Federal Ministry
of Education
and Research

Concepts And Results

The German Advanced IT Training System

BMBF PUBLIK

Bundesministerium für Bildung und Forschung

email: bmbf@bmbf.bund.de
Internet: www.bmbf.de

Fraunhofer-Institut für Software- und Systemtechnik [ISST]

email: info@isst.fhg.de
Internet: www.isst.fhg.de

BITKOM

email: bitkom@bitkom.org
Internet: www.bitkom.org

IG Metall

email: vorstand@igmetall.de
Internet: www.ig-metall.de

ver.di

email: info@verdi.de
Internet: www.verdi.de

ZVEI

email: zvei@zvei.org
Internet: www.zvei.org

BMBF PUBLIK

Imprint

Publisher
Federal Ministry for Education and Research
Public Services Department
53182 Bonn

Orders
Written orders – to the publisher
PO Box 30 02 35
53182 Bonn

Telephone orders to
01805 BMBF02
01805 – 262302
Fax 01805 – BMBF03
01805 – 262303
tariff: 0.12 Euro per minute

Email: books@bmbf.bund.de
Internet: http://www.bmbf.de

Contact
Email: international@apo-it.de

Layout and Text
layoutlabor, Berlin
Dieter Raupach, Detlef Witt-Schleuer
Fraunhofer ISST

Printers
Königsdruck GmbH, Berlin

Bonn [2003]

Although discussion about skills shortages has fallen off in recent months due to the current weakness of the economy, the underlying problems remain unchanged.
In the next few years, the IT sector will remain the most important growth sector in Germany and Europe despite the current decline in economic activity. There is parallel growth in demand taking place outside the IT sector, in public services and user industries such like banking and finance, graphics and media, and automotive. The system presented here provides urgently needed structural sign-posts for a quality assurance of IT professions – at a national and European level.

Introduction

The Reorganization Process and Advanced IT Training in Germany

In a multi-staged project that ran from 1999 to 2002, the Industrial Metalworkers' Union [IG Metall], the Unified Service Industries Union [ver.di], the Central Association of Electric Engineering and Electric Industries [ZVEI], and the German Association for Information Technology, Telecommunications and New Media [BITKOM] agreed on »Guideposts for the Reorganization of Advanced Vocational Training in the IT Sector«. In 1999, the »Guideposts« were integrated in the »Alliance for Jobs, Training, and Competitiveness« initiated by the German Federal Government. In implementing the Alliance resolutions, the Federal Institute for Vocational Training [BIBB] was commissioned by the Federal Ministry of Education and Research [BMBF] with developing the IT Professional Training concept, in conjunction with experts from industry and IT qualification.
In the course of the reorganization process, an expert team of human resources, technical and training specialists evaluated market surveys and job advertisements, along with descriptions of jobs and tasks from companies in the IT industry. Studies and profile descriptions from international companies and associations were also taken into account. It was examined whether these profile descriptions were currently in demand on the employment market and whether they would endure in the medium-term, according to the experts.
In a later stage, transparent occupational titles and legal regulations were developed. In 2002, these were implemented.
Along with partners from the industry and sciences, the Fraunhofer Institute for Software and Systems Engineering [ISST] developed the conceptual and didactical framework for the Advanced IT Training systems as well as the process-oriented curricula that stand at the heart of the system. In February 2002, the system was awarded the Advanced IT Training Innovation Prize.

Transparency Enables Mobility

The IT sector is highly international in character. By contrast, training systems are organized predominantly nationally. The System creates transparency compared with the large number of existing profiles and certification descriptions. It defines sector-wide standards and guarantees quality in the face of the numerous only partially comparable advanced training courses, examinations, and certificates. It provides mobility both within Europe and globally.

Quality Assurance

A new – private – certification structure was established that is not dependent on short technology cycles. It provides a basis for a mutually recognized certification within the EU.

The German Advanced IT Training System In Brief

Certification procedures compliant with European norms assure not only transparency and quality: Being workplace-oriented, certification proves competences being put into practice.

Proven Record of Success

Implementations of the Advanced IT Training System in large as well as small and medium-sized enterprises have been successfully completed. Evaluations prove the sustainability of the concept, and high quality standards of the results for employees and companies.

Recognition of Vocational and Professional Training

The new Advanced IT Training System has structures and standards comparable to the higher education sector for determining qualification equivalence by means of a credit points system. This is a big stride forward for the implementation of the agreement on the »European Credit Transfer System« concluded in the »Bologna Declaration« of European ministers of education in September 1999.

Work-Process-Oriented Curricula

In cooperation with more than 60 representatives from the ICT industry, such as Allianz, Deutsche Telekom AG, Oracle Deutschland GmbH, Siemens AG, numerous SMEs, and training providers, extensive and detailed curricula for each career profile have been worked out. There, the structure of the learning content is decided not on the basis of a formal organization of the subject, but rather on the basis of the work process.

Two pillars carry the Advanced IT Training System:

- **A system of 35 career profiles associated to three levels of proficiency.**
- **A methodology for workflow-embedded qualification.**

These two components are linked by reference processes: work processes described by event-process-chains that serve simultaneously as a reference for the particular job role and its curriculum.

Workflow-Embedded Training

The fact that the Advanced IT Training can be largely carried out in the workplace means that access is significantly easier. Higher numbers of participants do not involve higher costs. Training is undertaken with real work projects embedded in real work environments. Autonomous learning competency and the ability to cope with situations from real work scenarios are fostered.

Acquisition of Social and Behavioral Skills

By combining methods of formal and informal learning problems in teaching social and behavioral competences are explicitly addressed – and solved. With the help of a coach, every participant of the Advanced IT Training System continuously reflects the work and the qualification process.

Systematic Horizontal and Vertical Career Development

The newly introduced specialist's level opens the chance for a systematic career development from the vocational up to the academic level! In developing the Advanced IT Training System, particular emphasis was placed on designing the system so that individual qualification procedures and personnel development could be integrated into the company's organizational horizontal and vertical development process.

Independence from Short Innovation Cycles

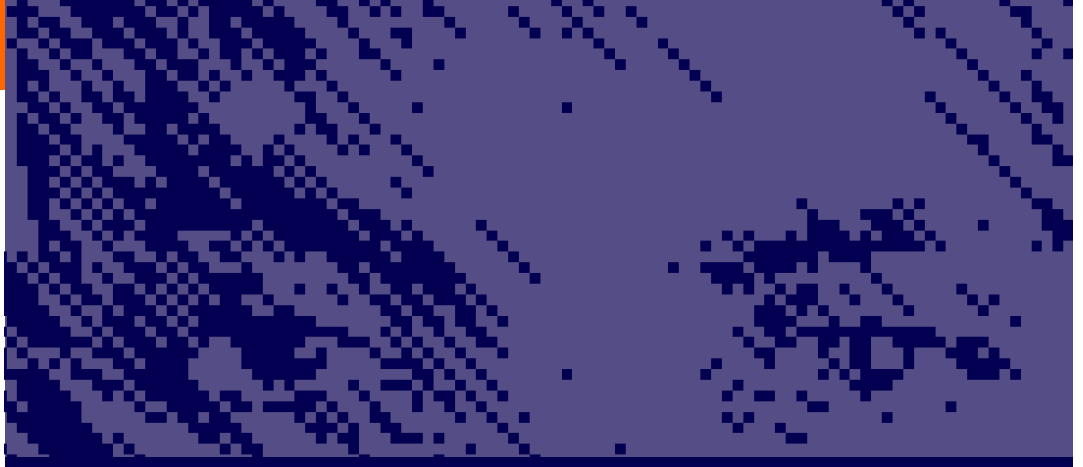
By focussing on process descriptions and associated competences, the system can react more flexibly to the short innovation cycles characteristic of the world of information technology.

Lifelong Learning

The motivation for lifelong learning lies not only in the employability of the employee. The capital of companies in the knowledge-intensive IT industries is literally in the heads of their employees. In the context of lifelong learning, the new Advanced IT Training System purposefully promotes individual responsibility and autonomous acquisition of knowledge and competencies in an environment familiar to the employee by means of its methodology.

Knowledge Management and Documentation

Knowledge management in a company involves generating and making available implicit procedural knowledge. The methodology of work process-oriented advanced training responds to this requirement. Employees learn by being actively involved in processes and by documenting their knowledge. This procedural knowledge is made available to other employees in the team and in the company – the company itself is, in the course of this, acquiring knowledge.



Providing Structure for Systematic Career Development

The initiative was not necessitated by the skills gap alone, but also by the need to create linked programs for graduates of the IT apprentice programs to further develop their careers and to provide urgently needed orientation for those seeking work in the new IT fields of employment.
With the introduction of a specialist's level a chance is given to re- and lateral entries, and those working in the field for some time, to solidify their working stance. A link had to be created between the vocational and the academic level. And an opening made

Facing The Challenges

for those coming from vocational trainings and wishing to advance to management positions that require academic training. Qualification on the specialist's level and academic curricula must be coordinated, and work experience must be acknowledged by means of a credit point transfer system.

Training Competences Being Put into Practice

The restructuring has made possible the creation of new designs for advanced education that meet the demands of changed qualification requirements – above all the training of soft and behavioral skills!
A combination of formal advanced education and informal experience-lead learning at work embedded in a mentor-mentee relationship helps to face the most challenging problems of a learning process: The transfer of knowledge into practice, and the acquisition of social competences.

Enabling Qualification at the Work Place

Experience in companies has demonstrated that regulated advanced education in innovative employment areas is only partially successful and is increasingly regarded as not practice-relevant, inherently lagging behind, rushed and prohibitively expensive.
Learning at work must be oriented towards the work process. The work process thus defines the relevant actions from which the learning goals and contents are derived. How can the work process be at the heart of the curriculum? By turning it into the curriculum!

Building Structure for the Sub-Degree Level

The reliance of IT- and IT-User industries on modern technology requires not only personnel with sophisticated technical expertise, but also with an advanced capability to cope with increasingly open work situations. People graduating from the vocational training level do usually do not yet show yet the necessary amount of specialization. On the other side, those coming with business trainings from academic institutions often lack the technical expertise. An entirely new level of qualification on the subdegree level was required: A »specialist's level«.

Creating Transparency – Certifying Quality – Supporting Mobility

As of today, human resource professionals cannot rely on any standard or calibration in personnel appointments. In the IT-industry – being relatively young and having experienced an unprecedented growth – lack of structure was met with pragmatism and creativity. As a result we find fantasy job titles, vague or even undefined job descriptions, hundreds of training qualifications, and vendor specific programs that are not coordinated with vocational or academic trainings, or curricula.

For the sake of a real quality assurance, transparency on job titles must be created. Tasks and competences associated with a particular job role must be clearly defined and any certification must prove that this knowledge can be put into practice: Records of classes attended do not serve this purpose. Likewise, with the short technology cycles in the IT industries, technology-based certificates do not provide proof for the ability to cope with an ever changing work environment.

Creating Efficient Training Structures

Advanced training differs significantly from vocational or academic training. Employees do have various personal backgrounds and different levels of experience and qualification. Course work and seminars face severe problems in teaching social and methodical competence. They do not address problems from existing work scenarios – neither are individual circumstances taken into account.

This results in significant loss of knowledge due to the »shot-gun effect«, lack of ways to utilize the acquired knowledge, and insufficient development of autonomous learning competence.

A concept »work-process-oriented learning« [»Arbeitsprozessorientiertes Lernen« – short »APO« in German] had to be developed, a methodology which closely combines learning and work, and builds up key qualifications that equip employees to cope with open work assignments and the rapid pace of change.

Creating Training Structures with Long-Term Stability

As a result of the ever shorter innovation cycles, knowledge gained in initial training can only be a basis for Advanced IT Training.

Learning content must be selected on the basis of the work process, not on the basis of a formal organization of the subject, or of technologies being applied. A description of job profiles and their associated training structures had to be found that is independent from the short innovation cycles. This requires some level of abstraction and a suitable methodology that had to be developed and that would put the actual work process at the center of the training structure.

The actual operational practice, the processing of the work tasks, the work itself can be regarded as a career development opportunity that provides job fulfillment for the employee and activates the personnel development potential in the company's interest.

A New Training Culture

A bilateral investment in the Advanced IT Training System – on the company's part by providing the infrastructure and quality assurance, and on the part of the trainees engagement and motivation – can contribute to lifelong competency development

The Advanced IT Training System

and with this to greater employment opportunities. This form of skills acquisition involves high-quality reflective learning coached by experts in the field in direct association with the problems and tasks as they can be found in the IT workplace itself.
On-the-spot problem-solving and teamwork in work groups and projects, in planning and steering tasks, etc., are the best way towards employability. The essential point is that problem-solving, negotiating and decision processes are assimilated by practice. This is a training culture that fosters the development of the initiative and autonomy required in the IT field and probably generally in the future practice of the profession.

Career Profiles of the Advanced IT Training System

By reformulating fields of ICT relevant business, 29 IT specialists were identified and described. These cover the entire business process chain, from analysis, consulting, and product development to sales administration, and support. In addition, 6 professional profiles on an operational and strategic management level were defined that secure the linking to academic training levels. [See figure 1]

These profiles have been worked out in close cooperation with more than 50 leading partners from the ICT industries and training institutions.
In order to clearly define the two professional and the specialist level, criteria for delineation have been worked out in the areas of

- Problem solving competency
- Communication
- Work planning
- Shaping work processes and the decision making framework
- Customer relations
- Influence on the competitive situation of the business

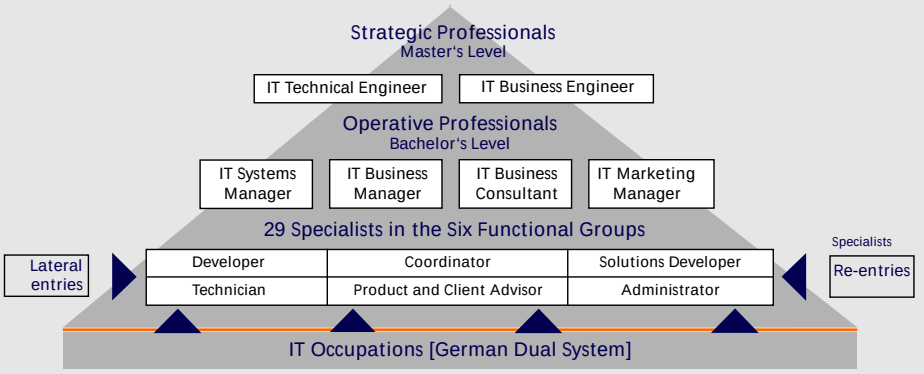


Figure 1: System of Profiles and Levels

The Specialist's Profile Groups

The organization procedure defines 29 specialist profiles to cover the combinations of fields of activity and areas of application in the computer, software and telecommunications sector required to meet the needs of the job market now and in the foreseeable future. The profiles also expressly include competencies in overlapping fields of activity and offer a holistic description of the entire role.
In drafting the profiles, account was taken of the relevant business activities of provider and user as well as the different »job families« within the companies. Six functional groups were defined:

Software Developers

IT Systems Analyst
IT Systems Developer
Software Developer
Database Developer
User Interface Developer
Multimedia Developer

Solutions Developers

Business Systems Advisor
E Marketing Developer
E Logistic Developer
Knowledge Management Systems Developer
IT Security Coordinator
Network Developer

Solutions Administrator

Network Administrator
IT Systems Administrator
Database Administrator
Web Administrator
Business Systems Administrator

Coordinators

IT Project Coordinator
IT Configuration
IT Quality Management Coordinator
IT Test Coordinator
IT Technical Writer

Technicians

Industrial IT Systems Technician
Security Technician
Component Technician

Product- and Client Advisor

IT Service Advisor
IT Trainer
IT Product Coordinator
IT Sales Advisor

Figure 2: Division of the Specialists into Groups

IT specialists have certain areas of competency in common that are typical for the specialist level in the Advanced IT Training System: These include problem analysis and solution, internal and external communication and presentation, conflict recognition and resolution, foreign language communication in English, project organization and cooperation, economic decision making, data protection and data security, documentation and quality assurance.

Despite these commonalities, a division is reflected in those areas of competency, in which a specialist must have specific knowledge, proficiencies, methods, and tools. Areas of competency are the nameable elements of professional competency of the specialists. The synthesis of specialized, methodological, social, and personalcompetencies constitutes the professional competence of a specialist. Areas of competency are, therefore, integrated areas of comprehensive professional competence and include work experience.

By combining knowledge, abilities, and tools and the integration of technical, methodological and behavioral skills that result in comprehensive professional competence, the specialists are able to work systematically and in a target-oriented fashion in processes and are able to successfully solve problems in the complex field of information technology, and are also excellently equipped to meet future challenges.

IT Managers: Operative and Strategic Professionals

Building on the specialists' profiles are definitions for four Operative Professionals [Certified IT Systems Manager, Certified IT Business Manager, Certified IT Business Consultant, Certified IT Marketing Manager] with larger areas of responsibilities [or responsibility for organizational units], generally including personnel and budgetary responsibilities. These functions differ according to whether the individual is involved more in product development or on the marketing side, whether he controls consultation processes or exercises management functions.

The following qualifications are of special importance and demarcate the transition from a specialist's to a professional's level:

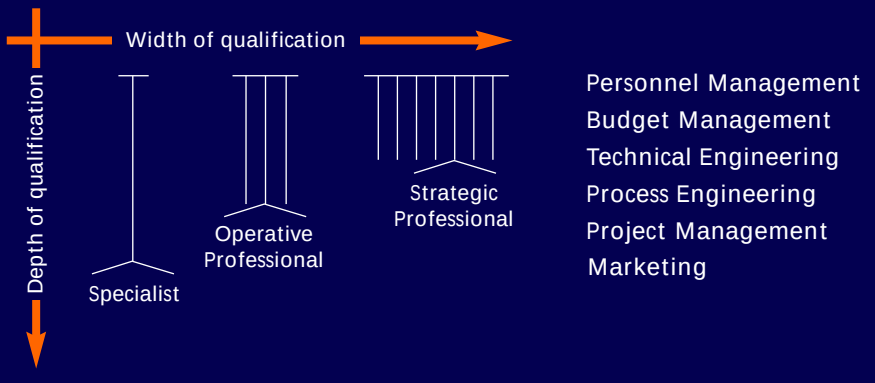


Figure 3: Transition of the Qualification Focus

The basis for these functional levels however continues to be specialist experience and specialist competence. »Just a manager« is not the aim here. Operative Professionals are thus understood to be experts with experience grounded in the practice of their profession in the various technical areas/branches of technical expertise who assume line management responsibility for projects or organizational units.

Two »advanced education« occupations are situated on a further strategic level, appropriately described as Strategic Professionals. Performing on an executive level for small or medium-sized companies or managing division for larger organizations, they either have to do with strategic product development and technological decisions [Certified IT Technical Engineer] or with business policies and company strategies [Certified IT Business Engineer].

The IT Process

The specialists are characterized by specific work processes, typical activities, and specific fields of the IT sector, and the corresponding fields of IT application. Their incorporation into the general IT process explains the similarities, interfaces, and boundaries between the profiles. Thus, it is possible for companies and organizations, as well as for the specialists themselves, to identify and select appropriate specialist profiles.
The IT process has been of great importance to structure the specialists' profile system, to identify relevant work processes, and their context.

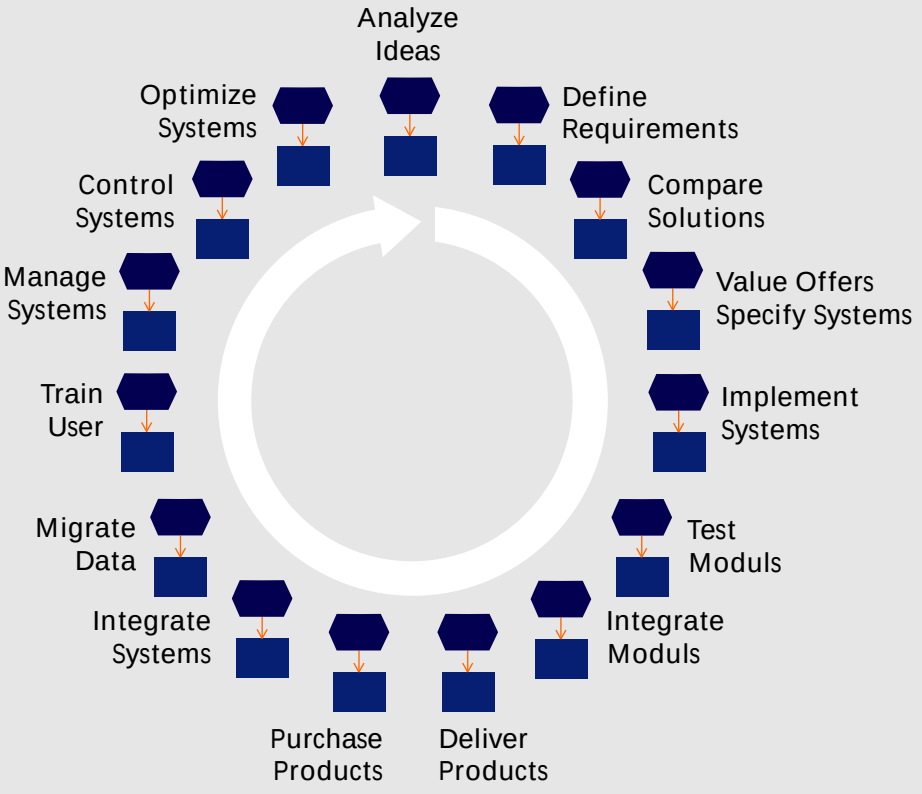
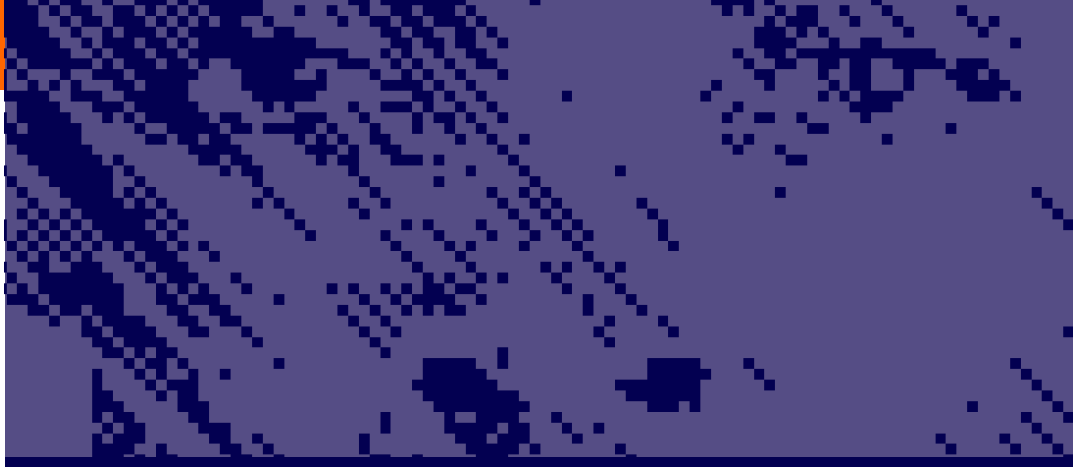


Figure 4: The IT Process

The above listed steps of the IT process take into account both the side of the developer and of the user. This enables the identification of typical activities and central tasks on both sides and shows interfaces, points of transition, and common functions.

The steps of the IT process are broad and complex work processes. For instance, operation, monitoring, and optimization of systems, must be carried out continually. The implementation of a system can take many man-months, and even transfer to the customer is often a multi-level process.



Even though broad job areas can be quickly identified, titles and tasks associated with the job vary greatly. There are few occupational titles which have a generally approved definition of the tasks involved.
A division must be found that is reflected in the areas of competency, in which a specialist must have knowledge, proficiency, methods, and tools.

Learning at work must be oriented towards the work process. Since work processes differ significantly in their fundamental conditions and task distribution, it was necessary to define the relevant processes more precisely. The Fraunhofer ISST, in co-operation with industrial and educational partners, has established standardized definitions of the work-related tasks of IT professionals which allow us to define work-related processes relevant for advanced training.

The reference project contains a definition of the tasks and core work processes, and a sequencing of these. It is the abstract description of work processes typical for an occupational profile. Methods, tools, technologies and competences are operationalized in the context of their [sub-] processes. Work-related processes are documented in so called event-process-chains.

The Reference Project: A Work-Process-Oriented Curriculum

Competencies and therefore learning content necessary for the accomplishment of the individual work steps can be derived from the work processes. These learning contents include specialist, methodological, social, and human competencies as part of the professional competence, and can be assigned to individual processes. This assignment then produces the basis for a process-oriented curriculum. The structuring of the learning content is decided therefore not on the basis of a formal organization of the subject, but rather on the basis of the work process.

A reference project thus enables the identification of a number of work processes relevant for advanced training in a company, which contain similar processes and learning contents despite their individual characteristics. The reference project serves as a template, which is filled with company specific content and procedures. A project does not have to cover the whole process. Sub-processes can be carried out within a number of real projects.

Work-Process-Orientation:

- **The structuring of the learning content is decided not on the basis of a formal organization of the subject, but rather on the basis of the work process.**
- **Competencies are operationalized in the context of their work process.**

The elaboration of reference projects took place in cooperation with partners from the ICT industries and training institutions. The results are detailed documents for every profile comprising on 60 to 100 pages core activities and the competencies for their successful completion in the context of the work process.

The following figure shows a part of such a model:

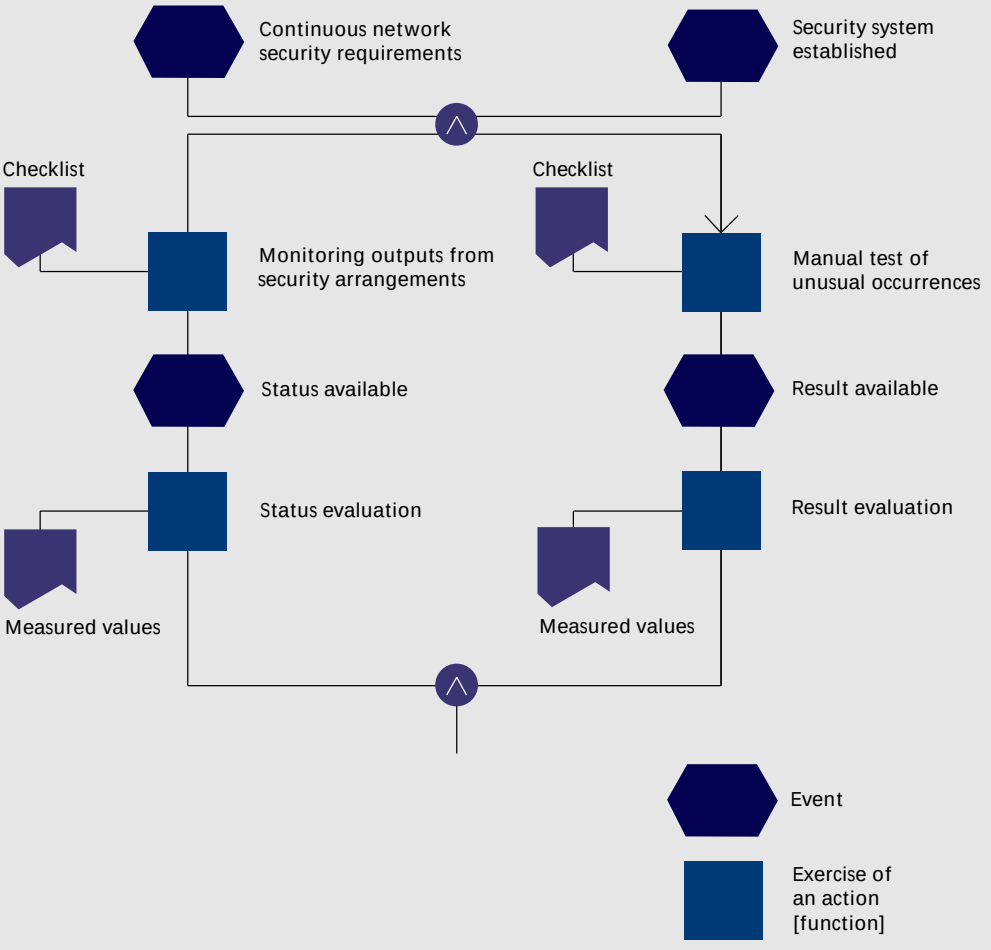
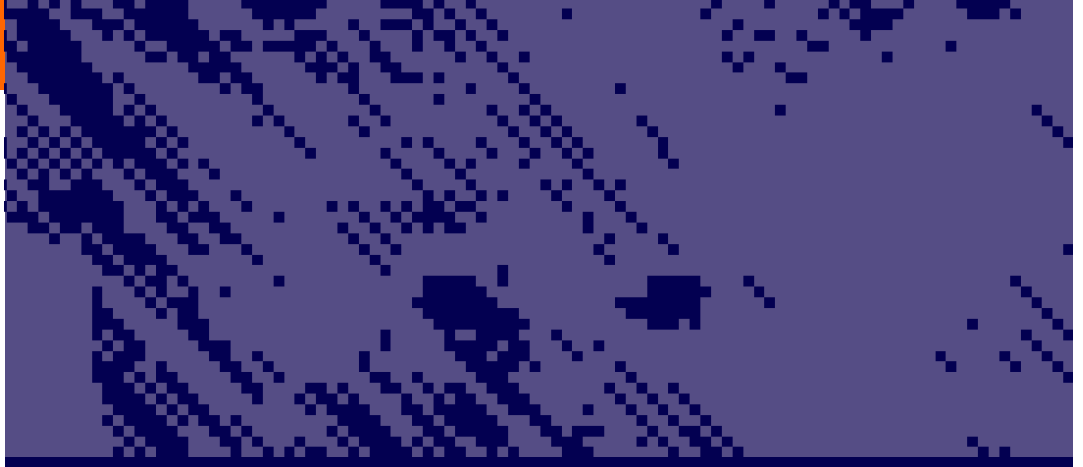


Figure 5: Part of a Sub-process from the Reference Project »Network Administrator«



Employees who are to take part in the work-process-oriented advanced training must be selected and must take part in an appropriate personnel development discussion. Here, individual and the company's objectives are coordinated and documented in a qualification agreement. The appropriate occupation profile [from 29 specialist profiles and six IT professional profiles] must be identified for those participants who want to obtain qualifications through the work-process-oriented advanced training; the formal entry criteria of the participants must also be examined and approved.

Implementation of Work-Process-Oriented Trainings

An implementation consists of the following key elements:

- A reference project as the basis for a functional description of the work processes inherent to the job role [the curriculum].
- A qualification project, which is a current and sufficiently complex real work assignment that corresponds in size and depth to the reference project.
- A systematic accompaniment by learning advisors: a coach for the support and reflection of the general learning process and technical expert[s].
- A structured documentation of the transfer project and the learning steps involved in its completion.

In order to achieve lasting results, a basis of workable knowledge over longer periods is necessary, i. e. not only application-related knowledge must be acquired, but also knowledge of basic theory and technology. In order to support these processes, the appropriation of self learning competence, and a regulated qualification, the participant will be continually supported by a coach, technical experts, employees, other participants, and a media infrastructure.

The advanced training process begins with the qualified description of the transfer projects and of the problems to be solved or the products and services to be developed. This includes a description of the sub-processes as well as the associated content and personnel requirements.

This representation, which also serves as the application for advanced education, will be tested and evaluated against the reference project to determine whether it has the necessary complexity and professional depth of the advanced education profile.

The individual necessary technical, personal and social learning requirements for the specialist or professional must be identified and agreed in a goal agreement between the employee and the coach for the learning process in the work processes. Coaching is an obligatory support for those who wish to obtain increased efficiency as a result of extra responsibility and self-management, and therefore aim to improve their own competence for this purpose.

The coach plays an important role in:

- Helping to gain knowledge and insights into the technical, personal and social challenges.
- Helping the employee to organize and reflect the qualification process.
- Giving support for personal development.
- Enabling the trainee to learn from mistakes.

Times for meetings to evaluate the work and learning experiences corresponding to milestones in the project are agreed in order to ensure meaningful reflection. At least six coaching meetings form part of the training process. The duration of the advanced training depends on the work routine in the organization and is not standardized.

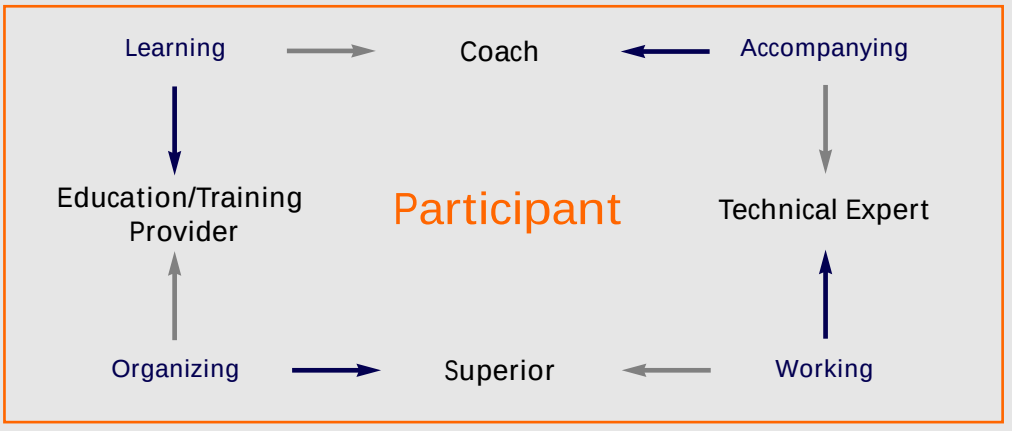


Figure 6: Task Distribution and Roles during the Implementation

The participant will work out the processes of the transfer project himself, will obtain the necessary background information and knowledge, will contact experts, and will document his work. Working and learning are interwoven.

The technical and procedural steps of the project, the communication processes and challenging situations, e. g. decisions, conflicting aims, and difficult customer conversations etc. are described in the documentation. The form of the documentation is fixed and must satisfy certain formal requirements.

There is an urgent call for transparency in the Advanced IT Training market. Certification procedures for the purposes of quality assurance give both employees [participants] and employers a reliable orientation and high transparency with regard to training options in the IT sector. In addition, these processes ensure comparability of qualifications and contribute to improved career prospects and mobility for employees [e. g. within the EU].
With the career profiles of the Advanced IT Training System well defined job titles – with coherent and conclusive descriptions of tasks and competences involved – are now available.

Whereas Advanced IT Training of operational and Strategic Professionals falls into an area regulated by national law, the Advanced IT Training of specialists in private enterprises is carried out within the framework of a comprehensive certification procedure determined in accordance with European norms. Consequently, qualification

Quality Assurance and Certification

of Professionals is shown by public examinations pursuant to federal regulations, qualification of Specialists by private certification through certification agencies accredited by the German representation of the European cooperation for Accreditation. Thus, certification through bodies properly accredited is fully recognized within the EU.

This structure was chosen very deliberately: The specialist's fields are influenced the most by the short cycles of IT technologies. The private structure facilitates a fast adaptation of content relevant for examination and certification in accordance with the current IT industry's needs and technological standards.

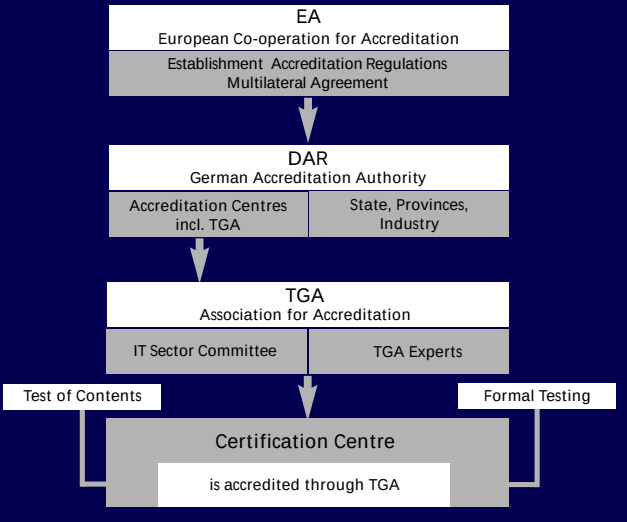


Figure 7: Integration into the European Quality Assurance

Certification of Specialists

In October 2002, a normative document was enacted. Worked out in compliance with DIN EN 45013 and ISO/IEC 17024:2002, an internationally recognized method to confirm competences, this document describes the procedures for certifying bodies to be accredited. Certifying authorities themselves certify participants from work-process-oriented Advanced IT Training as IT specialists with companies and training providers, if mastery of profile-typical work processes and characteristic areas of competency is shown.

The standards set out in the specialist profiles form the basis for certification. As providers of personnel certification services they test the conformity of the competence of personnel with relevant standards and criteria [IT specialist profile] to meet European and international requirements.

Examination of Professionals

Professionals are examined by the German Chambers of Commerce and Industry in accordance with the Regulation on Advanced IT Training in the Field of Information and Telecommunications Technology, enacted May 2002.

For every level, specific requirements for admission have been set up that are based on levels of qualification and durations of work experience relevant to information and telecommunications technology, and related to the responsibilities of the profile to be qualified in.

World Wide Web:

www.apo-it.de [Concept and Process of Implementation]
www.isst.fhg.de [Information about the Fraunhofer Institute]

Extract from Publications List:

English

- Caumanns, J./ Walter, R./ Rohs, M./ Grunwald, S./ Mattauch, W. [2001]: Advances in Vocational Training and Information Technology to Improve the Lack of IT-Experts. In: Szücs, A./ E. Wagner/ C. Holmberg [Hrsg.]: Learning without Limits: Developing the Next Generation of Education, Proceedings of the EDEN 10th Anniversary Conference Stockholm, Schweden, S. 180-184
- Mattauch, W./ Rohs, M./ Grunwald, S./ Walter, R. [2001]: A Workflow Oriented Model for Advanced Vocational Training in Information Technology. In: Society for design and process sience [Hrsg.]: Integrated Design and Process Technology, IDPT -Vol. 1, S. 28-33
- Rohs, M./ Mattauch, W./ Caumanns, J. [2001]: Further professional education based on working processes: Workflow embedded training in the IT Sector. In: Weichert, D./ Rauhut, B./ Schmidt, R. [Hrsg.]: Educating the Engineer for the 21st Century, Kluwer Academic Publishers: Dordrecht; Boston; London, S. 281-288

German

- Mattauch, W./ Caumanns, J. [Hrsg.] [2002]: Innovationen der IT-Weiterbildung. W. Bertelsmann Verlag, Bielefeld
- Rogalla, I./Witt-Schleuer, D. [2004]: IT-Weiterbildung mit System – Das Praxishandbuch. Heise Verlag, Hannover
- Rohs, M. [Hrsg.] [2002]: Arbeitsprozessintegriertes Lernen - Neue Ansätze für die berufliche Bildung. Waxmann: Münster, New York, München, Berlin
- Walter, R./ Caumanns, J. [2002]: Ablauf und Ergebnisse des APO-Entwicklungsprojekts, In: Bundesministerium für Bildung und Forschung [Hrsg.]: IT-Weiterbildung mit System - Neue Perspektiven für Fachkräfte in Unternehmen, Bonn, S. 26-30

Federal Ministry
of Education
and Research

BMBF PUBLIK