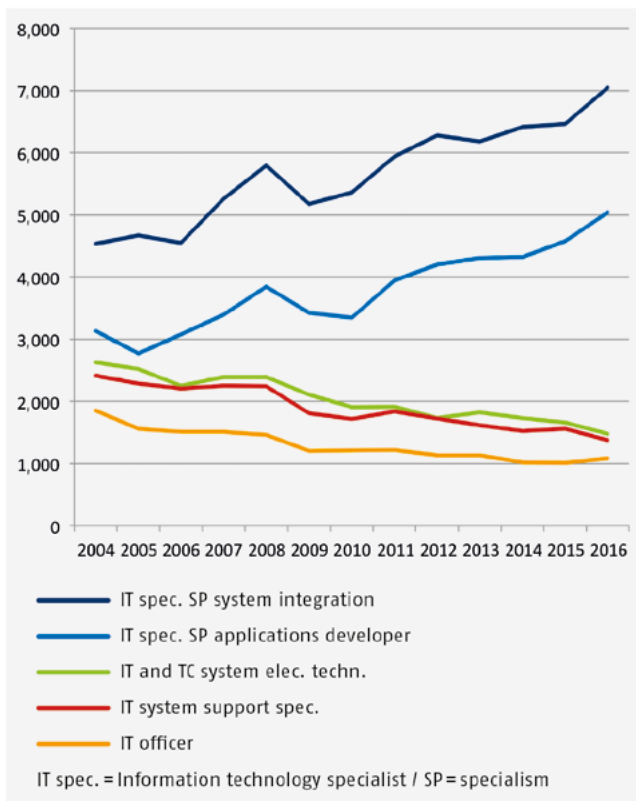
The development of the Internet of things will continue to drive demand for IT qualifications in all branches. “15 per cent of private sector companies have recruited new staff with digital competences over the last year, and 15 per cent plan to do so by the end of 2018. Moreover the ICT branch

Table 1

The four IT occupations including main task focuses

Training occupation	Main task focuses
Information technology specialist <ul style="list-style-type: none"> • Specialism of applications development • Specialism of systems integration 	Software development and programming Management and administration of IT systems
Information technology and telecommunications system electronics technician	Installation and repair of IT systems
Information and telecommunications system support specialist	Provision and sale of IT solutions
Information technology officer	Management and administration of IT systems

Figure 1
Newly concluded training contracts in the IT occupations



Source: BIBB survey as of 30 September each year

stands out with its high requirement for skilled workers, amounting to 31 and 43 per cent respectively at these two periods.” (BMW 2016, p. 14). Nevertheless, many companies fear that the shortage of skilled workers is a particular factor which could hinder the progress of digitalisation (cf. BMW 2016, p. 69).

Estimations on the development of the labour market assume that the need for skilled workers, which is growing anyway, will increase by up to 3.15 per cent more per year by 2030 because of the so-called fourth industrial revolution (Industry 4.0) than it would without this new production structure. Within this process, “37 per cent of the additional demand for IT occupations will take place outside the IT branch in the manufacturing sector” (cf. HALL et al. 2016, p. 6 and pp. 18 ff.).

The rising number of interlinked sensors and actuators in production, software-intensive embedded systems and the digitalisation of whole business processes will continue to heighten requirements in terms of reliability of networks, real-time processing, data security and processing large quantities of data. Although the resultant topics such as software development, cloud computing and big data and the huge issue of IT security are not fundamentally new, but universal and complex application scenarios are leading to new demands being placed on skilled IT workers.

These requirements relate to personal and social competences as well as to the technical area. Skilled IT workers are working in interdisciplinary teams on an increasingly frequent basis, or at least need to deal with contents which are not originally of an information technology nature. They also often work at interfaces and have to communicate with different target groups. “Core cross-cutting skills” such as “willingness to learn, the ability to work as part of a team, flexibility, problem analysis and problem solving abilities and management and project management competences” will become more significant in future, both for skilled IT workers and for skilled workers in general (cf. AICHHOLZER 2016).

In light of the developments described, the question posed for vocational education and training is the extent to which the existing IT occupations, even given their flexible and therefore adaptable structure, will be able to cover current and future requirements made of skilled IT workers in quantitative and qualitative terms.

BIBB evaluation study

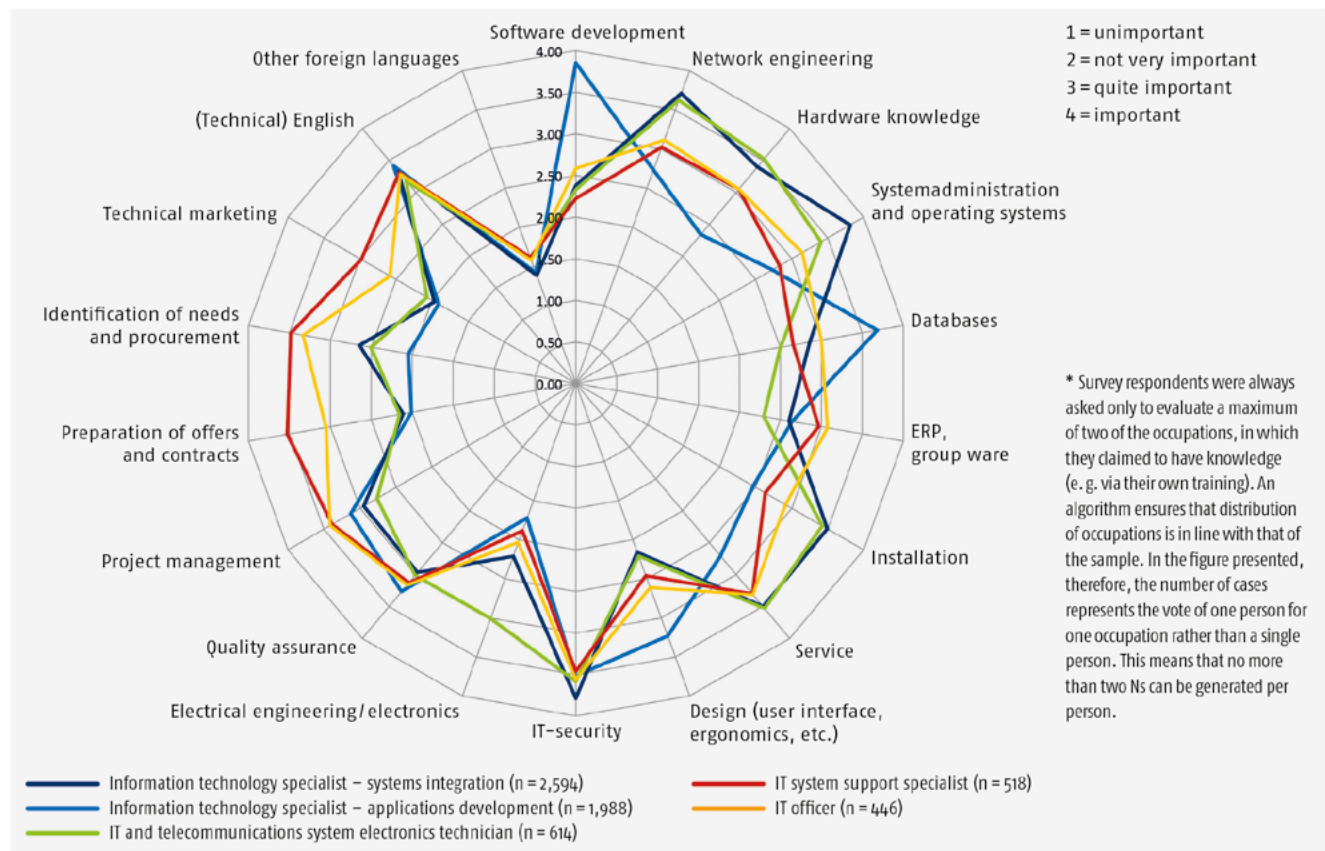
For this reason, the aims of the evaluation concluded by BIBB in 2016 were to identify current and foreseeable requirements for skilled IT staff and to draw up proposals for the future shaping of the IT occupations. The investigation, which was carried out on behalf of the Bundesministerium für Wirtschaft und Energie [Federal Ministry for Economic Affairs and Energy] with the support of an advisory council, followed a three-stage design. This comprised an exploratory phase and phases involving qualitative and quantitative surveys respectively (cf. CONEIN/SCHWARZ 2015).

Table 2
Distribution of respondents to the online survey by target groups

Target group	n	%
Trainees	1,767	29.0
Skilled IT workers	1,911	31.3
Training managers	1,237	20.3
Human resources managers, works council members, Young People and Trainee Council members, management staff	748	12.3
Teachers at vocational schools for IT occupations	438	7.2
Total	6,101	100.0

Figure 2

What role is played by professional competences from the following occupational requirements areas for the work of skilled IT workers?*



The results presented in this article relate firstly to a total of 54 semi-structured guided expert interviews. Trainees, training managers, human resources managers and management staff from ten selected companies were interviewed for this purpose alongside three branch experts, three teachers and three representatives from chambers of commerce and industry. Secondly, the representation is based on the results of the quantitative phase, in particular the online survey. A total of 6,101 cases that were capable of evaluation emerged from this survey and are distributed across five target groups (cf. Table 2, p. 11).

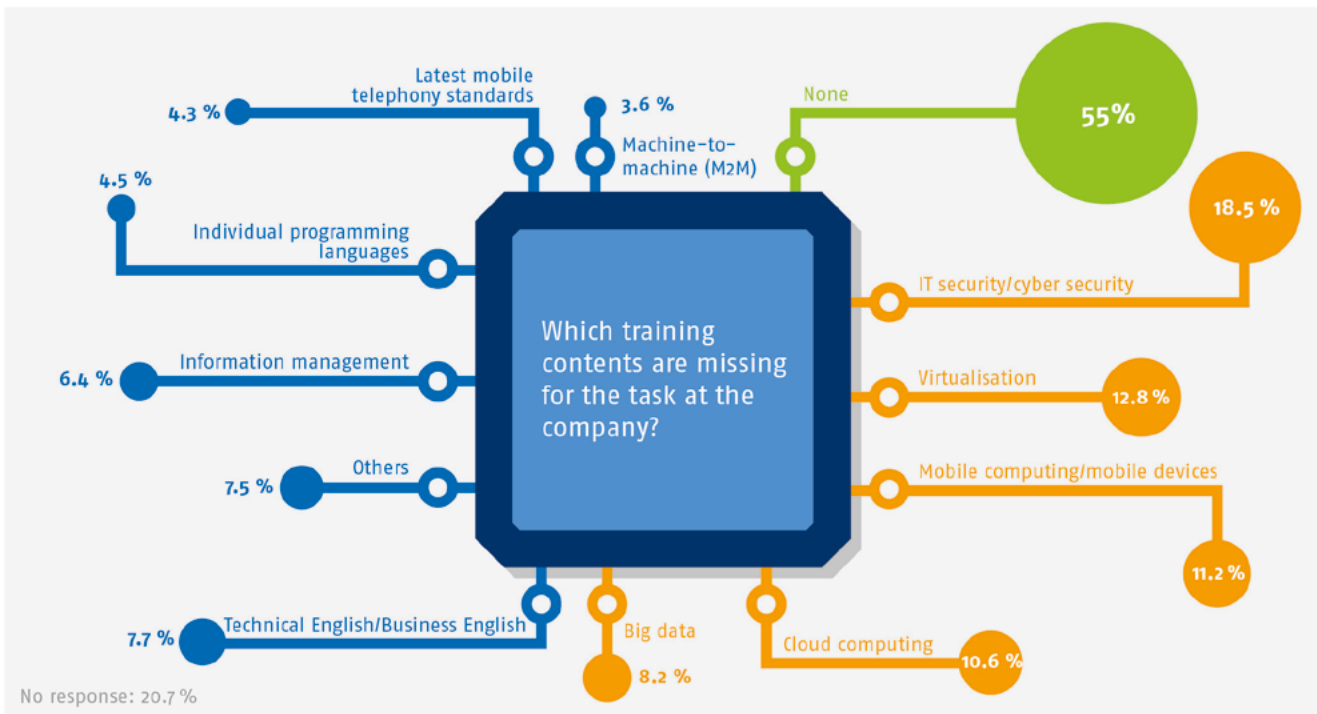
The skilled IT workers interviewed work in all branches. About one third are employed in the economic sector of information and communications, whilst the rest are distributed across virtually all other economic sectors, including eleven per cent from manufacturing industry followed by smaller proportions from public administration, other services and financial and insurance services.

The main focus below is on the results of the BIBB evaluation study, which relate to the urgent need for change in current IT training. These results refer to conceivable amendments to the design of occupational elements and to certain training contents (for further results cf. SCHWARZ et al. 2017).

Delineation of occupational profiles

Questions about the occupational significance of professional competences in 18 selected requirements areas make it clear that the various occupational profiles demand very different professional competence in some cases whilst exhibiting high degrees of similarity in this regard in other areas. The two specialisms contained within the occupation of information technology specialist (applications development and systems integration) are clearly delineated from one another and are objects of separate demand (cf. Figure 2). The areas of software development and databases, for example, play an essential role for information technology specialists in applications development. Information technology specialists in systems integration mainly require competences in the fields of network engineering, system administration, operating systems and IT security. In overall terms, the profiles have proved their worth. If anything, the indications emerging from the surveys suggest that these profiles should be more strongly separated. Whereas 44.4 per cent of respondents were in favour of retaining the specialisms, as many as 37.8 per cent thought that division into autonomous occupations should take place.

Figure 3
Which training contents are missing for the task at the company?



(n = 5,450)

There are content overlaps between the occupations of information technology and telecommunications system electronics technician and information technology specialist in systems integration, particularly in the thematic fields of network engineering, hardware knowledge, installation and service. The only area in which there is a significant delineation in requirements is the field of electrical engineering/electronics, a more major domain for information technology and telecommunications system electronics technicians. 54.2 per cent of information technology and telecommunications system electronics technicians thought that the two occupations should be combined, whereas only 22.0 per cent of the information technology specialists in systems integration surveyed were of the same view.

There are very large overlaps between the two commercial training profiles of information and telecommunications system support specialist and information technology officer. The only significant variance between the occupations relates to preparation of offers and contracts and technical marketing, where there is a difference of approximately 0.4 points (cf. Figure 2).

Need for change in training contents

Satisfaction with current training content was high in overall terms. More than half of all respondents answered in the negative when asked about missing contents (cf. Figure 3). If missing contents are stated, these primarily relate to top-

ics that play a role in connection with Industry 4.0, such as virtualisation, mobile computing, mobile devices, cloud computing or big data. In this regard, there are only marginal differences across all occupations and between the individual branches.

Regardless of target group, branch or company size, the highest degree of significance is accorded to the topic of IT security: *There are topics which are not yet well represented on the market generally. These include the topic of IT security. Very good experts are already in place, but the quality of training is not keeping up.* (member of management staff)

With regard to the topics of Industry 4.0 and the Internet of things, the interview partners mainly indicate that professional competences and technical knowledge require ongoing situationally-related updating in the face of the increasing complexity and individualisation of production processes.

Yes, [requirements have] changed, particularly in the area of agile software development, (...) the versatility involved has now become higher and broader. There is also the emergence of Industry 4.0 (...) Before we learned to programme in one programming language. Now programming is also learned in a situationally-related way. This means that I programme to suit the device, i.e. I may use either a traditional programming language such as C or web programming languages like PHP. Then there is also AJAX or Frameworks, which consists of many frameworks that need to fit. So the level of diversity is now greater. (branch expert)

Personal competences

Respondents certainly attach a high degree of relevance to selected personal competences required for the work of skilled IT workers. On average, these receive higher relevance values than the technical competences.

Particular popularity is given to the competence of willingness to learn, which is evaluated as the most important competence in relation to almost all occupations. This finding is also supported by the results of the qualitative interviews, in which human resources managers and management staff accord great significance to the continuing training of skilled IT workers and also expect employees to pursue corresponding activities in this regard. Conscientiousness, autonomy and results orientation are also considered to be relevant to all occupations. In the case of the two specialisms of the occupation of information technology specialist, particular relevance is also ascribed to the competences of being able to adopt a systematic and methodological approach and to problem solving skills. Communication skills and customer/user orientation are emphasised in respect of the two commercially-aligned occupations. Conflict resolution and decision-making skills tend to be viewed as less relevant across all occupations, and eloquence comes in last.

None of these results are surprising in any way and further support the call for personal and social competences to be imparted, including and particularly within the information technology occupations.

Recommendations

IT occupations are both sectoral occupations for the ICT manufacturers and providers and cross-sectoral occupations which are used by the users and customers of ICT solutions. They are also interface occupations which combine information and communication technology with production technology and business management. The increasing digitalisation of all economic sectors will bring about a strong growth in the number of networked and interacting systems and will therefore further increase the complexity of these interface functions. Skilled IT workers primarily work in a project-related way within an environment in which requirements change. The view of the experts surveyed is that personal and social competences will become even more important in future alongside professional competences.

The available results suggest that the IT occupations should undergo revision in respect of contents and structure:

- The following recommendations may be made with regard to the design of the occupations. The two commercially-aligned IT occupations of IT system support specialist and officer should be merged due to the fact

that they exhibit very strong overlaps. The two specialisms within the occupation of information technology specialist should be dissolved into separate occupations, because there is a clear difference between their profiles and demand continues to be very large in overall terms.

- Two thirds of skilled IT workers are employed in branches outside the ICT sector, including in the manufacturing industry. With regard to the topic of Industry 4.0, consideration should be accorded to establishing content such as production management, virtualisation and embedded systems more firmly into the training areas of applications development and system administration.
- The topic of IT security (data security, availability, data integrity and data protection including legal aspects) should be significantly strengthened. This should take place via a fundamental cross-occupational understanding of issues relating to IT security and secondly via occupationally specific contents (e. g. risk analysis, protection of hardware and networks/infrastructure, encryption, rights, legal requirements, certification, training).
- Personal competences should be accorded comprehensive consideration within the training contents.
- In order to take account of the increasing complexity, heterogeneity and speed of change of the requirements, differentiations in the form of elective qualifications should be introduced (for more information on the possibilities of elective qualifications cf. also SCHWARZ et al. 2015, pp. 67 ff.).

These and other proposals are currently being debated by stakeholders involved on both the employer and employee side with a view to rearrangement. ◀

Literature

- BUNDESMINISTERIUM FÜR WIRTSCHAFT UND ENERGIE (BMWi) (Ed.): Monitoring-Report, Wirtschaft DIGITAL 2016, Berlin 2016 – URL: www.bmwi.de/Redaktion/DE/Publikationen/Digitale-Welt/monitoring-report-wirtschaft-digital-2016.pdf?__blob=publicationFile&v=10 (retrieved: 07.09.2017)
- CONEIN, S.; SCHWARZ, H.: IT-Berufe auf dem Prüfstand. In: BWP 44 (2015) 6, pp. 58–59 – URL: www.bibb.de/veroeffentlichungen/de/bwp/show/7872 (retrieved: 07.09.2017)
- HALL, A. et al.: IT-Berufe und IT-Kompetenzen in der Industrie 4.0. Bonn 2016 – URL: www.bibb.de/veroeffentlichungen/de/publication/show/7833 (retrieved: 07.09.2017)
- SCHWARZ, H. et al.: Strukturierung anerkannter Ausbildungsberufe im dualen System: Abschlussbericht zum Forschungsprojekt. Bonn 2015 – URL: www2.bibb.de/bibbtools/tools/dapro/data/documents/pdf/eb_42381.pdf (retrieved: 07.09.2017)
- SCHWARZ, H. et al.: Voruntersuchung IT-Berufe. Abschlussbericht zum Projekt, Teil A. Bonn 2017 – URL: www2.bibb.de/bibbtools/tools/dapro/data/documents/pdf/eb_42497.pdf (retrieved: 07.09.2017)

 Translation from the German original (BWP 2/2017): M. S. Kelsey