GUIDELINE

# Shaping the Digital Transformation Within Companies – Examples and Recommendations for Action Regarding Basic and Further Training

The Federal Ministry for Economic Affairs and
Energy was awarded the audit berufundfamilie®
for its family-friendly staff policy. The certificate
is granted by berufundfamilie gGmbH, an initia-
tive of the Hertie Foundation.

Zertifikat seit 2002
**audit** berufundfamilie

**FSC**
www.fsc.org
**MIX**
Papier aus ver-
antwortungsvollen
Quellen
Paper from
responsible sources
**FSC® C003425**

# Table of contents

# Short version of the recommendations for action, working group 5

The working group's aim is to enable companies and employees to cope with the requirements of digitisation. These recommendations are meant for them, as well as the politically responsible stakeholders in the national government and the federal states.
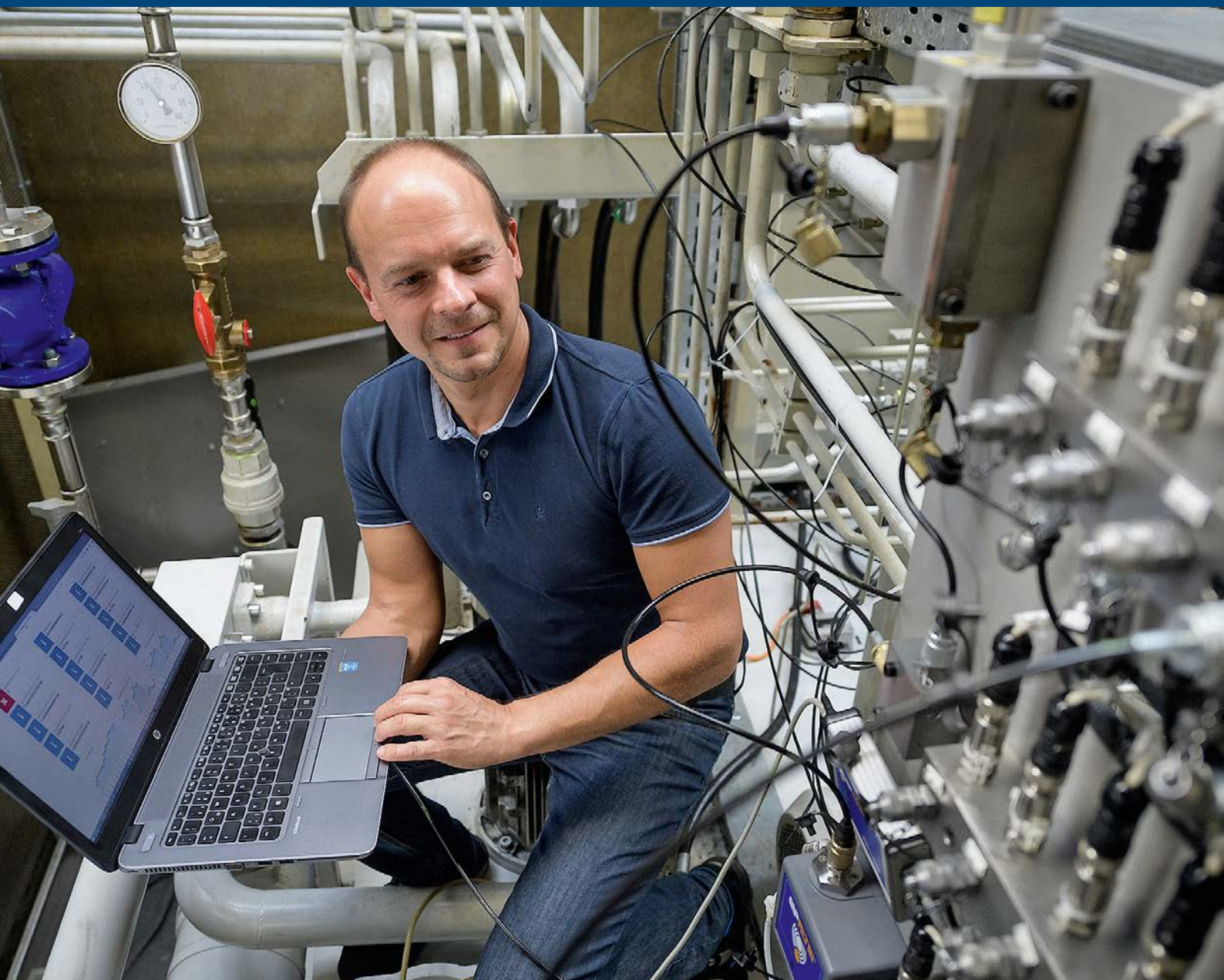
# A  Recommendations for action for companies and employees

The changes brought about by Industrie 4.0 and digitisation are happening at different speeds and in varying intensity in different companies. Therefore, the working group believes that it is important to develop customised solutions, which are drawn from and directed towards the practical situation in the company, for each individual case.

## Analysing the change

In practice, companies are increasingly looking for the best possible steps which they can take to try out and develop Industrie 4.0. In the current situation it is often still unclear what the new qualification requirements are and how they can be linked with the existing personnel, further education and training and organisational development. The working group recommends using instruments which give a realistic and differentiated picture of the qualification demands.

## Implementing training in the company

The competence, professionalism and experience of skilled employees will continue to be the foundation of their own successful vocational development and the competitiveness and innovative ability of their companies.

The close link between theory and practice means that dual vocational education will offer ideal conditions for students and apprentices to gain useful practical qualifications at an early stage. The working group therefore suggests that the existing possibilities for creating dual vocational training courses should be exploited even more within the company.

## Facilitating flexible and constant further vocational training

In the development of vocational competence for a digitised world of work, new forms and programmes in further vocational education and training and in-service learning will become significantly more important.

## Coping with major changes

Companies and their employees face up to the increasing and sometimes fundamental changes in the demands for qualification and training and develop new solutions. The working group believes that the combination of working and learning, theory and practice, qualification and competence development should be improved. This should be transferred into new models for apprenticeships and further vocational education and training, including aspects such as training for mixed-age teams.

The working group therefore recommends that qualification, apprenticeships, further vocational education and training and competence development should always be designed flexibly with reference to the applicable business process to ensure that it keeps up with continuous change.

## How can (further) education and training and qualification be promoted in the company? Promoting learning in the workplace

The working group encourages businesses and employees to work together to develop new learning and leadership cultures in the company. This should lead to working structures that facilitate learning and a culture of lifelong learning which unlocks personal development potential, employer attractiveness and competitive advantages.

Information and participation are essential to defuse people's fear of change. This is especially the task of the responsible stakeholders within the company. Co-determination and a negotiating partnership between the management and the workforce are important elements to ensure that the working conditions are conducive to learning and that the available offers for qualification are up to date.

The working group encourages businesses to create a framework for more learning at the workplace, and thus for in-service training. This way companies can make working procedures more conducive to learning for employees of all age groups and additionally increase the use of flexible forms of learning integrated into the workplace.

## Effective use of new media

The use of digital media and associated education and training offers can provide effective support in the transition to a learning culture which is appropriate for Industrie 4.0.

Before digital media such as learning games, simulations, assistance systems or instruction films are used to a greater extent, careful thought should be given to the teaching or learning processes in which they can effectively be used, in order to bring in-service training closer to reality and integrate it better into the working processes.

# B  Recommendations for political action

In the light of their own role, the companies and work councils involved in the working group expect the political stakeholders to create a framework that will ensure constructive cooperation between all parties and facilitate the acquisition of abilities, expertise and design knowledge for Industrie 4.0.

## Promoting media competence in schools

The working group suggests that the national government and the federal states should extend the promotion of media competence in schools.

Similarly, the school system should ensure that IT skills such as programming are sufficiently promoted.

## Making vocational education more attractive

The national government and the federal states need to strengthen the dual system.

The range of dual courses offered at universities and companies should be increased to match the rising demand for highly qualified experts, and the cooperation between higher education institutions and business companies should be encouraged.

## More advice on further vocational education and training for business companies

The working group suggests that the national government and the federal states should consider providing financial support for further education and training advice for businesses (especially SMEs) and employees.

The working group sees a significant need for research projects and advanced training subsidies for the study of teaching methods in further vocational education and media teaching strategies in the workplace, with similar offers for managerial staff.

## Linking different areas of education and training

Vocational education and training and higher education institutions must be more strongly linked. The working group suggests that revised and new curricula in all areas of vocational education and training should be increasingly inter-disciplinary and based on real working processes.

## Using test beds and competence centres for training and qualification

In the Industrie 4.0 competence centres and "test beds", the working group believes that workplace design, vocational education and training should play a significantly greater role.

# Foreword

Since the early summer of 2015 the Industrie 4.0 platform's working group on labour, vocational education and training has been intensively examining which new requirements digitisation and Industrie 4.0 present to the workforce in terms of professional competence, how qualification and education can be shaped to engage with Industrie 4.0, and which media channels, resources and forms of learning are suitable for this task. These are issues of essential significance – both with regard to successful technical and economic implementation of Industrie 4.0 and also with regard to there being a bright future for the various groups of employees.

The working group consists of companies' personnel responsible for education and training activities and also – with only a few exceptions – these companies' works councils. This is why the working group on labour, vocational education and training stands not only for a broadening of what have hitherto been rather technically-oriented topics addressed by the Industrie 4.0 platform, but also for a new participation format. Through the works councils, the workforce's perspective is systematically integrated into the working group's discussions and results. This format of participation has proved its merits in the working process. It clearly shows: The path towards sustainably responsible solutions draws its vitality from people's willingness to help in shaping it; it needs transparent and openly discussed solutions, , and an approach taken jointly by representatives of employees and employers, as well as politics and science.

In its discussions, the working group takes as its orientation point the challenging image of the future that Industrie 4.0 represents and that was developed by the platform. Fully utilising cyber-physical systems' potential in the future makes the following possible:
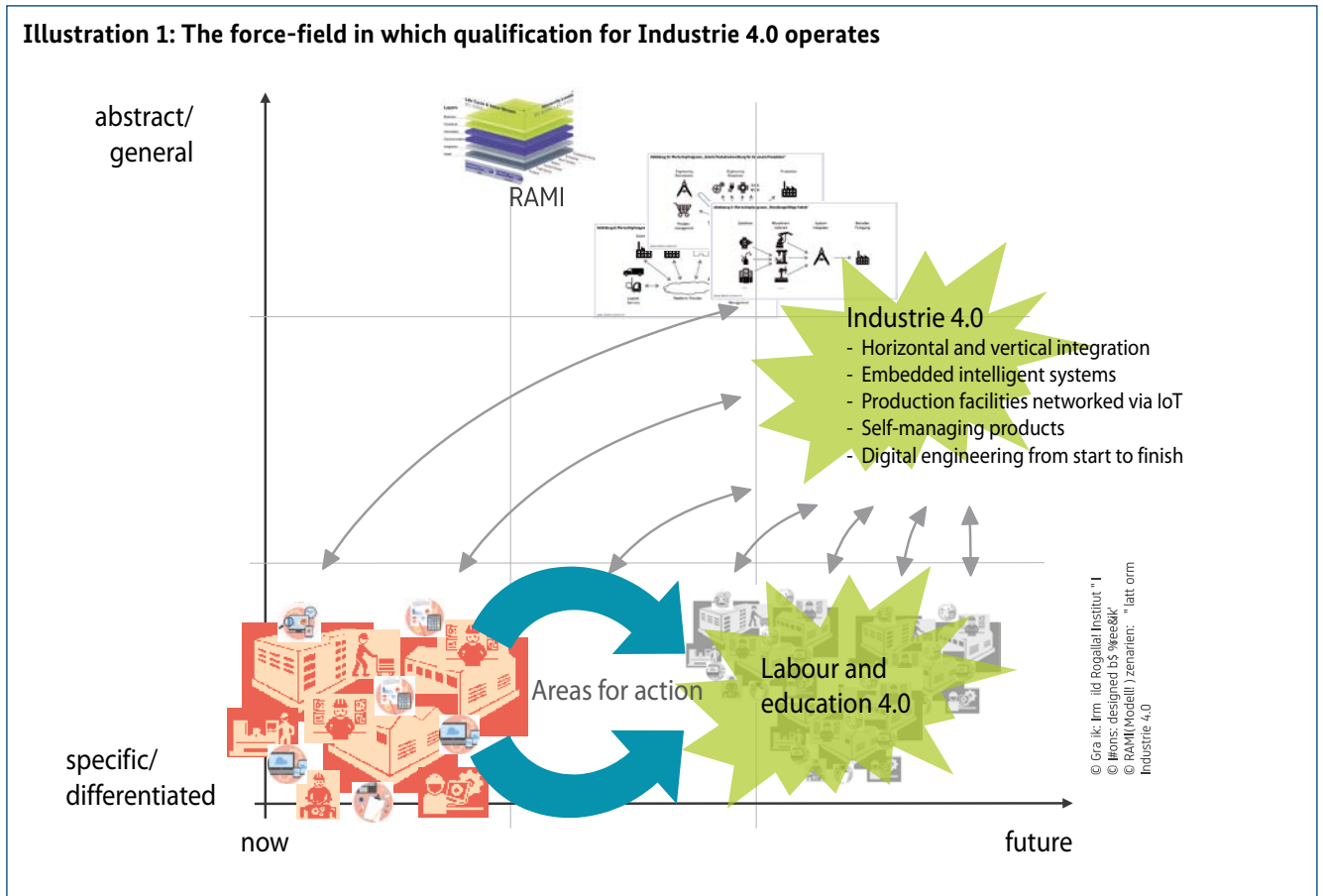
- Processes and IT systems can be integrated horizontally as well as vertically,

- products and production facilities alike can get smart and gain decentral 'intelligence' by using embedded systems,

- data, services and things can be interconnected by the internet and

- these interconnected elements can manage themselves.

- The foundation for this is digital engineering from beginning to end, drawing together the planning of the factory, the products and the production.

The target for this comprehensive digital transformation is greater flexibility, higher efficiency, lower costs and reduced consumption of resources, primarily in classic industry sectors – mechanical and electrical engineering. Production driven by orders, in a versatile factory, supported by self-organising and adaptive logistics and intelligent services of a new kind – these are some of the challenges that are being tackled as part of this.

This image of the future, shaped by technical opportunities and abstract as well as exacting, currently finds itself contrasted with an extremely heterogeneous starting position in the companies: that position ranges from production facilities that are already highly automated today, for products rich in variation; it includes new services supported by IT, and it reaches right through to classic tightly-scheduled assembly operations involving a high proportion of manual labour. Similarly, there are great differences in the degree of digitisation and networking: some companies currently have intensive support by networked IT systems, ranging from purchasing, via development and design, through to production planning and production control; simultaneously, others have only intermittent instances of use of individual systems or programmes.

Between these poles, it is essential to locate the areas for action, in pursuing company qualification and education on the path towards Industrie 4.0. In this context, the qualification-related requirements are every bit as diverse as the target groups: digital transformation influences not solely the work of companies producing and manufacturing, but also equipment-suppliers and service-providers, suppliers of software and hardware, specialists on systems and on networks, as well as providers of infrastructure. Similarly, in the training itself, irrespective of whether it is vocational education and training, a course of study or some form of tuition during the process of working, digitisation and networking will serve both as the subject-matter of the knowledge imparted, as well as the tool and medium used to perform that task.

That is why the examples, compiled in this brochure by the orking group on labour, vocational education and training, highlight a formidable bandwidth of areas of activity and current challenges being faced on the path towards qualification for Industrie 4.0. In total there is already a whole range of exciting approaches today, attempting to make vocational education and training easier to get through successfully, more adaptable, and more open. These specific practical approaches to solutions can serve as points

**Illustration 1: The force-field in which qualification for Industrie 4.0 operates**

abstract/general

RAMI

Industrie 4.0
- Horizontal and vertical integration
- Embedded intelligent systems
- Production facilities networked via IoT
- Self-managing products
- Digital engineering from start to finish

Areas for action

Labour and education 4.0

specific/differentiated

now                                                                future

© Grafik: Irmgard Rogalla Institut "F[ ]
© Ikons: designed by Freepik"
© RAMI(Modell) zenarien: "Plattform
Industrie 4.0

of orientation for other firms; they prove to be useful and motivate companies to initiate activities of their own. However, the examples that this brochure puts into the spotlight do not mean that urgently necessary reorientation processes with regard to education and training come into fruition 'more or less by themselves'. Yet they are unquestionably easier to put into reality if organisations are able to learn from one another and are able to adapt and further develop according to the given company's own needs. A key finding of the working group is that "learning from one another" can be a highly-promising, tangible strategy, also – and especially – for small to medium-sized firms, who have so far found it difficult to strengthen the workforce's qualifications for the digital transition.

The examples from companies originate from actual practice of qualification activities, providing (among other things) an insight both into education and training directed at digitisation topics (conducted SAP training operations for production employees' work), and also into offers of services for works councils, aimed at shaping corporate policy 4.0 and labour policy 4.0. As part of this, use of digital

media, learning at the workplace, and new forms of learning all play a large and increasingly important role. This is not a new insight but one that assumes a new dynamic under the conditions presented by digiisation: It is not enough to (try to) cover the demand for knowledge and skills solely by turning to those undergoing apprenticeships. In a digitalised world of work, there is a fundamental need to open up more (and increasingly diverse) opportunities for further education and training of employees, spanning over all levels of vocational qualification. To a greater degree, this also includes ways of learning while directly performing one's tasks and, more broadly, at the workplace.

It is not enough – at least in the medium term – to direct the focus onto one group of professionals or one functional area. Especially in the case of new business models or comprehensive networking activities, the changes go much further. This is what drives the challenge of developing an all-encompassing product offering of vocational education and training, one that covers all qualification stages and enables all employees to obtain qualification and further training.

**Illustration 2: The areas for action emerge from a firm's starting position**



Icons designed by Freepik

A second group of examples examines the question of which qualification-related and competence-related requirements emerge from the changes that working life is undergoing, and how these can be pinpointed. Analyses of trends and competences are one possibility and are currently being conducted in many firms. Yet it must be kept in mind that the digital transformation brings profound ramifications for work processes and the structuring of work. Questions also emerge regarding a reorganisation of work and, associated with this, changes to patterns of tasks, activities, areas of responsibility, qualifications and professional competences.

**Illustration 3: Labour & Training 4.0 need to be structured on a systematic basis as a socio-technical system**



Labour and education 4.0
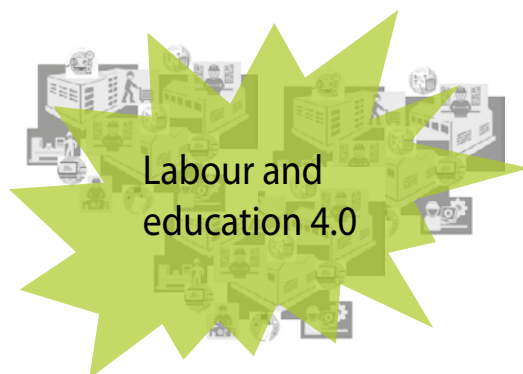
The examples from the companies show: Industrie 4.0 can be structured but does demand that those involved actively structure it. This challenge calls for and requires a corpo-

rate, management and human-resources culture conducive to learning. The path towards this is being mapped out now – and by no means solely by those formally responsible for training matters and by the works councils. If Industrie 4.0 is to be put into effect successfully, the current topics of structuring education and training need to be closely linked up with those of development of technology, organisations and human resources. This is what is meant by the drawing up of new socio-technical systems. It is also clear that such a reorientation can only succeed if there is a whole new quality to how people are able to network and participate. This is far from being an easy task, but it is an important process for drawing together different aspirations and interests, as well as jointly releasing the power to shape events. Security of employment, protection of personal data, transparency and openness in corporate communication – in short: a reliable framework and trust; these serve as important prerequisities to reach this clarification process within companies. Then the task of politics is to establish a suitable framework for shaping the work in a way that is conducive to learning. A crucial insight from corporate practice shows that such a framework is all the more stable when constructed in a spirit of mutual respect and partnership between management and the workforce.

With this in mind, we hope that you find this a stimulating reading as you apply its lessons in your own company!

Dr. Constanze Kurz
Konrad Klingenburg
Dr. Irmhild Rogalla

# Examples from companies:
# vocational education

# ABB – All for all instead of everyone for themselves

"More and more customers are requesting different types of miniature circuit breakers, including special types in small batch sizes. To achieve the necessary production flexibility economically and with the required process reliability, we designed our automatic production line ML2 to minimise the time and expense needed for retooling", says Frank Mühlon, manager of ABB Stotz-Kontakt. The production line has been fully operational at ABB Stotz-Kontakt in Heidelberg since May 2016. The plant was developed and constructed by the company's own plant construction department using the latest Industrie 4.0 concepts. The high degree of automation enables this energy and automation technology company to produce up to 8,000 variants of miniature circuit breakers (MCBs) in its Heidelberg factory and to react flexibly to changes in the market. MCBs are circuit breakers which protect people from injury in the event of a high electric load such as a short circuit and prevent damage to the equipment which is protected by the MCB. The production plant in Heidelberg is linked with other ABB locations throughout the world for data analysis and quality assurance, which is an outstanding example of the possibilities of Industrie 4.0.

"The production line is supported only by specialised electricians and mechanical engineers who can carry out programming work themselves. On the whole, the competence required is significantly shifted towards software", says Dr. Erhan Serbest, the manager of the production unit.

## Vocational education for the production line ML2

Heidelberg is also the home of the largest vocational education centre of the German branch of ABB. At present there are a total of 598 young people who are working for their vocational qualifications there. They include 258 dual education students from the areas of electrical engineering, mechanical engineering, industrial engineering and business management. There are also 340 apprentices in mechatronics, electronics, industrial mechanics, production mechanics, toolmaking mechanics and commerce. "Our vocational education in Heidelberg is a collaborative system. Most students and apprentices are from ABB, but 80 people who are learning a trade or profession with us come from our 18 partner companies", states Marcus Braunert, the manager of the ABB vocational education centre, and he adds: "Industrie 4.0 means that

adequate vocational education is increasingly demanding, complex teaching equipment and very good teaching personnel are needed. The model of collaborative vocational education will certainly be used even more frequently in future."

Vocational education in metalworking and electrical occupations has been reorganised as from 2000. The political powers, employer and employee representatives, business companies and scientific community designed the reform to enhance the competence areas which are also important for Industrie 4.0: process orientation, self-directed action and IT skills. "The reform was thus far more interdisciplinary in character and contained a greater focus on cross-cutting topics", Braunert says in summary. "Around 2009 we started to use the existing leeway in the vocational education curricula to adapt the content to make more allowances for our own specific needs. For example, vocational schools use products from another supplier for programmable logic control systems (PLC). Within the company we then teach the trainees using our own PLC system." The young apprentices are also taught how to use our proprietary software for the data analysis, remote diagnosis and on-line maintenance. In addition, ABB places a major focus on robotics. From December 2016, the first training courses will be held on the new ABB robot YuMi, the world's first really collaborative two-arm robot which can be used for tasks such as assembling small parts.

It was no accident that ABB chose that time to start adapting its vocational education programme. 2009 was the year when the predecessor of the ML2 production line, the ML1, was taken into service. "The installation of the ML1 meant that we needed mechatronics specialists with a special focus on programming, so we trained them ourselves. We gained experience with the first production line, and trained our apprentices on it. And we still benefit greatly from this development with the ML2", Braunert adds.

The ML1 was developed and built together with a partner. So the ABB Stotz-Kontakt plant construction department was "only" involved in the process. But the ML2 has been completely designed, developed, planned and constructed by the
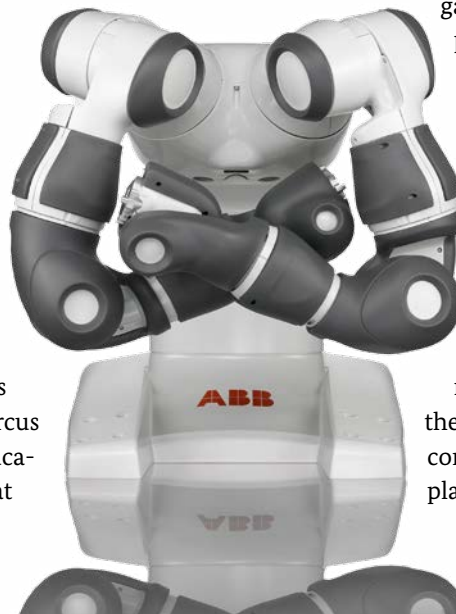
company's own plant construction department. Throughout this phase, apprentices were also involved as a way of preparing them for the challenges of such a complex system right from the "word go". Our vocational education centre is not an isolated unit, it is closely networked with the other parts of the company, so the instructors also benefit significantly from the knowledge and experience that are present within the company.

## Silent adaptation

"As a result of our experience with the ML1 and the early adaptation of our collaborative vocational education system, the transition to our Industrie 4.0 production line ML2 was almost silent", concludes Dr. Serbest. "Our staff are also trained well enough in the software sector, so we can solve programming problems ourselves. That makes us independent of external providers."

Braunert adds that the close link between training and production greatly increases the employability of the young apprentices. "The newly qualified young people are usually recruited directly into high-tech positions, and directly after their training they can already play a full role in the work of the company."

"The example of the ML2 shows how production can be economically achieved in a high-wage country if the right conditions are created and if continual investments are made in the qualifications of employees, apprentices and dual education students", explains Dr. Serbest. In accordance with this principle, ABB constantly works on the development of its vocational education institutions and on new further training concepts to keep its employees up to date in their knowledge of digitised production.

## Early adaptation and close interaction between departments

Several factors played a decisive role in the first adaptation of ABB's vocational education programme to the demands of Industrie 4.0. First of all, ABB was prudent in its reactions to changes, but reacted at an early stage. After the reorganisation of the central apprenticeship schemes in the metalworking and electrical sectors, the company initially waited to see what effect the changes would have. When the ML1 production line was installed, the company adapted its teaching content and main focus areas to place greater emphasis on the specific needs of the factory. The close links between the individual departments of ABB Stotz-Kontakt and the principle of striving mainly for internal solutions (internal planning and construction of the plant) also had a positive effect on the education and training programmes. Throughout the company, comprehensive specialist expertise is brought together and shared with the instructors and apprentices in the vocational education centre.

"The example of the ML2 shows how important it is to have a comprehensive and sustainable approach in both the concept design stage and the implementation stage of such projects. We are currently working to consolidate this experience in an analysis tool 'Work 4.0'. This should enable the responsible persons to specify their requirements for the conditions necessary for Work 4.0 in the context of Industrie 4.0. If the aim is to implement innovation in production, it is necessary from the outset to consider factors such as the changing skill sets needed by the employees and to develop appropriate solutions. And to do this, the operational units and central departments such as Human Resources and Research & Development must be brought together around one table", says Jan-Christoph Schüler, Country HR manager.

Braunert also regards the collaborative vocational education system as a decisive factor: "We utilise the partner's resources and learn from him; this happens in both directions and is better than working in isolation."

### The ABB Group at a glance
ABB develops, manufactures and distributes energy and automation equipment for the power supply, industry, transport and infrastructure sectors. ABB Stotz-Kontakt GmbH is based in Heidelberg, is part of the group of companies and was founded in 1891. The ABB Group has a world-wide total of about 135,000 employees, including over 10,000 in Germany. The Group headquarters is in Zürich/Switzerland, but ABB operates in a total of about 100 countries. The annual turnover lag in the 2015 financial year was around 35.5 billion dollars.

# Festo – Learning factory: an integral part of production

The Festo Group is a leading world-wide supplier of automation technology and solution provider for technical education. This is a firm that knows all about the challenges posed by Industrie 4.0. It knows that products are becoming ever more individualised, innovation cycles ever shorter, and production technology ever more complex. "Inustrie 4.0 means that staff will need higher and higher levels of qualification," says Dr Reinhard Pittschellis, Head of Development at Festo Didactic. "If an error occurs somewhere in the production process, trying to locate where that error lies is becoming considerably more complex. Today, there is a whole number of IT systems involved that constantly have to be updated or replaced. Staff therefore need to understand how the whole system fits together so that they can take the necessary action."

For Festo, qualificationis important for two different reasons: As manufacturers of automation technology, the company needs staff with an expert understanding of technology and methodology so that they can provide customers with state-of-the-art systems. At the same time, Festo is also a world market leader in initial and further technical training. Education and training facilities that teach complex subject matter need to offer innovative methods of learning that enable people to learn exactly what they need to know and to do so quickly.

## Learning factory: an integral part of production

The learning factory is a key means of training Festo staff at the production site in Scharnhausen in the South-West of Germany. The lab is spread across an area of 220 square metres and is divided up into four different sections – machining, assembly, multi-disciplinary skills and processes – along with a media centre providing access to eLearning tools. It offers learning stations, all of which have access to power, compressed air and network connections on a pull-down system that runs across the ceiling. These learning stations are kitted out with original components and software from production. The learning factory is thus an integral part of the technology factory in Scharnhausen, rather than an isolated training facility. Valves, valve clusters, and electronics are produced and manufactured right next to the learning stations.

"Having training facilities closeby is important," one member of staff says. "We can undertake training whenever we need to, without having to take time out to travel somewhere else. We can then directly apply the knowledge we have gained on the production floor." The ability for staff to move from theory to practice straight away has proven effects on learning. Retention levels are higher and a deep level of understanding is cultivated which is of vital importance for the complex processes involved in Industrie 4.0. Pittschellis calls this the "vertical dimension of learning": applying the knowledge gained in training to actual production tasks straight away cultivates the ability of staff to think and act integrally. Staff not only learn how to execute a certain task and how one part of the process affects the next; they also gain an in-depth understanding of the process as a whole, which can be transferred to other areas.

Another thing that's special about the learning factory is that it is largely operated by apprentices. Management and booking tasks are undertaken by business and technical apprentices, who run the learning factory from the apprentices' office as a small practice and advisory company. They book the training sessions, get hold of the right equipment, prepare the teaching modules, produce and update teaching media, and maintain facilities to keep them in good working order.

The learning factory is designed to mirror the various processes that are developed in the factory, so possible training

## Festo at a glance

Festo is the world's leading manufacturer and service-provider of automation technology. It is global market leader for initial and further technical training. It was founded in 1925 and currently employs 18,700 members of staff at around 250 sites in 176 countries. Its headquarters are located in Esslingen am Neckar in the South-West of Germany. In 2015, the company's turnover totalled €2.64 billion, of which just under 8 per cent was invested in research and development.

topics are gathered in from management and production once a year. Different module descriptions are developed which include core learning objectives, number of participants, names of the instructors, duration, different periods in which the training module is being offered, and the desired methodology to be used. The aim is to develop a standardised catalogue of training sessions that can be continuously updated. The catalogue currently comprises around 100 different training modules.

## It's the people that are key

"We need to be aware that it's the people that are key to a company's success, even in an age of digitised production. This is why we are investing a great deal in our staff and are involving them in developing the training modules. Our staff have now taken part in over a hundred different training sessions and are constantly developing new modules in line with needs at the factory," says Manfred Zahn, Head of Training. "The concept is appreciated by apprentices and well-seasoned colleagues alike. The type of training offered at Festo mean that staff are motivated, are aware of what's needed on the production floor, and develop just the skills they need." Even departments that have a finger in many different areas within the factory, such as IT, development, supply chain, and sales attend training sessions in the learning lab and use it to try out new applications.

## Dusting off a tried-and-tested instrument for training

The learning factory is not a new invention; it is a tried-and-tested instrument for training that is already being used by a number of different companies and universities," says Pittschellis. "By setting up the learning factory at Scharnhausen and integrating it into a modern production facility, we have been able to really boost the key advantages of having a learning lab: eliminating the gap between theory and practice and between training and application."

Even the fact that the learning lab is directly next to the production line generates a whole number of positive effects on its own. It facilitates the exchange that takes place between the various different disciplines, between experienced staff and apprentices, as well as the transfer of theory into practice.

# Mechanical Engineering Industry Association (VDMA)

## Initial vocational training remains as it is

In Germany as elsewhere, assessments differ regarding the development of qualification within the context of Industrie 4.0. The forecasts regarding qualification needs are crucially influenced by the respective technological vision within a particular company and, associated with this, the changes to business processes, to the organisation of work, its content and resources. In the surveys and case studies of companies, undertaken by the Mechanical Engineering Industry Association (VDMA), three possible variations emerge: in the 'Growing Gap' scenario, the division between highly-qualified personnel and those at a low level of qualification becomes more pronounced – a polarisation takes place. The second variant is called the 'General Upgrade' – this means the need to qualify all employees. The third variant emphasises the growing significance of qualification of subject-specialist personnel. The study points to this as being the most point of connection between abstract and specific requirements.

Accordingly, a need for change is indeed evident with regard to the structure of vocational basic and further training. However, this need is predominantly of an evolutionary nature and is to be mastered within the existing system. A large-scale and substantial requirement to effect changes is envisaged for further training. By contrast, for initial training more than a half of the companies surveyed expect no changes or minimal changes.

Source: Mechanical Engineering Industry Association; VDMA (publisher): Industrie 4.0 – Qualifizierung 2025 (Industrie 4.0 – Qualification 2025). Frankfurt/Main. VDMA, 2016.

# BENTELER – The concept "apprentice teaches apprentice"



With about 30,000 employees and 161 locations in 40 countries, the BENTELER-Group stands for a high degree of excellent material, production and technology in the areas of Automotive, Steel/Tube and Distribution. The closely dovetailed company processes require BENTELER's employees to display a high level of interdisciplinarity. The employees must have a fundamental understanding of the other divisions of the company in order to fulfil their own roles. In its vocational education programme, BENTELER puts this interdisciplinary principle into practice from the outset, together with the concept "apprentice teaches apprentice" which gives the apprentices responsibility and appreciation from an early stage. The principle is that apprentices pass on the basic knowledge in their areas to other apprentices. This approach is a complete success. By acting as instructors, the apprentices consolidate their own knowledge in their core area, gain a better grasp of company processes, enter into discussions which transcend the boundaries of individual disciplines and feel valued because of the responsibility which they are assigned.

## Industrie 4.0 as a driving force and an opportunity

In close cooperation with its customers, BENTELER must always be up to date in all areas of its work, and ideally even better than up to date. "Our environment is constantly changing. We see Industrie 4.0 as a driving force and an opportunity in global competition. What does this change demand from our employees? Flexibility and interdisciplinary thinking. Teaching interdisciplinary competence is therefore our emphasis in the strategic development of our vocational education system", says Thomas Koch, Head of vocational education at BENTELER. This is

also reflected in BENTELER's portfolio of vocational education. This year, in addition, to mechanics, electronic technicians and mechatronics technicians, BENTELER is also training two production technologists for the first time. For the production technologist, process orientation and an interdisciplinary approach are part of the fundamental concept of their job and do not need to be integrated into additional units. At BENTELER, the production technologists should analyse and optimise the production processes and bring different areas closer together. So BENTELER focuses on Industrie 4.0 even in its vocational education programme and deals with future-oriented topics as early as possible. To be successful in the long term, BENTELER needs a powerful and efficient workforce consisting of employees who can think like a business entrepreneur, act on their own initiative and react flexibly to changes.

BENTELER offers vocational education in Germany at a total of 15 locations of its Automotive, Steel/Tube and Distribution divisions. Currently, a total of 750 young people are being trained in the company in different apprenticeships and study courses. Paderborn is the company's largest location. That is where there are most apprentices – almost 500 young people. The main focus of the vocational education is on technical occupations such as industrial mechanic or the recently added production technologist. There are also commercial and IT apprenticeships and combined study courses where higher education studies are combined with intensive practical work in the company.

"We need interdisciplinary competence in all areas and all occupations", says Koch. "We need specialists with a generalist knowledge and we need generalists who have a knowledge of the processes. One example is our commercial staff who work in sales and purchasing. They need to know our products and understand the needs of the customer. They must at least have a basic understanding of the technical concepts. This also applies to our staff in the personnel department who may need to form a very good impression of new colleagues."

## The concept "apprentice teaches apprentice"

To achieve this interdisciplinarity, BENTELER contacted a vocational school. The resulting agreement was that apprentices in commercial occupations have elective subjects consisting of 80 teaching hours on the basics of material, metalworking and electrical technology – sub-

jects outside their specialist areas. The success of this initiative quickly became apparent. Therefore, BENTELER also included this approach in its own vocational education programme, building on what has already been learned. Here, the apprentices have an additional two-week practical placement in metalworking and electrical settings. "Our motto is 'apprentice teaches apprentice'. So the technical apprentices teach each other the basics of their own specialist areas, and the commercial and technical apprentices also teach each other", Koch says to explain BENTELER's proprietary concept. The Works Council has actively monitored and supported this process. "There are many advantages of this approach. First of all, gaining an insight into other areas gives the apprentices a better understanding of the interaction between their own responsible areas and the other departments and enables them to have an overall impression of the processes. Secondly, their role as 'teachers' helps them to understand the core content of their own specialist area more deeply. If you can explain it, that means that you have really understood it", concludes Koch. And thirdly, this dual role as a learner and instructor enhances the social competence of the apprentices. For young people, responsibility is a challenge which they are willing to accept because it also means that they are valued. And fourthly, the learning units which involve dialogue between apprentices also enhance the long-term communication between different divisions of the company. "Earlier, the different groups tended to keep to themselves and hardly spoke with the other groups", Thomas Koch recalls. "Now there is lively contact between the groups, and they meet on equal terms."

**The BENTELER Group at a glance**
The BENTELER Group operates in the divisions Automotive, Steel/Tube and Distribution. The company was originally founded in 1876. Now, the international holding company has its headquarter in Salzburg, Austria. The Group's 30,000 employees in 161 locations in 40 countries earned a total turnover of 7.59 billion EUR in the 2015 financial year.

## Results and learning examples for other companies

For BENTELER, the desired effects have been achieved. "Our young employees understand the processes better and are more equipped for their own tasks in our highly automated production system. Reservations were overcome. The apprentices appreciate the challenge of acting as instructors. They tackle their new tasks in a motivated and ambitious manner", says Koch. Before the "apprentice teaches apprentice" concept was adopted, BENTELER had used external instructors to teach the basics. "The external instructors did not know our company well enough. And our own apprentices quickly achieved much better evaluation grades from their colleagues", says Koch, pointing out the resounding success of the concept.

In the Purchasing department, Thomas Koch even reports that the classical career structures have been revolutionised due to the change in the vocational education programme. Two young people rose to become team leaders in a relatively short time due to their interdisciplinary competence.

## Courage to embrace what is new

Initially, reservations about the "apprentice teaches apprentice" concept were expressed within BENTELER. On the one hand, the apprentices did not immediately believe that they could fulfil their teaching role. On the other hand, the instructors had their doubts about whether the plan would work. "We just have to show some trust and let the young people get on with it", Koch says to encourage the people who are responsible in other companies. He then sums up: "Recruiting and developing our employees is the key to our success", thus underling that a combination of tried and tested solutions and the courage to embrace what is new is the right way to face the future.

# Phoenix Contact – Dual-study trainees develop Table-Football Unit 4.0

The normal table-football unit in a bar has only one thing in common with the one that dual-study trainees at Phoenix Contact have built: you play on it in the old, established way – one person against another.

Why approach an abstract topic from the viewpoint of playing a game? What is the 'thing' referred to in the Internet of Things? "OK, consider the football in a table-football unit as this 'thing'." In essence, that was the instruction from Eugen Heinrich, Head of the Study and Projects Group at Phoenix Contact, on 11 March 2016. He was addressing around 30 trainees from the year-2015 intake on the dual-study programme, who are currently working on the following traineeships: information science; electrical engineering; business and engineering; business and information science; and mechatronics engineering.

This spontaneous idea of beaming today's table-football unit into tomorrow's world quickly developed into an ambitious initiative: the Table-Football Unit 4.0 was to be operationally ready in three months, in time to mark the opening of Phoenix Contact's new training centre on 10 June. A schedule was set-up and tasks were defined. The students organised themselves into three teams.

## Industrie 4.0 is about solving problems

This much was clear: if the ball was to be the 'thing', it needed to be identifiable. This is made possible by an RFID Tag, a coded transponder – colloquially called a 'radio-label' – with a code that a reader-unit recognises. The search for table-football unit balls with pre-installed RFID tags in on-line shops was without success. The balls had to be manufactured in-house.

So take some polyamide powder, weld it to the right points by laser beam; This process is called lasersintering. These semi-spheres were white. To sort them later in a user-friendly way, they were coloured-in red, yellow, green and blue. The balls sintered in two halves were made to form one unit by a bayonet-mount, i.e. one section is inserted into the other and they are turned in opposite directions. However, in a test game these ball-halves broke apart. So they were filled up with hot adhesive, fitted with an RFID tag, and glued shut. The second test was passed by the balls and by the tags in the balls.

The whole process took eleven hours – four hours of construction, two hours of preliminary heating, four hours of cooling down and one hour of follow-up processing (projecting beams at the balls, using glass spheres).

The RFID tag makes each ball identifiable. The table-football unit has a photoelectric barrier in both goals and an RFID reader unit. This means that the course of the game is recorded (the data is channeled into the background, to be stored in a database on the professional cloud. Each ball knows how long it was played, both per game and as an overall total (hours, minutes, seconds), by whom (Player 1, Player 2), and who scored how many goals with that ball.

Unlike a normal game of table-football, in 'Kicker 4.0'-kick-off does not come from the ball being introduced from the side; instead it is placed onto the centre-spot – after it has been brought from inside a goal, using a lifting device; from there, it comes into open play again.

What distinguishes Kicker 4.0 is firstly the ball and secondly 'DAISy' (Digital Automation Integrated System), a sorting machine. The latter stores the balls and issues them to the players, each of whom can steer at each ball and select it in a targeted way, by means of a PC. Each player can maintain their own set of statistics. The most successful players can also be shown – Max Meier, 105 games won, ratio of goals scored to goals conceded: 7-to-1.

**Phoenix Contact at a glance**
Phoenix Contact GmbH & Co. KG is a company that provides components, systems and solutions for electrical engineering, electronics and automation – in total more than 60,000 products. The family business, founded in 1923, employs 14,500 staff worldwide and in 2015 it generated turnover of EUR 1.91 billion. Company headquarters is in Blomberg, in Germany's Ostwestfalen-Lippe region. The Phoenix Contact Group is comprised of twelve companies in Germany and more than 50 sales companies throughout the world. According to its own information, the company is "familiar with the requirements that are imposed by digitalisation, thanks to its experience gained in in-house mechanical-engineering operations, along the entire product life-cycle." Phoenix Contact is one of 25 core companies that form the top-level cluster called "Intelligent technical systems – Ostwestfalen-Lippe" (it's OWL), initiated by Germany's Federal Ministry of Education and Research.

This serves as an added-value for the player, the 'Use Case', a system's externally-visible behaviour from the user's viewpoint. The registering of the data and the intelligent data-management elevate traditional table-football into the realm of 4.0.

## From strip-format advertising through to automatic stadium atmosphere

However, that does not say it all about the table-football unit made by the Phoenix Contact's dual-study trainees. There is advertising placed onto strips; using magnets, the mounting for the strips is attached on the plastic boards surrounding the table-football unit's interior; each strip measures 100 x 33 millimeters. 32 strips were needed to cover the pitch's entire periphery.

One strip each was designed for each profession and each dual-study course for which Phoenix Contact conducts a traineeship. The photos used came from the picture data-base in the intranet and were scaled into a 95 x 32 millimeter format.

The floodlights consist of four spotlights with eight LEDs each respectively. To create stadium atmosphere, Phoenix Contact's language-output element PSD-S AE V15/1 was used. This stored 15 audio files, each able to be played individually. All sounds have special triggers, such as kick-off, a referee's-type 'stop' signal or a goal, and each provides background audio suitable to the given situation.

The two main menus only have the following points of difference: firstly, the game ends after a pre-set time period (3 minutes and 20 minutes), and secondly after a certain number of goals is scored (from 5 goals to 20 goals). Using the 'Pause' and 'Stop' buttons, the players can pause or end the game.

Both playing screens also have two error-reports, shown as soon as certain preconditions prompt them. The first error-report appears if, during the game, the RFID reader registers the presence of a ball other than the match-ball currently in use. The report notifies the player that play cannot continue until either the correct ball is registered as being in play again or the 'Stop' button is pressed. The other error-report appears if something passes through the photoelectric barrier but the RFID reader does not register a suitable input-signal.

In addition, the table-football unit can be operated using a control-deck that has four keyboard-keys ('Start', 'Stop', 'Issue a new ball', 'Illumination_Switch-Cabinet') and a grid ('Manual mode').



## Equal to the task

When the table-football unit was all set to play, shortly before the Training Centre was due to open, the last test – the 'full-operational rehearsal' – was about to start when a plastic panel slid out of position. A great misfortune! A rush of frantic activity – and the problem was able to be eliminated in good time, "even if everyone was bathed in sweat", as Project Leader Norbert Wrede remarked. He noted that he had hardly ever experienced such a highly-motivated project-team as the Kicker Team – "everyone was firmly convinced that they'd do it."

Kicker 4.0 managed to reach the front-page of 'Contact', the employee newspaper. However, the game is not yet suitable for series production – "you would need very deep pockets to make that happen", says Eugen Heinrich. Nevertheless, the toy is not sitting there gathering dust. "In 2017 the Table-Football Unit 4.0 is at the Hannover fair on the 'it's OWL' booth." The idea is that, if the unit is not at a trade fair the apprentices and the dual-study trainees should be able to have a game with it.

# Siemens – The right methodology for the future

Siemens is a leading international technology company focusing on the fields of electrification, automation and digitisation. The company has headquarters in Berlin and Munich.

Owing to competition in the fields in which it works, Siemens constantly has to push towards shorter innovation cycles, greater flexibility, and a more efficient use of resources. Digitisation is a fundamental element of Siemens' corporate strategy. Given the fields in which the company works, such as industrial automation, and given the fact that it has around 300 production locations, Siemens has already started to look intensively at trends like Industrie 4.0. "The strategic focus of our work is on the growth fields of electrification, automation, and digitisation, so ensuring our vocational education is innovative and will prepare apprentices for the future is crucial to our success," says Christoph Kunz, Head of Portfolio Management at Siemens Professional Education (SPE). "We need to equip the next generation of Siemens employees with the right skills at the right time." With Siemens currently training around 12,500 young people around the world (incl. 2,500 for a select list of external companies), this is a task that carries considerable responsibility.

## The Industrie 4.0@SPE project

In order to develop the right vocational education, Siemens set up a project called Industrie 4.0@SPE. The project focused on analysing the changes taking place as part of the increasing digitisation of the world of work so that vocational education content, teaching methods, and the knowledge and skills of instructors could be systematically adapted to these needs.

"The first thing we did was to think about what effects Industrie 4.0 and digitisation has on us as a company. New measures needed to be designed with the needs of our company and Siemens vocational education in mind," said Kunz, describing the basic thoughts that the company had. "We started by building up a network that would allow us to gather together information all about Industrie 4.0," said Erik Engwer, Professional Training Instructor for Electrical Engineering and Head of Electrical Engineering at the Siemens Training Centre in Berlin. "This enabled us to gain a picture of the future". The project served to point up a range of key topics that needed to be covered in vocational education. These were: smart organisation and control for the entire value chain, flexible networking between people, machines and products, comprehensive collection

# Survey by Federal Institute for Vocational Education and Training (BIBB)

## Digital media are seldom used

Within companies' everyday vocational training work, digital media play a relatively minor role. This was the conclusion of a representative survey among all respondent companies with at least one employee (with a good half of these being companies that conduct formal vocational training), undertaken on behalf of the Federal Institute for Vocational Education and Training (BIBB). Among the most important media formats used in training, the first four are classic formats: tuition books and subject-specialist books; other written material; group work (face-to-face); and face-to-face tuition. It is only after this that digital media come in – 'subject-specialist software' and 'information offerings in the Internet'. A certain role is still played by learning programmes (WBT or CBT); all other digital media are characterised as 'fairly unimportant' or indeed irrelevant.

Differences emerge between companies: in large firms, the classic media formats or learning formats respectively – presenting a paper or a project, face-to-face tuition and group work – play a much greater role than in smaller firms.

It is primarily in the finance and insurance sectors that a lot of use is made of digital media, in addition to above-average usage levels in (B2B) services close to companies. By contrast, such media are used to a below-average degree in training for the manufacturing-technical sector and for craftspeople's work.

Source: Gensicke, M. et al. Digitale Medien in Betrieben – heute und morgen. Eine repräsentative Bestandsanalyse (Digital Media in Companies – Today and Tomorrow. A Representative Analysis of Current Status.) WDP 177. Bonn: Federal Institute for Vocational Education and Training (BIBB), 2016.

and analysis of data, combined with the aim of raising efficiency and effectiveness and of unpicking the seams between the real and the virtual worlds.

Building on the basis established in the project, a total of 25 digital skills were identified that are becoming more and more important as the process of digitising industry becomes rooted ever more deeply (e. g. databases, security, sensors). An analysis was then undertaken of 50 typical user cases in order to determine what processes, technologies and roles are affected by the digitisation of industry. For every one of the affected roles, the changes in needs in the 25 different areas in digitisation were identified. "Let's take the role of Service Technician, for example," says Kunz. "The analysis enabled us to see that that skills requirements in the areas of systemic thinking, network protocol, cloud computing, and data analysis will increase enormously over the next few years." Overall, Kunz sees a growing need to take an interdisciplinary approach, as well as seeing the rising importance of IT skills. "The electrician of the future will only be 60 per cent electronics expert, but will be 20 per cent mechanic and 20 per cent IT expert," says Kunz. This is why every member of staff at Siemens now receives instruction in additive manufacturing and robotics as part of their vocational education.

Training for the skills that will be needed in the future, as pointed up by the analysis, are being covered by newly developed learning sequences. The learning sequences are designed to supplement existing vocational education plans within the scope that is available under the company's vocational education regulations.

For Siemens, simply adapting the content of vocational education was not enough. "Once the various topics have been identified, the didactics and methodology used have to be looked at accordingly," says Kunz. The focus is placed on practical application of the training content in practice projects. Erik Engwer is proud of the 'coffee machine project' undertaken by his apprentices in Berlin: "There were just two conditions that we gave to the apprentices – the project had to be presented in four weeks' time, and an individual production line had to be planned and created." Based on this, the apprentices decided to create a multi-functional coffee machine with integrated sensors that use a Human Machine Interface (HMI) in order to select the product. "The apprentices did everything themselves. They started by brainstorming their particular idea. They then ordered some of the various elements they needed and produced others themselves using 3D printing. The apprentices undertook project management, documentation processes and the final presentation in front of training staff all by themselves", says Engwer. The apprentices demonstrated their dedication by even developing and programming an app which allows the coffee machine to be controlled.

## The foundation stone has been laid

"We are right in the middle of a process," says Kunz. "Adapting our vocational education to meet the needs of digitised production will definitely take some time still, and we will need to keep reacting and responding to new developments as we go. But the foundation stone has been laid." Siemens has identified 25 key digital skills and has analysed 50 typical applications of Industrie 4.0. Based upon this, Siemens education experts have created a database which they have populated with around 20,000 entries on digital skills. The experts have identified all of the relevant changes to the skills that need to be taught in each of the Siemens Professional Education (SPE) training courses. This work can now be used to further develop training content. The education experts have also integrated amended learning methods, teaching material and training for instructors and lecturers as part of the overall concept. The first learning sequences to be developed – dealing with topics such as 3D printing, for example – have already been integrated into vocational education plans and been used in practice.

## Developing a clear idea of what's needed

"Before we start to create new education programmes, we first need to develop a clear idea of what the company actually needs," says Christoph Kunz, Head of Portfolio Management at SPE and at other companies. He also said that it was important to consider what learning methods should be used and how teaching staff could be best equipped. Kunz added that vocational education 4.0 was not the same as simply using new media and apps, saying that whilst the digitisation of learning was one element in future-based vocational education programmes, it must be used with care and consideration. "In principle," he said, "overhauling our vocational education can be seen as a classic process of change: we have to get everyone on board – the apprentices and instructors alike – and the whole project needs to be supported by management, who have to be clearly committed to these changes."
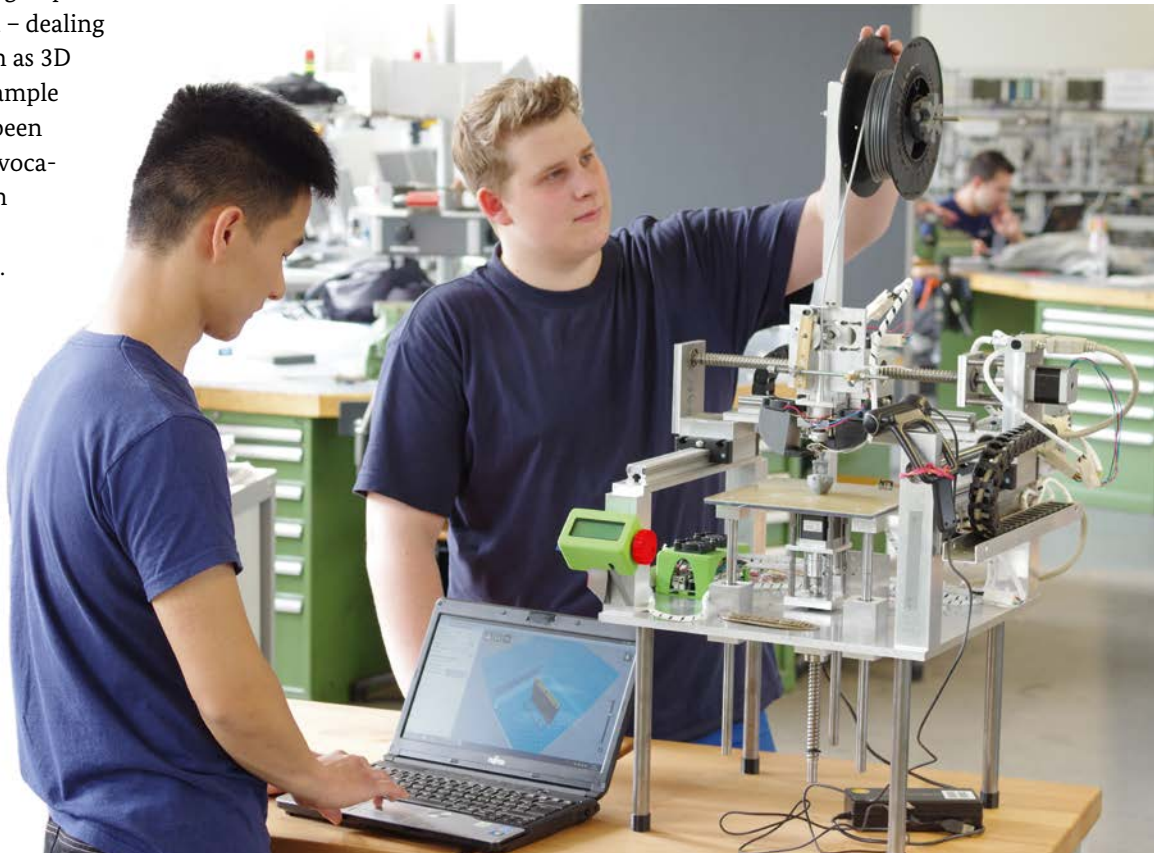


### Siemens at a glance
Siemens is a world-leading technology company focusing on electrification, automation and digitisation. The company has headquarters in Berlin and Munich. Founded back in 1847, Siemens now employs 348,000 people across the world, of which 32,100 work in research and development. The company has a total of 114,000 members of staff in Germany. It has operations in more than 200 different countries and in 2015 recorded an annual turnover of €75.6 billion.

# Examples from companies:
# further training
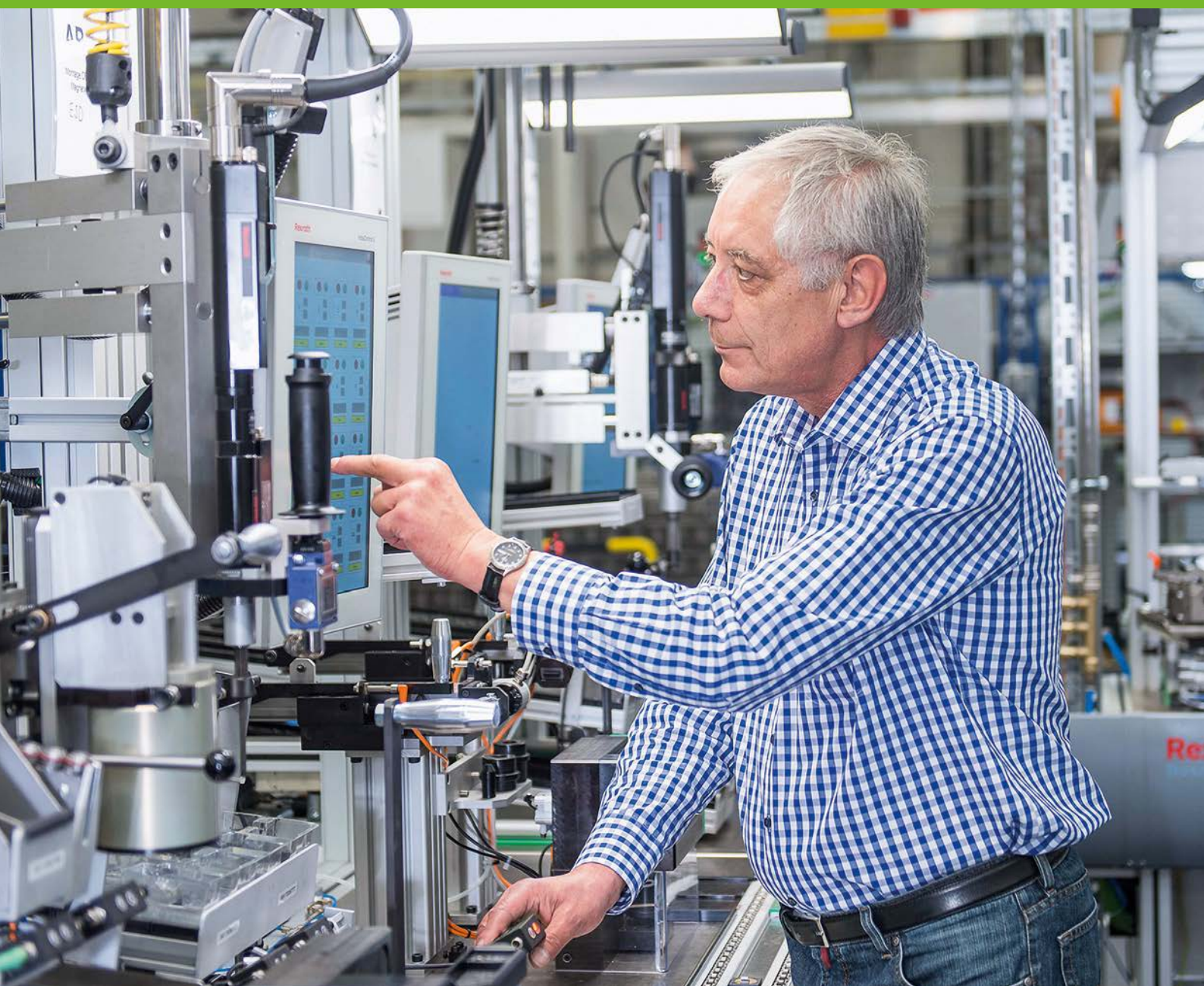
# Bosch – Good training for everyone at the company

According to Dieter Lochbihler, Chairman of theme Works Council at Bosch Blaichach, the ever greater digitisation of production has two sides to it. On the one hand, he says, the changes are enormous; work and requirements are being transformed at rapid speed, and new technology, such as tablets and smart watches, is being used in the factory halls, opening up new methods of production and making new forms of qualification a must. And on the other hand?

"On the other hand, Industrie 4.0 has to be explained to staff in small steps," he says. "What they need is systematic training so that they are able to use and handle the new technology and assistance systems." Bosch is already doing this.

Lochbihler says that just a year or two ago, there was much apprehension among the 3,400 staff at the factory in Blaichach. "Staff didn't know what to expect and the only thing they could see was that they were suddenly going to

have to meet new requirements in their work." In the end, the use of digital technology has made it possible to supply the line in a much more flexible manner; instead of having to hold fixed quantities of materials at the ready for each machine, it is now possible to react quickly to the status of production processes at all times. This is changing the portfolio of tasks that staff have to undertake at the plant. "Our staff need to use new technology", says Lochbihler. "In addition to this, their responsibility actually increases because they have to take charge of the flexible filling of the machines." This applies especially to the plant managers. They particularly have to step in and act whenever there's a standstill in or disruption to production. In cases like these, mobile end devices that are networked together enable global error location to be undertaken on identical machines. The employee receives recommendations for action via tablet and must evaluate each one. "In order to master these tasks, staff need to apply network thinking and to take responsibility for decision-making," says Mr Lochbihler. He said that it was important to train employees in this.

At the Bosch plant in Blaichach, training modules are provided for all members of staff, irrespective of what their particular role involves. These training modules are constantly being further developed, are designed around the needs of the particular group of staff to be trained, and can be undertaken flexibly – ranging from short training videos on the basic principles of Industrie 4.0 or on how new technical devices are used, to full-day seminars on how to handle new systems or on specific methods for teamwork or management practices. The Works Council not only considers training important, but also communication. "It's about helping people to understand Industrie 4.0 and taking away any fears." This involves using the monitors in the staff rooms as well as the information boards on the production floor. "We do not want to, and will not try to hold the digital transformation back," says Lochbihler, "but if we want to shape this transformation to get the very best out of it for our company, our staff need to be well-trained."

# Tips for works councils – Dieter Lochbihler on using Industrie 4.0

**About Dieter Lochbihler:**

Dieter Lochbihler was born on 19 August 1968 in Gunzesried in Bavaria. After completing vocational education as an electronics technician for energy, he later obtained the qualification of master craftsmen in electrical engineering and became a training instructor. Mr Lochbihler has been a member the works council at Bosch Blaichach since March 1994. He has had a seat on the general works council since May 2002 and has been Chairman of the Works Council at Bosch Blaichach since 2003.

*Is training on Industrie 4.0 essentially just the same as any other kind of training?*

No; we have to take on new approaches here. Industrie 4.0 is a much bigger number. We need to ensure we get every single person on board, which in our case means 3,300 different people. We need to provide training for each and every person, no matter their job role, and to constantly develop the training we provide. Instruction might take the form of short training sessions at the production line and videos on Industrie 4.0, or full-day seminars that look at how to use new IT systems or at new methods for teamwork or management practices.

*Should the works council also take up the topic of Industrie 4.0 itself?*

Yes, definitely. Industrie 4.0 is 'the' topic of our future and is turning the world of work on its head. It's our job to play a part in shaping work conditions for our staff.

*At some point, the employers and the works council will meet to look at this issue for the first time. What is the most important decision that needs to be made in order to make a success of things?*

The most important thing is to involve all members of staff in an open dialogue. We have a staff contact on each side who is responsible for compiling and collating the key issues. Industrie 4.0 needs to be one of the primary areas of focus in the work of the works council. There is a working group on Industrie 4.0 at our plant. But this is a topic that also needs to be discussed and coordinated by the more superior bodies, as well as by the general works council.

*It remains to be seen whether Industrie 4.0 actually creates more risks than opportunities, and whether it will enhance work or will destroy jobs. How can employees' fears of becoming the losers be assuaged?*

This is a worry that's been around for a while and we have been looking at it closely since the start of industrialisation.

The change is going to be permanent – jobs will disappear, new ones will develop. Industrie 4.0 is not the portent of a destructive revolution, but is an evolutionary process that is taking place at rapid speed. It is a process that must be discussed openly, with everyone, and be actively shaped bit by bit by the works councils and people in charge. We are making Industrie 4.0 something that can be experienced by integrating the new technology into daily life. In our canteen, for example, all of the plates are fitted with an RFID chip. When the plates pass over the counter, they are coded, and the food can be paid for automatically, without the need to use cash. This shortens waiting times and makes the lunch break longer! No one has lost their job and we were actually able to extend the range of meals on offer.

*Will the strong hierarchy at the plant be compatible with Industrie 4.0?*

We need to redefine our management and cooperation structures and remain in dialogue with everyone involved. The task of managing the plant is too important to be left to management staff alone. Staff will be given the opportunity to make decisions themselves. Nevertheless, the task of managing the company is, and will continue to be important, but it needs to take place in an atmosphere of openness and approachability.

*Can training on Industrie 4.0 be fun?*

It has to be fun, otherwise we won't be able to get the processes actually implemented. You have to have get staff used to using them, bit by bit.

*Young people are able to more readily embrace new technology than the older generation. What can be done to get them on board nonetheless?*

That's an easy one to answer. One way is by ensuring mixed-age teams. It's the mixture that's important. The younger members of staff who are very good at using the equipment help the older ones who have greater experience, so it's beneficial for both sides.

# Training in the world of 4.0 – Siegfried Czock on initial and further training

**About Siegfried Czock:**

Siegfried Czock (psychology and business management degree) was born on September 11th 1958 in Afferde/Hamlin in the North-West of Germany. He is married and has two children. Since 1987, Czock has held various positions in the areas of personnel and training at Bosch. He is currently Head of Vocational Ecudation and Further Training for the whole of Germany.

*Is the kind of training designed to prepare staff for Industrie 4.0 different from the vocational education and further training given in the past?*

Training on network-based production, or Industrie 4.0, isn't only about providing staff with technical knowledge and methodology. On top of IT skills, staff involved in this kind of production also need process knowledge and excellent communicational skills. Networking changes normal work processes, so Industrie 4.0 should be seen as a process of change that needs to be shaped together by everyone involved. That's why it's important to integrate the requirements for Industrie 4.0 into our corporate vocational education.

*How should an employer respond if the works council brings up this topic first?*

The shift towards Industrie 4.0 is a great opportunity for both sides. The process of change associated with this ought to be shaped by the employer and his employees together. So it's not so important who approaches whom, but just that discussions like these happen as early as possible. And particularly when a company has in fact already started to think about introducing Industrie 4.0 applications in its work processes.

*At what point do you start to call the modernisation of production and administration 'Industrie 4.0'?*

The core of Industrie 4.0 is the networking of facilities and the new possibilities of expanded data gathering and evaluation for controlling production processes. It also fosters the development of new products and services. This transition from classic automation towards use of an Industrie 4.0 application is usually seamless.

*Industrie 4.0 is not only met with enthusiasm but also different fears. How can fears among the employees be assuaged?*

Like with any process of change, Industrie 4.0 will call normal routines into question and will replace them with processes that are new and unfamiliar. That's why it's important to start to address the questions and the concerns of staff early on. It's crucial to take the fears of employees seriously and to integrate the process knowledge held by staff as the changes are made by enabling them to have their say. So the process needs to be transparent and open. Staff and staff representatives should be involved from the very beginning. By coming alongside one another, it's often possible to move away from emotion-based fears towards informed judgements. The aim should be to turn man and machine into a successful team.

*Industrie 4.0 has a lot to do with open communication, an exchange of knowledge, and teamwork. Will the strict hierarchy at the company be compatible with Industrie 4.0?*

Irrespective of the company hierarchy, the machines and products part of Industrie 4.0 will be connected and continuously exchange data with one another. Production specialists therefore often work in interdisciplinary projects. This happens beyond the organisations' boundaries, i.e. via networks. We therefore think that the management culture in many companies will go on to develop and change. The question as to what kind of management structure is most successful for a particular company depends on the kind of work being undertaken, and on the staff and the management there.

*Industrie 4.0 enables a company to be better placed. Should the staff also share in these gains?*

Organising how staff partake in their company's success is a general task undertaken by the social partners. The shift towards Industrie 4.0 represents a gain for both sides. Not only can they help simplify work processes, but they can also play a part in raising competitiveness.

*How can a company stir the interest of older members of staff for Industrie 4.0; when are they already 'past it'?*

Life-long learning is not a question of age. A key factor in the success of the changes, however, is making these something that everyone can experience and partake of. The best way is having staff be excited about the new technology and having them recognise that the change in their work or tasks will actually support them in their work.

**Insight from research – No. 3**

# Federal Ministry of Labour

### Ongoing vocational training – A must

The technological transition leaves nobody unaffected – not only the more highly qualified; two-thirds of workers at a low qualification level also feel a need to constantly develop their own professional competences further. This is the result of a study in 2015, in which more than 7,000 employees from almost 800 companies were surveyed about digitalisation's consequences for their work. In all, 78 per cent of the employees see the need to further develop their skills on an ongoing basis. This is no surprise considering that, over the last five years, among 60 per cent of the less qualified and among 80 to 90 per cent of the more highly qualified, the primary factor generating changes in the technical equipment used at their workplace has been information and communications technology. However, there are big differences between the business sectors with regard to their use of digital technology. Manufacturing technology ranks among the front runners: more than 80 per cent of the employees use computers, internet or a smartphone at their workplace.

Source: German Federal Ministry of Labour and Social Affairs (publisher): Monitor („Digitalisierung am Arbeitsplatz. Aktuelle Ergebnisse einer Betriebs- und Beschäftigtenbefragung"). Monitor (Digitalisation at the Workplace. Latest Results of a Survey among Companies and Employees). Berlin, 2016.

# Münstermann – Further training to order

Globalisation has radically changed vocational education and further training at Münstermann. And this has changed the culture in the company.

The introduction of new style further training at Münstermann followed a classical pattern: the change in the market environment changed the need for qualifications. One example: when the first large order was received from the UK 20 years ago, communication with the new customer had to be in English, and regular training courses were held from then on because not everyone at Münstermann was good enough at English. Now English lessons are held three times a week with between eight and 18 employees who sacrifice their working hours (and can make up the time beforehand or afterwards). Anyone who wants to can take part – from apprentices through to sales engineers.

The introduction to digitisation was also customer-driven. Münstermann is not a mass production manufacturer, it develops special solutions together with its customers. If a customer has already introduced Industrie 4.0, Münstermann reacts to that: In the past five years the number of employees in the measuring and control engineering sector has increased five-fold, i. e. it has risen from three to 18.

The Telgte-based family business is itself largely digitised. If any faults arise on the customer's premises, the machines and equipment are repaired by remote maintenance. Customers can follow the progress of current orders by webcam. There are frequent world-wide web conferences with customers and suppliers, which saves everyone expensive flights and a lot of time.

But there is more. Error reports are submitted on-line. Not only current orders are visualised, this also applies to project planning. Supplier catalogues are increasingly used on-line. Digitised systems in the purchasing department permit automatic follow-up orders for material.

## Constant exchange of knowledge

Training courses are held regularly, for example the annual courses on health and safety at work and occasional courses at the request of the employees on subjects ranging from materials to personal development. Training does not need to be solely vertical (subject-related), it can also focus on other topics (horizontal). Further training is also provided on the premises of customers or suppliers – and in return, customers and suppliers send their employees to Münstermann.

"To do justice to the various high demands of the customers, we ensure that we have a corporate culture in which all employees communicate with each other to exchange and develop their knowledge", says Magdalena Münstermann, who managed the company in the fifth generation together with her husband. The company has now been taken over by their son Frank, representing the sixth generation.

Exchange of knowledge – this means not only an exchange between employees who work next door to each other, it also includes an exchange of knowledge between the administration, production, design and marketing departments or between Purchasing and Sales. Communication takes place across departmental and subject-based boundaries. People are encouraged to express their own ideas.

When a new order is due, after the kick-off meeting a meeting is then held every week which is attended by

**Münstermann at a glance**

From a smithy to a plant manufacturer: The family company Bernd Münstermann GmbH & Co. KG in Telgte near Münster was founded in 1845 and is now in its in sixth generation. Since the turn of the millennium the company has developed to become a globally operating industrial company. The 260 employees design and produce specially designed plant and machinery with a special emphasis on drying systems and conveyor and dust extraction systems for industry. Münstermann presents itself to the market as an all-round supplier of drying and heat treatment systems, including the associated conveyor and filter systems. In Germany, throughout Europe and sometimes even in Russia and Saudi-Arabia. The products are usually customer-specific individual solutions. 60 to 80 per cent of the products are exported throughout the world.

The company is active in the German Plant and Machine Engineering Federation (VDMA) and belongs to the Metalworking Employers' Federation in North Rhine Westphalia. The company does not have a works council, but it has an employee representative board.

all participants to compile and update an Excel list (who does what, by when?). On reason for this open dialogue is that every employee has plenty of experience and special knowledge, and if this is shared it will "lead to new ideas and creative solutions", says Magdalena Münstermann. "We can only solve problems together if we know each other and know about each other." The knowledge that is necessary today is contained in many heads, it cannot exist completely in one head.

And a high general level of knowledge makes fast decisions possible; power-based knowledge makes them more difficult.

The hierarchy at Münstermann is shallow and flexible. Supervisors and managers should provide a stimulus, motivate their staff, delegate responsibility and not just tasks; in any conflict they make the decisions. When one project has been completed and new project is not yet due, the former project manager can become a regular member of another team.

Staff fluctuation in the company is almost non-existent; the average age the staff is about 41. That is roughly average.

## The company's own metalworkers in training

Each year, Münstermann trains six to eight metalworkers (specialised in design engineering) and technical product designers. The latter also learn to use 3D printing. A specially installed 3D printer enables them to get to know the latest technology at an early stage. This even encourages older employees to get to know this technology. "All employees, both apprentices and others, must learn to 'think in 4.0'", says Magdalena Münstermann.

In the selection of apprentices, the company does not apply the principle of selection by achievements, it accepts candidates from all types of school, from special school pupils through to candidates with the Abitur qualification which entitles them to enter higher education. The company also offers candidates the opportunity of a dual course of study: they can study mechanical engineering at the University of Applied Sciences Münster-Steinfurt. Münstermann cooperates with this university and with other higher education institutions.

Every apprentice participates at least once in a four-week practical placement abroad to promote inter-cultural competence.



When apprentices successfully qualify, they are usually taken over as permanent employees; some obtain further qualifications by in-service training, e.g. as qualified technicians.

## Arouse interest at an early stage

To promote the interest of young people in the world of work, Münstermann offers trainee placements. They take one to two weeks. Up to six pupils can get to know the practicalities of work in the company at the same time. They are integrated into a specialist working group and involved in processing orders. Every two days they change to another specialist group and get to know different employees, different working procedures and different orders. They also get to know the work of a product designer, although very few of them can operate the necessary software. So that they can draw in spite of this, apprentices have compiled a video which explains the operation of the design software by screen capture and contains exercises.

More than three dozen pupils go through this sort of practical session in the company each year. To ensure that this system is not limited to Münstermann, Magdalena Münstermann initiated the "Telgte model"; it promotes cooperation between schools and businesses (www.telgter-modell.de).

Magdalena Münstermann believes that the company's culture is fundamentally transferable. But open communication, curiosity and enthusiasm cannot be enforced, they must be shown by example so that young people can experience them. By supervisors and by the management.

# SAP – Individual qualification by cloud-based learning

Digital transformation is a challenge even for a successful global software company such as SAP. Especially the growth of cloud concepts leads to disruptive changes in the business software market and creates a variety of new requirements for business models, organisations and employees. Starting from the structures that have developed up to now, SAP therefore uses the in-memory database and development platform HANA to work on the migration of existing software solutions to the cloud and new cloud-based services – or to the areas of 'Big Data' and the 'Internet of Things'.

The global Early Talent manager of SAP SE, Markus Bell, says: "To fulfil these new requirements, we endeavour to attract people who are specialised in the latest technology, and we recruit the best talents from the generation of digital natives. Especially in established locations with an organically developed age structure like Germany, however, we ensure that all employees are offered a systematic further training strategy which will continuously qualify them for the new requirements."

"We see a special demand in three core competence areas", says Markus Bell. The first competence area comprises knowledge and skills in using new technology. This includes knowledge in the use of central cloud technologies or abilities in using Big Data. The second competence area focuses on questions related to modern project work in a team: how can time and project management and communication in the team be effectively organised? And the third area is the knowledge of the SAP world. What is the corporate strategy? What products are in the SAP portfolio? What security and compliance requirements apply?

## The learning platform Success Map Learning

SAP's annual budget for further training underlines the importance that in-service qualifications enjoy in the company – SAP now invests 140 million euros per year. SAP sees itself as a company that is in a permanent learning process. Further training is therefore very strongly embedded in the everyday work setting. Based on this, SAP has developed a further training concept that consists of three central steps:

1. **Determining the qualification needs:** For example, the development organisation evaluated the needs of central competitors and partners and the requirements in job adverts in the software development sector. In addition, a poll was carried out amongst the company's internal thought leaders on future technologies that are relevant to SAP.

2. **The planning and implementation of further training:** SAP uses the cloud-based learning platform "Success Map Learning", which is also part of the SAP product portfolio. This platform makes it possible to prepare individual "Learning Roadmaps". The Roadmaps may include both general areas of competence such as leadership and specific technical topics such as data science. The specific parts of the courses are assembled on the modular principle from over 35,000 learning opportunities in annual development discussions with the relevant manager. All employees can also access the learning platform via mobile devices, view their own learning history and come together in learning groups. Managers can recommend specific learning modules to their employees on the platform and view the learning progress of their team.

3. **Evaluation:** Each course and instructor can be evaluated on the platform by the persons who have completed the course. In addition, the further training programme is also evaluated in the annual staff survey which is used as a basis to compile central indices for the development of the further training.

Susanne Müller now works in the HR University in the Walldorf headquarters of SAP. When she started with SAP, she took part in the "HR Early Talent Program", which was designed for selected new employees with less than two years of work experience. Training courses using Success Map Learning were an integral element of the support programme.

### SAP at a glance

The German IT company SAP is specialised in business software and the world market leader in this area. The relatively recent company (founded in 1972) is now represented by branches in 130 countries. Most of the approximately 77,000 employees are academics (80 per cent). The Walldorf-based software giant achieved an annual turnover of 20.8 billion EUR in 2015.

Susanne Müller was particularly impressed by two virtual training units. "One unit presented the SAP product portfolio. The trainer drew the complex SAP portfolio very clearly on a digital board and added an oral commentary. In addition, as participants we could ask questions and exchange opinions at any time via a chat window", she recalls. "I found the use of the method very effective, and after the unit I contacted the instructor directly with an application-related question." Networking teachers and learners – bilaterally or in theme-based communities – is possible on the platforms and is explicitly encouraged.

The second unit which Susanne Müller talks about aimed to teach how to communicate effectively with supervisors and executives. "Some months after this unit I had a presentation to the Human Resources director. I looked back at the recording of the unit on the learning platform and took the advice to heart: keep sentences short, put the most important points first. That was very helpful."

When Susanne Müller herself sees a need for training, she can use the search function on Success Map Learning to find an appropriate course. "There are mandatory courses, for example on IT security, which we must complete within a certain time. In addition, I can also take courses on my own initiative, and they are even automatically added to my Outlook calendar." The next course she wants to take is on gamification.

## The employees feel supported

"The learning platform Success Map Learning and the training opportunities as a whole are intensively used and positively regarded by the employees", concludes Markus Bell, and he can support this statement by solid figures: In the annual world-wide employee survey in 2015, 74 percent of the more than 54,000 respondents stated that over the last 12 months they had been able to use opportunities to improve their abilities and their competence. 75 percent of

the employees also confirmed that the learning and development opportunities fitted in with their own career goals.

## Low entry threshold and direct practical relevance

"Motivation is the central element for successful further training and for learning in general", comments Markus Bell on the basis of many years of experience. "Here, we must create an organisational framework for the employees so that they can enjoy learning and not feel that it is a burden. The flexibility of the training programme is therefore a key to success in two ways." Firstly, Markus Bell says that flexible access to the courses – including access from mobile devices – is important. And secondly, he says that the courses must be able to be flexibly adapted to individual needs and individual learning behaviour.

In addition, the direct practical relevant of the teaching content and the social dimension of the learning experience are very important for a successful learning process. Practical relevance is assured by learning on the job. The way learning takes place at SAP also reflects the social dimension: under the slogan "Everybody is a teacher, everybody is a learner", employees can switch flexibly between the roles of instructor, mentor and participant, and can thus help each other to succeed in their learning. In addition, social competence also features in the teaching content, which is shown by the second core competence area with subjects like communication and working in a team.

And finally, the systematic collection and integration of employee feedback via the cloud-based learning platform is a key condition for the continuous and sustainable development of the further training programme.

# Project APPsist – Learning in the working process with an assistance system

Learning on a tablet – that sounds like time after work on the settee, but the idea is really implemented by Festo in its plant at St. Ingbert-Rohrbach in Saarland. The factory has 2300 employees and manufactures pneumatic cylinders. Tablets will be used in production in future. An assistance system – APPsist – runs on these tablets.

APPsist is an artificial word made up of app (APPlication) and asSISTance. The research project of the same name began in January 2014 and is due to end in December 2016. The goal of the project is that employees in assembly work-places can in future take over more complex tasks with the aid of intelligent software based assistance and knowledge systems. The systems are capable of learning, use artificial intelligence and offer exactly the support which the employees need. It is clear that the use of systems like APPsist requires the agreement of the workforce. Section 87 (1) sentence 6 of the German Works Constitution Act specifies that the participation of the workforce is required for the "introduction and application of technical facilities which are designed to monitor the conduct or performance of the employees".

The Festo works council member Carsten Kemmer reports that the staff had no fears or reservations about APPsist. In his opinion, it was "of decisive importance" that the employees were involved from the outset and that their suggested improvements were accepted and implemented by the experts. According to Kemmer, the cooperation between scientists, members of the works council and company representatives was "very fruitful". He says that

this gave the engineers and software specialists "several new perspectives and insights".

On the tablet, information about the remediation of machine errors is displayed and communicated step by step. In addition to the explanatory text, short video sequences show how some working tasks can be completed. These are tasks which the employees have not carried out previously. The system guides employees through the maintenance process step by step – without test and check lists on paper. When the employees have grasped the new steps in the working process, they can skip individual explanations or the whole assistance system. On request, the instruction films also provide background knowledge about the product.

On the partly automated U-shaped assembly line where the assistance system is being tested, three employees are assembling pneumatic cylinders. Their work is enhanced by APPsist, and new tasks are added. For example, the system gives the employees instructions to remedy small errors, e.g. when the system gives the error message "Action necessary: change grease drum".

"The assistance system was very well accepted by the employees, they liked testing it", says the Festo works council member Kemmer. No wonder – they helped to develop it. "In the evaluation meetings, the front-end was constantly improved by employee input." This inspired the programmers. Initially, the works council had to remind the project partners again and again "that it is people who will have to work with the product". Thus, the initial data collection frenzy of the external experts was reduced to a minimum. An agreement was reached with the company to ensure the protection of data.

Data glasses were initially discussed in connection with the selection of APPsist hardware. But there is very little information available about the health effects of such augmented reality glasses, so the misgivings of the works council prevailed and the employees now use tablets. The fact that APPsist can be used not only for work, but also for learning, is a factor that "everyone sees as positive", says Kemmer. It must be decided where and for how long the new learning opportunities can be used in the company. It is even possible that APPsist will make itself superfluous.

This could happen when an employee has a command of the processes, i.e. the teaching function has been successful.

Prof. Dr. Christoph Igel of the German Research Center for Artificial Intelligence (DFKI) also considers that the project has been successful so far and offers great opportunities. In his opinion, the assistance system is also a new venture from a scientific perspective. He says that the system marks the development of a knowledge service for real-time learning on the shop floor which calls on machine and plant data and uses methods of artificial intelligence. "This makes a new dimension of individualisation in workplace training possible for the first time."

What are the next steps of digitisation in the Festo factory in Rohrbach, and what can other works councils learn from this example? "The early involvement of the works council and the employees is essential", says Carsten Kemmer. But he has learned that genuine participation costs a great deal of time. Initially, her recalls that only one member of the works council was responsible for the APPsist project, but that five works council members are now responsible for Industrie 4.0. "There are now already two other ongoing projects in the factory which we are involved in."

At the Hannover Messe in April 2016 the project results were presented on a linked automatic assembly line; trade fair visitors could test the state of development of the APPsist system for themselves. All functions and elements could already be experienced "and were positively received by all" according to a statement by the Project Systems department at the Ruhr University of Bochum, which was another partner in the research project.

The latest status report of September 2016 reads as follows: "The following procedural model has proved itself successful. Firstly, all necessary steps for the implementation of a process were determined in an expert workshop. (…) (Then), in a second step, the process must be optimised in a dialogue of experts to generate a best-practice approach. This must especially take into account the intended target group … Before the process can be used in the real environment, it is also essential to test it in an evaluation meeting with experts and also shop floor workers (= employees in production) to make the final adjustments to the content which is shown."

**Insight from research – No. 4**

# World Economic Forum

### Further training – the royal road

The main demands placed on the employees will change over the next five years. This applies both to competence areas of a cognitive, social and personal nature, ranging from independent learning to creativity, and to basic and advanced IT knowledge and abilities. But the extent of the changes will vary depending on the line of business and the company involved. This was the result of a 2015 survey of personnel managers in the world's largest companies in seven branches of industry, ranging from automotive to energy.

Extending and improving the qualifications of the existing workforce is therefore the most important employment strategy – in all sectors and branches of industry. Because the speed of change will increase and the possibility of "disruptive", in other words revolutionary technology cannot be excluded, the importance of further training will increase significantly in almost all companies.

This is the conclusion reached by the World Economic Forum: further vocational training and instruction for employees is regarded everywhere as the prime means to cope with digital change.

Source: World Economic Forum (ed.) (2016) The Future of Jobs, Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution. Cologny/Geneva: WEF.
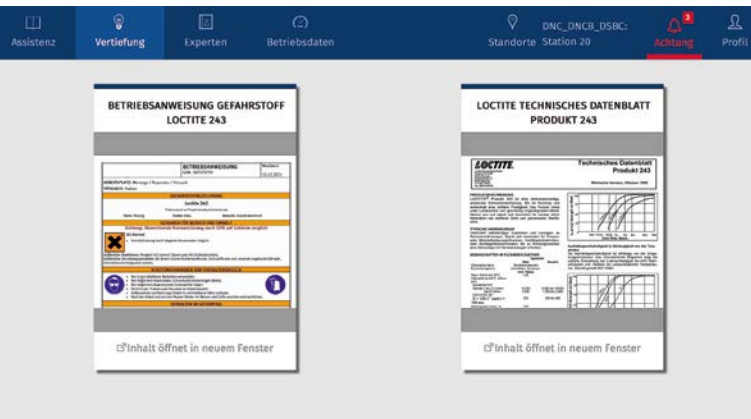
## This is APPsist

The project "APPsist – Intelligent Assistance and Knowledge Services in Smart Production" is one of 14 collaborative projects which are subsidised by the Federal Ministry for Economic Affairs and Energy (BMWi) in its technology programme "Autonomic Systems for Industrie 4.0". The project partners – business companies, research institutes, higher education institutions and interest groups – develop prototypes of intelligent, software based assistance and knowledge systems which support employees in their interaction with machines or plant by using the methods of artificial intelligence. The project also deals with work organisation questions and economic issues which can arise in connection with the introduction of this new generation of mobile, context-sensitive, intelligent and adaptive assistance systems which provide knowledge and action support in production. Employees, works councils and the trade union IG Metall were involved in the project from the outset.

## How APPsist works

A typical situation in production: a machine stops working, a light turns red and shows the plant operator that an error has occurred. The plant operator goes to the machine, determines that the error code is XYZ, looks this in the manual to find out what the error is (XYZ = Component not recognised) and calls the maintenance staff to ask for help. The fact is that this leads to long stoppages and high costs because two employees are involved in solving the problem.

In the world of tomorrow it works like this: The machine sends the error code to APPsist. The assistance system translates the code "Component not recognised" and trans-

mits this message directly to the machine operator's tablet, data glasses or smartwatch. He in turn goes to the machine, logs in to the system and receives instructions to remedy the error, which he works through step by step. This enables him to get the machine going again relatively quickly on his own – without any maintenance staff.

APPsist adapts to the user and the situation and gives priority to the best solutions. If the operator cannot solve the problem on his own, he can use the tablet to contact experts by phone or e-mail. At the same time the system provides background knowledge, in other words further training in the workplace. The individual knowledge structure and learning success are documented and can be certified.

## Who is involved in the project?

The German Research Center for Artificial Intelligence (DFKI), which has sites in Kaiserslautern, Saarbrücken, Bremen and Berlin, says that it is "the leading Germany research institute" in the field of innovative software technology. In the international scientific community the DFKI is regarded as one of the most important "centres of excellence", and in terms of the number of employees and the volume of external funding it is currently the world's largest research centre in the field of artificial intelligence and its applications.

Festo AG & Co. KG is a group of companies in the field of control and automation technology with its headquarters in Esslingen by the river Neckar. The company claims to be the "global leader" in automation technology and in technical apprenticeships and further vocational training. Its aim is to offer its customers maximum productivity and competitiveness in factory and process automation.

The industry partners of the APPsist project, in addition to Festo, are Fertigungstechnik GmbH and Brabant & Lehnert Werkzeug und Vorrichtungsbau GmbH. The development partners are the DFKI, the Festo training centre, Fraunhofer IAO, the Ruhr University of Bochum (RUB) and the joint working group of RUB and the IG Metall trade union.

For more information: www.appsist.de

# Examples from companies:
# changes to how people work

# Company map for Industrie 4.0 and Work 4.0 – seismograph and navigation system

The fourth industrial revolution is arriving on tiptoe. In some companies it is already far advanced, in others it is just starting or is still a complete mystery. To clarify things, there is a company map for Industrie 4.0 and Work 4.0.

First there was the steam machine which revolutionised production, and it was followed by electricity and information technology. Now we are facing the fourth industrial revolution with Industrie 4.0. In theory we can describe it very precisely. Industrie 4.0 stands for networked and digitised production: Raw materials, machines and employees, manufacturers, suppliers and customers communicate with each other, and control each other. Industrie 4.0 permits the implementation the individual customer wishes under the conditions of mass production – and is nevertheless cost-effective. Networking and digitisation allow highly flexible production with decentralised control.

What effect to these changes have on the employees? How are working processes, qualification requirements and workplace stress changed? What opportunities can be harnessed, what risks should be avoided?

Works councils that want to exert their influence require a good overview. Has Industrie 4.0 already started in your company? If so, where and to what extent? With what effect on the number and quality of jobs?

## The map provides guidance

To document the scenarios for the design of future work environment, the company map for map for Industrie 4.0 and Work 4.0 is an illustrated instrument to help you to answer these questions. The company map was tested in connection with company change processes by the Dortmund consulting company SUSTAIN CONSULT, then developed further in collaboration with IG Metall North Rhine-Westphalia to take digitisation and networking into account.



**Illustration 4: Company map: Industrie 4.0 and Work 4.0**
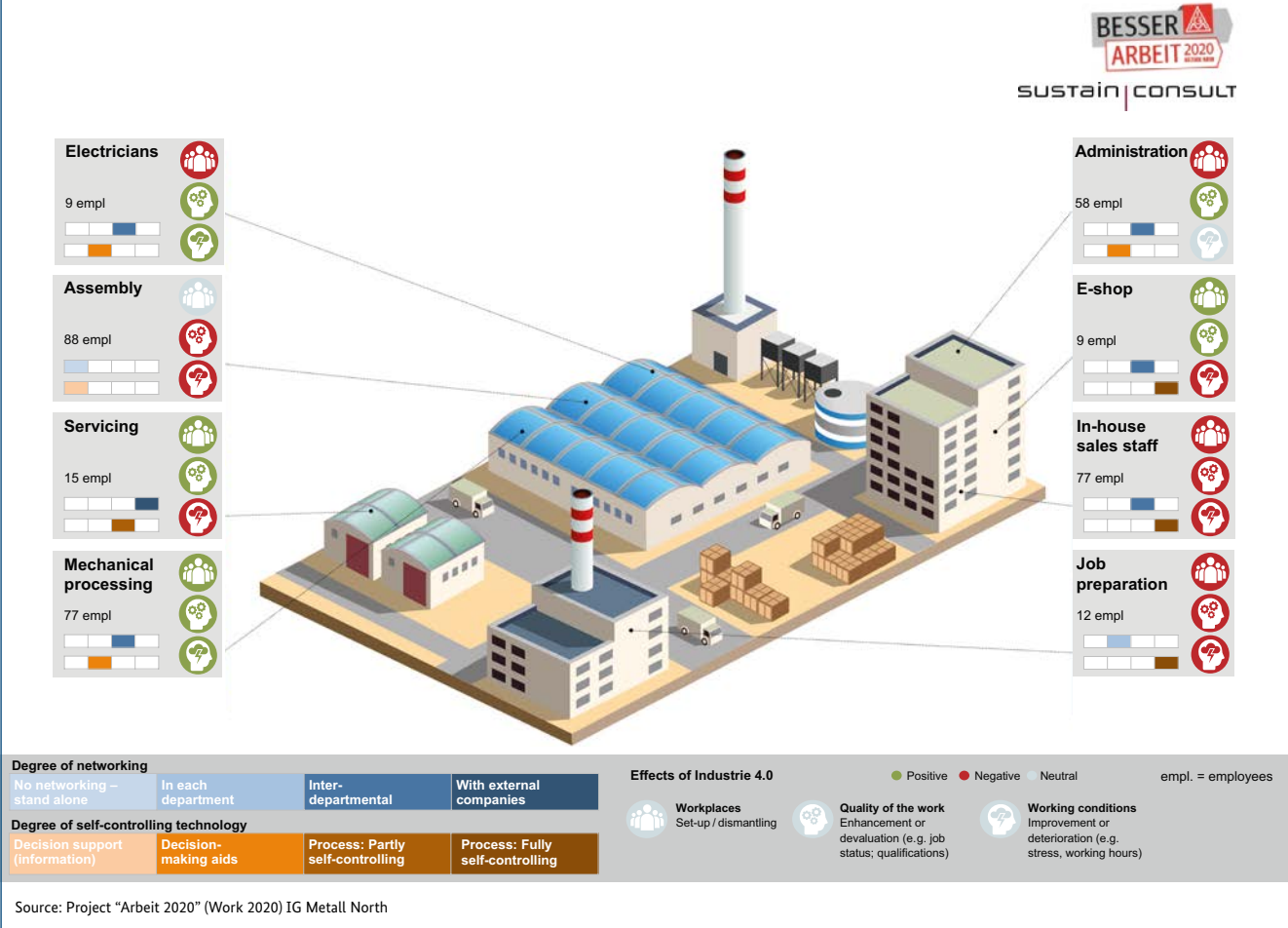
Source: Project "Arbeit 2020" (Work 2020) IG Metall North

It helps to identify fundamental changes in the company. It allows the systematic guidance and it indicates where there could be a need for action.

In each functional area of a company – i.e. areas such as development, job preparation, production, financial oversight, maintenance, logistics and sales – colours can be used to show the degree of networking and self-controlling that exists there. Different shades of blue on a four-level horizontal scale show whether networking actually exists, whether it is only present in this functional area, whether it crosses department or site boundaries or whether it even exists with external companies. A second scale with different shades of orange visualises the degree to which components are controlled by technical systems. Does the technical equipment support the decisions of the employees, does it provide decision-making aids, does it partly or completely control and guide the processes?

And what effect does all this have on the working situation of the employees? Are jobs created or reduced? Are the requirements increased or reduced, is the value of the work enhanced or devalued? What about the working conditions (work load, work intensity and working hours): are they improved or worsened? Each of these factors – employment trends, work requirements and working conditions – is visualised with a pictogram. These development trends are marked by different colours: Red: negative development, Green: positive, Grey: neutral, Red/green: no clear development.

## Assistance for works council members

Just as a seismograph gives a warning of an earthquake, the company map shows whether and to what extent elements of Industrie 4.0 are already operating in the company. At the same time it is a navigating system, says Thomas Gebauer of Sustain Consult: "The members of the works council can see at an early stage what they must do."

The company map provides several benefits for members of the works council. It gives them a general overview. They can inform the employees systematically and enable them to participate. And they are well prepared for negotiations with the management to influence the Work 4.0 process in the interest of the employees.

Depending on the size of the company, the company map can be drawn up in two to four all-day workshops in the company.

At Trilux in Arnsberg, North Rhine-Westphalia, the company and the works council have already worked with it. The Work 2020 project of the IG Metall – which the company map is part of – has created "a very specific contribution to transparency", says Trilux manager Johannes Huxol. He considers this important "because all the employees need to understand and support this development – that is the only way we can be successful". The works council chairman Thomas Bause also emphasises the practical benefits of the company map. Now, he says, "the issues involved in designing the system become clear".

The works council chairman of Achenbach Buschhütten in Kreuztal near Siegen, Daniel Wollny, also praises the project and says that the company map achieves much: "A complete change of mood is now taking place", he says. "Industrie 4.0 suddenly becomes tangible. We can see what it has to do with us. We notice that it involves processes that we can influence ourselves, processes that directly affect our working environment."

## Industrie 4.0, a social project

Industrie 4.0 is not just a technical project, it is also a social project. Therefore, the trade union IG Metall has been involved since 2012, helping to develop the world of work for tomorrow. In North Rhine Westphalia the Work 2020 project is regarded as a pilot project of the "Alliance for the Economy and Work 4.0" sponsored by the federal state government in North Rhine-Westphalia. One thing is clear: "We need to face up to the change in the world of work, to learn together and act together. This will enable us to ensure that digitisation is carried out in the interest of the workforce." Otherwise, the IG Metall chairman Jörg Hofmann says that "digitisation would be a project for companies which otherwise would focus exclusively on rationalisation."

# KUKA – Agile development for engineers

KUKA AG is one of the world's leading automation companies. It is a global technology company which offers one-stop solutions to its customers from different sectors of industry, from automotive to electronics, from cells and individual components such as robots to fully automated plant equipment. The trend towards intelligent digital factories and flexible production concepts creates challenges for KUKA, because development cycles are becoming ever shorter in the dynamic area of industrial production.

The rapid development means that new employee qualifications are necessary, and this in turn requires a new organisation of working procedures – and innovation processes. "Employees from our locations in Austin, Augsburg, Budapest and Shanghai jointly develop new high-tech products via digital working platforms", says Silvia Buchinger, KUKA's corporate personnel HR manager. "Designing such complex processes efficiently is crucially important for our company."

## Development by the Scrum model

Innovation cycles are constantly becoming shorter, the project requirements are increasingly volatile and software is becoming more and more important in the automation sector. KUKA therefore uses agile development methods. This means that instead of extensively designed development processes which are planned in detail from the outset, KUKA uses short and fast development intervals based on the Scrum model.

The development is carried out in iterative work intervals, known as "Sprints", which last between two and four weeks and build on each other. After each Sprint the development team presents the progress of the work to other project participants, such as the pilot customer. The results are tested and discussed. If it becomes apparent that the development is moving in a wrong direction, or if there are new insights about other necessary steps, the work content for the next Sprint is assigned new priorities. The presentation of the results, the short cycles and the dynamic changes in priorities should enable any problems to be recognised and solved at an early stage. This means that products can be ready for the market sooner. The Scrum method therefore aims to achieve faster and less expensive development of high quality products and a stronger focus on the customer. Often the customer is already involved even in the development phase.

"Development projects are very complex", explains Silvia Buchinger. "Therefore, it is not possible to create a masterplan at the start of the development process which will underlie the whole development. Often, a significant part of the requirements and the possible solutions is not yet known at the beginning. These uncertainties can only be overcome in the course of the process on the basis of the interim results", she continues. "In Scrum, the development and planning is carried out in small steps in self-organised teams. A detailed plan can always thereby only be made for the next Sprint, i. e. the next two to four weeks development phase", explains Buchinger. "If 400 developers have to develop by the Scrum method, they must be supported by a sustainable internal further training concept, and this must be put into practice in the everyday life of the company."

"KUKA's background is in the classical mechanical engineering sector, so we have drawn inspiration on agile development methods from various software manufacturers", Buchinger adds. In its software development, KUKA has worked with the Scrum model for some time. Now it is rolling out this method to other development areas.

To this end and with the support of an external service provider, it has trained employees as certified Scrum masters. Scrum masters play a central role in agile development. They are "serving" leaders for the development team. They do not give procedural instructions to individual team members, they monitor and support the development process and ensure that the principles of the method are adhered to. They hold regular daily working meetings (10 – 20 minutes), ensure a constant flow of information between the members of the development groups and obtain support from outside the team if necessary.

The management, personnel HR department, personnel HR development and works council all participated in the implementation of the Scrum method.

## 20 Scrum masters involved

"Currently there are 20 certified Scrum masters working at KUKA to bring change into the company", says Silvia Buchinger to sum up the initial success in the transition. "New products are already being developed with the Scrum method, and the transition to this method is already providing the first high quality results."

## Change is only possible in a dialogue

A comprehensive change process such as the introduction of a new product development model in a highly innovative company must be supported and modelled by the management. Close cooperation between the management, personnel departmentHR and works council helps to take different perspectives into account at an early stage and thus to achieve long-term success. The way in which Scrum is introduced is a decisive factor for the success and acceptance of the method in the development teams. It is important to help the development teams to understand which why this method is being used and also to support the employees in developing agile ways of thinking. A process cannot simply be imposed, it must be appropriately followed through. The acceptance and introduction of the new project structure in the workforce can vary widely. "Software developers are familiar with Scrum, but others still have to learn to work with agile methods", says Buchinger. "It is important that the management reacts sensitively to any friction and that it is is also openly discussed even at team meetings." Another important element of the method is the retrospective meeting that is held after each Sprint in which the team, with the support of a Scrum master, analyses what has gone well, what has gone less well and what changes should be focused on to ensure that problems do not recur in the next Sprint.

### KUKA AG at a glance
KUKA AG is a global automation company which offers customers from very different sectors world-wide solutions for their production. The company was founded in 1898. Today, KUKA has 12,300 employees and achieves an annual turnover of 3 billion EUR. It has its headquarters in Augsburg with subsidiaries on all five continents.

# Study by the University of Hohenheim

**We can manage Industrie 4.0**

"Do we have sufficient competence today to shape Industrie 4.0?" This question was studied by researchers at the University of Hohenheim in Stuttgart. They calculated a working ability index, which they called the "AV index". The AV index determines work requirements which arise due to complexity and uncertainties. It is based on an evaluation of a survey of 20,000 employed persons by the Federal Institute for Vocational Education and Training (BIBB) and the Federal Institute for Occupational Safety and Health (BAuA).

Important results:

- The distinction between routine tasks (that can be automated) and non-routine tasks (that cannot be automated) is not suitable. It does not do justice to the actual work in industry, the qualification structure or the dual vocational education system.

- Especially in automated or digitised working environments, the comprehensive personal experience of the employees is indispensable to be able to deal with the complexity and uncertainty of work situations.

- Today, 71 per cent of all employees already have an AV index value of above 0.50. That means that they can cope with complexity. Only 19.7 per cent of employees have an AV-index value of 0 – no complexity.

- In the production-based careers which are especially relevant for Industrie 4.0, above-average AV index values were reached. The highest results were in core IT careers, followed by technicians and engineers. Then came metalworking trades (for example industrial mechanics).

The study's conclusion was that a large proportion of employees are fit for the transition to Industrie 4.0.

Pfeiffer, S., Suphan, A.: Der Mensch kann Industrie 4.0. Kurzfassung (People ready for Industrie 4.0. Short version). University of Hohenheim, dept. of Sociology, 2015.

**Insight from research – No. 6**

# Elias research project

## How workplace-based learning works

New concepts and approaches to the design of modern work and production systems to encourage learning are the goal of ELIAS, a collaborative project of the Federal Ministry of Education and Research (BMBF). The abbreviation ELIAS stands for "Engineering and Mainstreaming of Learning-based Industrial Work Systems for Industrie 4.0". It is decisive to begin at an early stage: from the start of the process of developing technical systems, possible systems to enhance learning should be taken into account and planned which facilitate learning during the work process and the acquisition and preservation of competence throughout the employee's life and career. In the project, a model for the design of company learning solutions was developed for work-based learning. There is also an available catalogue of instruments and forms of learning: "Arbeitsorientierte Lernlösungen für industrielle Arbeitssysteme: Lernen für die Arbeit" (Work-based learning solutions for industrial work systems. Learning for work) (http://bit.ly/2cYWrFX). These "learning solutions" are being tested in practice, for example, by the medium-sized enterprise Zwiesel Kristallglas in the course of the transition from Industrie 3.0 to Industrie 4.0.



**Principles**
• Industrie 4.0 as cyber-physical and social systems
• Promotion of learning for competitive and production capability
• Promotion of learning as an engineering task
• Promotion of learning as a mainstreaming task

**Methods**
• Interdisciplinary and design-based approach
• Learning factory with work systems and demonstration units
• Integration of work design and competence development

**Tools**
• ELIAS planning tool for work systems
• Module catalogues for ELIAS methods and technology
• Use of simulation and scenario technology

Source: http://projekte.fir.de/elias

# Software AG – The learning organisation is serving as a model

Any company that wants to stay in business in the age of Industrie 4.0 needs not only innovative partners, but if you ask Dr Peter Dern, Head of Corporate University at Software AG, "it also an innovative training strategy".

Given that those companies who develop high-tech want to stay ahead of the competition, they are "a hundred per cent customer-focused", says Dern. He cites this as being the reason why a core focus of corporate training is placed on the development and fostering of soft skills and skills in methodology. He believes that learning organisations, in which constant learning is normal, should serve as models, since an approach like this is analogous to the permanent process of digitising work processes.

A learning organisation is a system that is in constant movement. The findings made serve as a starting point for adapting development processes such that the knowledge bases and scope for action stay in line with requirements. This means that the organisation has to be open and individual; not only able to be creative in its problem-solving, but also fostering creativity of approach.

So what is needed?

- Orientation towards actual benefits for the customer.

- Ability to cooperate and solve conflicts; mutual trust and team spirit.

- Process orientation and self-regulation in the group.

- A democratic style of leadership that invites participation.

- Tolerance when errors and mistakes happen; reward for participation.

The orientation towards the customer at Software AG goes so far that the development of innovative products and services can actually be called "co-innovations". It requires a set of new skills, such as the ability to develop and negotiation and communication strategies, to think creatively, and to exchange knowledge.

What does this mean for staff at Software AG? Key positions at Software AG should be held by both experienced staff as well as by the company's leaders of tomorrow, who should all be able to explain their product – the Digital Business Platform – to others. How is it possible to think in a new way and work in a different manner?

## The method of design thinking

Design thinking was originally a method used by designers to develop brand new products expressly designed around the needs of the user. It has since become a way of organising thought processes used by management – another way of asking the question as to how we learn and how we want to work. Design thinking enables new and surprising forms of creative cooperation to develop. Pooling the ideas of a heterogeneous group of people is a key concept here. When it comes to problem-solving and developing new ideas, an interdisciplinary team is more than just the sum of its members.

The process aims at bringing together as many different opinions, sets of experience, and ideas as possible in order to solve a particular problem. The process is based around the work of designers and consists of six different steps:

- Understanding the problem.

- Observing, researching and generating findings in order to describe the status quo.

- Breaking down the observations into one prototype user.

- Developing ideas: Using creative techniques, such as brainstorming, brainwriting, or pre-mortem ("Imagine the situation in a year's time, assuming that a disaster has occurred").

- Prototyping: Developing prototypes in order to demonstrate ideas and to test them.

- Refining: The concept is further improved based on the insights gained during prototyping and is continually refined until the optimum, user-oriented product is created.

According to a traditional, widely used training model, some 70 per cent of professional skills are attained through learning on the job, 10 per cent through coaching, and just 10 per cent through further training. Talking to Peter Dern, he says that this training formula is not really helpful, since it is unable to say whether a person is actually learning the right thing. He says that employees can actually learn the wrong skills in their everyday professional life: "No matter how much you go running, it will never teach you to swim."

## Modern teaching methods and motivation

Software AG is taking a different approach. It not only applies modern teaching and learning methods such as e-learning, interdisciplinary teamwork and web conferencing but also banks on staff undergoing training to take on the role of teachers – and thus of multipliers – who are able to transfer their knowledge effectively and efficiently, not just to employees of Software AG but also to customers and partners.

It is up to the employees to decide whether they would like to participate in further training. "But if you want to become a learning organisation, you have to inspire employees to pursue continued learning", says education expert Dern. This is one of the core tasks of the Corporate University of Software AG. One way of fulfilling this task is to lower obstacles to further training. This includes building a corporate culture that appreciates those who plunge into the adventure of further training. Peter Dern: "We are embarking on design thinking to become an organisation that truly learns."

Design thinking is a methodology that was designed by Software AG's product development department. The goal was to create more user-friendly products for customers. "And we have managed to achieve this goal," says Peter Dern. "Our sales success and the feedback from our customers are testament to that."

## User orientation is paying off

The design thinking process has also significantly improved the company's internal IT service portal. The IT service portal was rather dry and uninviting until someone put together a group of employees from different departments and asked them to use the portal and to comment on their approach, in other words, to "tell their user story" (Peter Dern). "Just by listening and observing we have gained a lot of information about what is good, what is bad, what is of interest to the users, what they are looking for, whether or not they directly find what they are looking for or whether they only get the information they seek by searching for some time, or if they do not get it at all." After the re-launch of the intranet portal, the usage of self-service functions increased significantly and the number of misdirected referrals in the helpdesk system declined noticeably.

Nevertheless, Dern adds a word of warning: "Don't take it too far. Design thinking should not be reduced to marketing.

It's about product innovation." What does this mean? "Look at how the customers deal with the product and see what they miss. And never ask them what they want. How are they supposed to know that? Henry Ford once said: 'If I had asked people what they wanted they would have said faster horses.'"

## Design thinking is ideal for SMEs

Design thinking is a problem-solving technique that cannot only be used by major corporations. "It is ideal for SMEs", says Dern. "The method is quickly learned – and then you don't need to pay for expensive new consultants!" What he is saying is that the potential for solving operational problems is already there. It does not have to be bought but to be unleashed and brought to bear. In that sense, design thinking embraces and values the potential of the company's own employees.

According to Dern, the problem in small and medium-sized companies is often that the company's engineers think they know best what the customers need. Having to ask themselves the question 'what is the customer actually looking for?' is "often a culture shock" for them, says Dern.

### Software AG at a glance

Founded in Darmstadt in 1969, the group is the most powerful German software producer after SAP and Wincor Nixdorf (see statista.de). It is divided into three business segments, with the Digital Business Platform (DBP) being the largest (50% share of sales). With a total of 4,337 employees in 70 countries, Software AG generated revenues of EUR 873 million in 2015.

The IoT Evolution magazine, a trade journal for the Internet of Things, chose DBP as the product of the year 2015. In addition, Software AG recognises outstanding achievements of its customers and partners. In 2016, the Innovation Awards at the Innovation World went to projects dealing with the topic of digital transformation.

The Software AG Foundation is the largest single shareholder, holding 30% of the shares. The foundation is active in the promotion of science and supports self-help projects in the areas of education, child and youth welfare, disability assistance, help for the elderly and conservation of natural resources. Since 2008, Software AG has been the main sponsor of the SV Darmstadt 98 football club which, after 33 years, returned to the first German Football League (1. Bundesliga) in 2015/2016.

# Elschukom – From state-owned collective to producer of high-tech wire



The company Elschukom GmbH already experienced 'disruptive' market changes before that current buzz-word was on everyone's lips. Shortly after German reunification, the firm emerged from what remained of the 'Kombinat Keramische Werke Hermsdorf', a ceramics producer. At first the company concentrated solely on manufacture of electrical-equipment safety units. Yet the company management quickly realised that the world had not exactly been waiting for another safety-units manufacturer – the firm switched to specialising in manufacture of wires, including extra-fine wires. Elschukom remained true to its roots and continues to produce fuse-element wires for equipment safety units. It now also refines special wires for other business sectors, e.g. musical-instrument strings and the textile sector (key term: 'smart textiles'), as well as domestic wires, contact wires and wires used for wire saws.

Time and time again, what European, Asian and American clients order from this medium-sized firm, with its head-quarters in Veilsdorf (Thüringen), is individual and innovative solutions. This is also why, within the workforce of around 100 staff, more than one-fifth continually direct their energies to the further development of products and processes. "Our market environment is very dynamic", notes Jan-Peter Krauss, Sales/Prokurist – General Manager at Elschukom, "so to match this we have to optimise our internal processes on an ongoing basis, in order to remain flexible". Substantial changes made at Elschukom were the formation of a new Process Engineering (PE) department and the implementation of an ERP (Enterprise Resource Planning) system, developed in-house, for wire-production by machine: this system integrates and utilises a large amount of corporate data. The process optimisation and digitalisation were not without consequences for the staff of this medium-sized company from Thüringen. Changes and new requirements made themselves evident in all the company's activity areas.

## Optimisation of interfaces with a new department and new production technologies

Using an additional, higher-level Enterprise Resource Planning (ERP) system, Elschukom records data on all company processes – from the customer-order through to the delivery of the goods. This new system involved a major adjustment, notably for the Production team members, who in some cases had experienced hardly any changes to their working processes in 25 years. As Krauss puts it, fears are a factor that must be taken seriously here; they are primarily counteracted by open communication and by providing help, he noted. "We took the 'old hands' and dispelled their fears by making clear to them that the process will not work without them. We need the colleagues' years of experience gained in production and administration", Krauss explains.

Among other changes, the workforce was expanded at the same time, to include an apprentice in production technology. He operates as a linking element between the software, production and research & development departments respectively. Among professions for which there is a specific vocational education programme, the production-technologist profession is relatively new and

is still hotly-disputed. Nonetheless, as Krauss points out, for Elschukom a production technologist is exactly what is needed. This vocational education imparts knowledge in the structuring of processes, in manufacturing procedures, in production and enterprise management. This combination of professional competences enables the production technologist to analyse, simulate and optimise processes. "It's at the interfaces that Industrie 4.0 becomes a reality. And they are also the production technologist's point of approach". The production technologist is also a point of contact for the colleagues in Production and his role is to provide assistance. He 'translates' the experience provided by the subject-specialist colleagues, putting it into the ERP system and using this practical knowledge to optimise processes.

Likewise, in the Process Engineering (PE) department the key issue is interfaces. Elschukom has created a kind of playing-field for four team members in PE, who had also attracted particular attention with their strong commitment and high degree of creativity. This special department's goal is to use interdisciplinary collaboration to optimise processes, define interfaces and further advance the digital integration of the various parts of the company. In the workshop, planned and set-up by the team members

---

**Insight from research – No. 7**

# The World Bank

### Digitalisation affects blue-collar and white-collar alike

How work is affected by new technologies is dependent on
- the type of activity
- how those technologies provide support to the workforce.

If routine work comprises a high proportion of all tasks, regardless of whether this is predominantly cognitive work or predominantly manual work, there are many possibilities for automation. This affects accountants and office personnel as well as machine operatives. Whether the focus is on analytical work, provision of social care, or creative activities, the deployment of technology can also lead to higher productivity.

There are very many activities, primarily manual ones, that have productivity levels which are hardly influenced by digital technology. This refers not to routine activities but rather to services that engage with the individual customer close-up, such as hairdressers or other service activities that can hardly be automated.

This much is clear: digitalisation affects blue-collar workers and white-collar workers equally, i.e. production workers and administrative workers. This constitutes the greatest difference in relation to earlier waves of rationalisation.

Source: World Bank Group (2016): Digital Dividends World Development Report 2016.Washington DC.

themselves, an information scientist, a mechanical engineer, an electroplater and a control technician are adjusting and trying things out to improve activity sequences; for the most part, they are acquiring new specialist competences without having instructions provided in advance. As Krauss notes, "the positive self-fuelling dynamic unleashed in these spaces set up for team-members' developments is something that you just can't plan".

## Effective processes, satisfied workforce

Drawing together three points of emphasis in operations is already yielding positive effects – product and process optimisation in R&D and PE; the adapting and integrating of software with regard to ERP; and the expansion of specialist competences among the workforce by adding the production technologist. The effects are evident with regard both to the firm's competitiveness and to the indi-



vidual team members. The production personnel have been relieved of their fear of being steam-rollered by the changes. They are familiarised with the new system by their IT-specialist colleagues, in a 'learning on the job' process, and their role is appreciated due to their wealth of knowledge gained through experience. The colleagues from Process Engineering are given scope for creativity by the company management. Both factors positively affect the workforce's motivation and its specialist qualification. Of course, Process Engineering also includes machines' design

and optimisation. Thanks to the precise analysis, backed by data, ergonomic aspects and the safety of workspaces and of machines were able to be improved – without even looking at the additional effects from the Controlling department's perspective. Through optimised processes, the company saves costs and can make better investment decisions on the basis of comprehensive process-data.

Krauss's interim conclusion: "The development is not yet concluded but we see the first successes as a vindication of the path that we are taking."

## Giving people scope and making an interdisciplinary exchange of inputs possible

At Elschukom the working processes were restructured in such a way that team members can learn from colleagues that have other qualifications, independently, with immediate practical application and without fear. This interdisciplinary learning on the job is crucial to employees' ongoing qualification.

In the context of their 'Industrie 4.0' activities, companies must constantly check whether their employees' competences and the existing profiles of individual professions continue to match the company's latest requirements: considering the positions for which we are currently offering vocational education, and the relevant respective numbers of personnel, are we still set up in the right way? Especially with Industrie 4.0 in mind, in which a key role is played by the interfaces that connect various specialist-competence areas, it becomes ever more important to map out the path that the company's professional training is to take. At Elschukom the analysis led (among other things) to the set-up of a traineeship for a production technologist.

Highly-dynamic environments also demand a company management that transfers freedoms and elements of decision-making authority to its employees, while living an open corporate culture as its daily reality. That way, team members have the confidence to put forward ideas and unleash their potential.

**Elschukom at a glance**
Elschukom Elektroschutzkomponentenbau GmbH produces protection modules for the most diverse range of application areas. Elschukom is global market leader in the area of fuse-element wires. The company, founded in 1990, employs around 100 staff at its corporate facility in Veilsdorf (Thüringen). The company is managed by Ute Poerschke and Manfred Thauer (both are graduate engineers).

# Examples from companies:
# changing requirements

# Daimler – Qualification moves closer to the workspace

As one of Germany's first industrial enterprises to do so, Daimler is offering the dual-study traineeship in 'Business Management/Industrie 4.0'. Alongside business management, trainees gain knowledge on IT disciplines and on Industrie 4.0. For this automotive group, education and qualification are a success factor in the shaping of Work 4.0.

Digitalisation is changing the automotive industry root-and-branch. The development towards self-driving and networked vehicles, cooperation between humans and machines, and Industrie 4.0, serve as the key words signalling this development.

Especially in times of transition, a company must secure its competitiveness. Alongside innovative technology, the qualification of the employees makes the decisive difference. This is what becomes a competitive advantage if a company succeeds in educating and qualifying its workforce at an early enough stage and in accordance with its needs. New knowledge and new skills are called for. At the same time, digital-learning formats open up new paths for imparting knowledge and expertise.

Daimler has formulated a guide as it tackles this process: 'Prospects for 2025: guiding principles of Education and Qualification'. This is about innovation in professional training, digital learning, innovative formats for learning and worldwide training centres.

Individuals' career paths are becoming more diverse and more dynamic. The declining half-life that knowledge has means that new demands emerge for new possibilities to assimilate and retain knowledge. Innovative models of qualification must make lifelong learning possible. Daimler is banking on sound basic qualification in the initial traineeship and on fostering the subsequent specialisation process step-by-step. In this context, innovative corporate education and qualification must properly take into account the heterogeneity both of the people learning and of the knowledge content being learned, as well as the interlocking of basic and advanced training into the process.

## New dual-study traineeship for the Smart Factory

In production, Daimler is pursuing the smart-factory concept, taking the path step-by-step towards the intelligent, digitalised factory. The aim with such a factory is to improve resource efficiency and ergonomic suitability, as well as to improve integration of customers and partners into the value-creation processes. Central aspects are the versatility of the factory and cooperation between humans and robots. In pilot applications Daimler has already deployed robots for light-construction tasks and tested them for series production.

In principle, this is about developing forms of work that combine the workers' cognitive abilities with robots' strength, stamina and reliability. This fundamentally changes the employees' working environment. IT is now at the centre of activities, not the mechanical processes.

More complex activity sequences in production and the working process in the smart factory's networked structures present the workforce with changed requirements in terms of qualifications. Digital transformation leads to an increase in the significance of further professional training, with a need for new professional qualifications such as the following:

- Extended skills in dealing with large quantities of data, in data analysis and data security.

- A new understanding of the systems of decentralised intelligence and an ability to work effectively with new products and machines, coupled with holistic process-thinking.

- Because products are becoming more individual, employees must be able both to quickly switch-over the current production process and also to call-off information straightaway about new products or variations that have not been produced for a longer period.

For the World of Work 4.0, education and qualification of the employees constitute a key to shaping a successful future. Companies need a good mix, consisting of young experts introducing new know-how into the company and experienced subject specialists who know all the company's activity sequences. Both groups must be familiar with up-to-date developments.

Profiles of some professions are now already being adapted to changed requirements. Through the ongoing process of ascertaining future requirements in relation to professional competences, qualification processes are set into motion, with new building-blocks being integrated into companies' vocational education and further training.

A current example relates to the dual-study traineeship: since October 2016 Daimler is one of Germany's first

industrial enterprises to offer the dual-study traineeship known as 'Business Management/Industrie 4.0'.

In production, knowledge-intensive activities are increasingly called for; less routine work is needed. Daimler is working on the basis that the operation of machines is receding into the background to a significant degree, while process development, process supervision and maintenance are advancing into the forefront. Cognitive and interactive elements are gaining greater significance.

## What is decisive: interdisciplinarity and collaboration

Alongside working with data-protection and Big-Data issues, interdisciplinary collaboration and the development of innovations constitute important competences, making it a prerequisite for employees to have a high degree of self-organisation and capacity for effective teamwork. This is exactly what digitalisation requires: the person learning must show increased self-reliance and must direct their own activities. This starts with the issue of what information is to be found in the internet, and where, and ends with the matter of how to differentiate correct from incorrect information.

To develop vocational education and further training, the decisive factor is the extent of success achieved in firing up the enthusiasm of teachers and trainers for innovative learning content and learning processes. Daimler supports its trainers and other teaching personnel by means of qualification measures, encouraging them to seize upon and try out technological developments and trends.

The collaboration with the works council is an important success factor in this. The structuring of Industrie 4.0, as well as education and qualification, are all topics subject to works-council co-determination; plans are agreed between company management and the works council.

## Online Platform DAS@web – the Daimler vocational education system

Digital learning systems and learning methods make it possible to teach and to learn independently of the location or time. They support the enhancement of flexibility and the individualisation of processes of professional qualification. Using learning-on-demand formats, learning can be integrated directly into the working process when so required. For instance, in the future the learner can use interactive data-glasses in order to learn new processes in assembly operations.

Today's working practices are already hard to imagine without new learning formats such as e-learning. Daimler is

**Daimler AG at a glance**
Daimler AG, with its headquarters in Stuttgart, is the second-largest publicly-listed German vehicle manufacturer, with 2.9 million private vehicles and commercial vehicles sold per year; its most famous brand is Mercedes Benz. In addition, the company provides mobility services and financial services. At the end of 2015 the Group had 284,000 employees worldwide and had generated an annual turnover of EUR 149.5 billion.

already starting with corresponding programmes of initial professional training: since 2012, teaching personnel and trainees have DAS@web – the Daimler vocational education system – at their disposal. This makes it possible to impart knowledge independently of a given place or time, while ensuring that the learning content is available on a lasting basis and is up-to-date.

In its production and assembly, Daimler Trucks is committing itself to modularised qualification, based near the individual's workspace. The goal is to integrate qualification for new production processes into everyday working life. In the 'Ambi-Wise' project, that is receiving funding from Germany's Federal Ministry of Education and Research, Daimler Trucks is testing out a concept for further training that is close to working practice. The concept is based on the deployment of digital media near the individual's workspace. Since 2005, Daimler Trucks has been building up a digital learning platform that is available worldwide. It describes individual steps in working processes in a standardised way, for the respective manufacturing and assembly section, as well as processing those steps from the viewpoint of teaching that unit of knowledge. The knowledge can be called-off worldwide in the relevant local language. Hitherto it was solely at specified locations that it was possible to access the digital learning platform for production. The description of the steps in the activity and also the qualification of the workforce 'near the job' took place at terminals in the production environment or in designated group-spaces. The digital learning platform is now being made available on a mobile basis: this means that, in assembly and manufacturing as in other areas, the qualification process is being moved closer to where the individual team member works.

Learning in the digital world also relies upon the individual employees' capacity to take the initiative: the 'Daimler Connect' internal social network offers the employees the opportunity to improve in their daily work by benefiting from shared knowledge, by finding experts more quickly, and by collaborating more efficiently, worldwide. It is notably from 'Digital Natives' that this type of learning in the company environment is expected and is used.

# Telekom – Educational chain to becoming a Cyber-Security Professional



Deutsche Telekom is one of the world's leading suppliers of telecommunications and information technology. It employs 226,000 members of staff and has an annual turnover of 69.2 billion euros. The company is now the midst of digital transformation and particularly needs to respond to the changes in technologies, customers and business models. "To be successful in this environment, we need clever strategies, innovative products and services, and the right staff to deliver these," says Markus Lecke, who is responsible for education policy at Deutsche Telekom.

## Skills management: an analysis of trends is the first step

Deutsche Telekom finds a certain share of the employees it needs on the external labour market. "In 2015, we hired around 1,700 members of staff in Germany," says Lecke, adding: "In addition, some 1,800 of our own young talents were taken on after completing their vocational education or a dual course of study. At the same time, it is becoming more and more important to continue to train employees who have been working at the company for a long time." According to Lecke, customised training programmes help enhance staff's employability. In order ensure that it has the best "digital pioneers" in its own ranks in the future, and staff who recognise and are open to the most important

trends, Telekom has set up a comprehensive skills management system.

The skills management system includes four essential steps:

1. Technological, customer and business trends are recognised at an early stage and monitored.

2. The trends are assessed in terms of their importance to the company. At the same time, it is also assessed how quickly the company must react to the trend and whether it concerns only one specific department or the entire company.

3. Based on the analysis, the specific skills development and training needs of the individual groups of employees and departments are identified.

4. Finally, training programmes are developed and introduced that cover these skills and training needs.

The four steps of the model have already been implemented for the trends of All IP, Big Data and IT security. In the field of IT security, in particular, applying this model was urgently necessary. Security is a key issue for almost all companies on the way towards a digitised economy. IT security experts are highly sought after and hard to find on the labour market.

## IT security – a major training focus

"In order to meet our need for skilled experts in the area of IT security, we have set up an educational chain that leads to the high-level qualification of Cyber-Security Professional" says Lecke. "The possible paths of study include IT vocational training or dual degrees in IT, Chamber of Commerce training programmes, workshops, practical exercises, project work and study modules, which can be recognized in a master's degrees in the later phase." The content of the various training options complement one other. Training

**Deutsche Telekom AG at a glance**
Telekom is one of the world's largest suppliers of telecommunications and information technology. It was not only in 1995 when that the company became a public stock company. More than half the company's 226,000 employees work outside of Germany. The branch offices located in over 50 countries are managed from the company's headquarters in Bonn. In 2015, the group generated turnover worth 69.2 billion euros.

on the job, i.e. the daily work in the respective department, is given a high priority. In this context, individual learning objectives are agreed with each employee.

What is more, the tailor-made training programmes are not only available for young staff. Experienced employees are also given the opportunity to embark on training to become security experts. In this way, the company is seeking to break away from the traditional pillars of education and to more effectively integrate vocational education and further training or university studies with on-the-job training – right through to employees becoming experienced experts. "The requirements in the field of computer science, in particular, are changing so rapidly that lifelong learning becomes indispensable. Just as there are constantly new and different forms of cyber attacks happening, the people who fend them off must remain flexible and capable of learning," says Lecke.

The path of further training leading to the qualification of Cyber-Security Professional set out above is just one tool in the toolbox. For example, Telekom has set up its own Chair for Data Protection and Security in Computer Science at the Leipzig University of Applied Sciences. In the winter semester 2015/2016, the first bachelor's degree students started their studies there, focussing among other subjects on data protection awareness, IT law and forensics. The research findings produced at the chair are to be incorporated into further training curricula. Further to this, learning modules are being developed which will benefit the employees' learning process.

In the coming years, Telekom will further develop its skills management approach. For example, training opportunities are to be made available at global level in order to meet transnational training needs within this large international corporation. This will be accompanied by a growing digitisation of the training portfolio. "Industrie 4.0 is thus not only leading to the development of 'Work 4.0', but also 'Education 4.0', in order to meet the requirements of the flexible, cross-cutting and increasingly global development of industry," says Lecke.

## Young experts from within the company's own ranks

The number of Telekom's training programmes alone is outright impressive: in 2015, more than 32,000 seminars with some 300,000 participants were held in Germany alone. Each employee spent an average of 3.6 days on further training. In the past three years, 30 talented young professionals have been trained as cyber-security experts and have thus acquired the necessary skills to meet the strategic business needs of the company. Based on this success, Markus Lecke is optimistic about the future: "We are very satisfied with what has been achieved so far, but we will be working on further fine-tuning our skills management approach".

## What is needed is a vision

Identifying trends at an early stage and then analysing and evaluating them fully is crucial for implementing needs-oriented training opportunities at Deutsche Telekom. Each trend is examined as to whether and in what way it is relevant: is the trend important for the entire company or only for a certain business unit? Will its impact be short-term or long-term? Once these questions have been answered, suitable training and skills development programmes will be designed and offered to the workforce.

The new possibilities opened up by digitisation have also been used here. Employees are now able to access web-based training units in a fast and flexible manner from anywhere in the world.

Different education methods have been linked together and offered to both young and experienced employees alike – in each case tailored to the needs of the respective employee.

# Airbus Operations – On the path towards HR 4.0 in aviation

The "Human Relations 4.0" future project was launched in January 2017. "HR 4.0" is part of the much wider Airbus project "Industry 4.0 – Factory of the Future in the Aviation Business."

Project manager Jan Balcke firmly believes that Industrie 4.0 will "significantly" change the entire aviation industry – with repercussions not only in terms of technology and organisation, but particularly for its employees. "So it is all the more important that we identify and discuss the challenges and opportunities for employees at an early stage."

The aim of HR 4.0 is to shape future workplaces in aviation, to qualify its employees, and to prepare them for technological change.

## Cooperating with partners

Airbus seeks to accomplish all this with partners from research and industry as well as representatives of employers and employees, along the end-to-end aviation supply chain. The project is thus implemented in close cooperation with Prof. Dr. Christoph Igel of the German Research Centre for Artificial Intelligence (DFKI) as well as Airbus' core partners German National Academy of Science and Engineering (acatech), FESTO Learning Centre, Hamburg Centre of Aviation Training plus (HCAT+), IG Metall, Nordmetall, and Ruhr University Bochum. "Due to its interdisciplinary, interprofessional, and international approach, HR 4.0 is unique in Germany and in the aviation industry from a scientific and technological point of view. This cooperation between industry, research, and social partners is an unprecedented experiment that will serve as a model for others," says Igel.
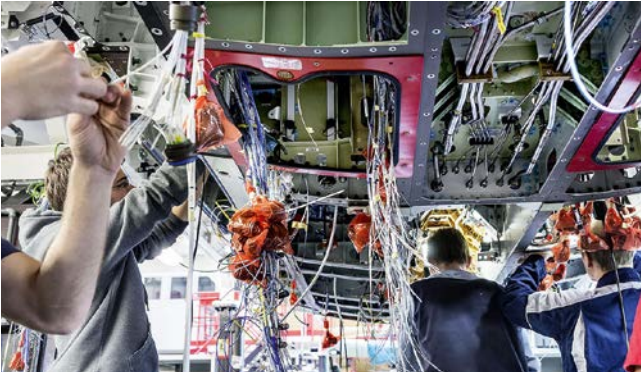
Industrie 4.0 will bring about fundamental changes in the relations between people, organisation, and technology. These changes will be felt most keenly by employees, which is why in times of Industrie 4.0, competency models must be reviewed at all corporate levels. Qualification shall be achieved through learning at work. New workplaces must be designed and tested. White-collar and blue-collar work must be reorganised according to the changed overall conditions set by Industrie 4.0.

The Internet of things, services, and data has provided a global stimulus toward Industrie 4.0. The parameters of this transformation are determined by the Airbus corporate strategy, co-determination, and the governance, culture, and values of Airbus.

## Industrie 4.0 *by* and *for* the employees

At the heart of the digital transformation process towards Industrie 4.0 are the employees: they are the change agents. Their future tasks are only just taking shape – a first set of potential topics has been identified, the first questions have been phrased. However, many solution approaches are still abstract and not tailored to any specific industry. There is a lack of specific requirements for manufacturing in general and aviation in particular.

The overall objectives of the project are to

● establish a cross-institutional network of internal and external HR & Industrie 4.0 experts,

● set up a think tank for developing HR 4.0 concepts, and

● establish research and learning factories for testing concepts related to workplace design and employee qualification.

According to Klaus Ahlborn, Chairman of the Central Works Council at Airbus, everyone is talking about Industrie 4.0, but "still in very vague terms." The actual consequences for employees – from aircraft design engineers to mechanics – are not yet known. Ahlborn expects that requirements will increase, not only in terms of qualification but also with regard to employee availability. "So we have to make sure that our employees' rights are respected." To make its priorities clear, the Central Works Council chose "People 4.1" as the title for the 2015 assembly of works council members on Industrie 4.0. In fall 2016, a key elements paper was signed by the Board of Management and the Central Works Council. According to Ahlborn, both sides agree that "no employee with whom we embark on this process must be left by the wayside." Moreover, it must be ensured that employees also benefit from the expected productivity gains.

**Airbus Operations GmbH at a glance**

Airbus Operations GmbH is a subsidiary of Airbus Group (formerly EADS), which is a European Company (SE) with 136,574 employees and a turnover of 65.5 billion Euros (in 2015). The company employs around half of all employees working in Germany's aerospace industry. Airbus Group is the largest aerospace company and the second largest defence company in Europe. Among the Group's three divisions, Airbus is the one that manufactures commercial aircraft. In Germany, approximately 17,000 people work at Airbus in the four Hanseatic Cities of Hamburg, Bremen, Buxtehude, and Stade. With 12,500 employees, Hamburg is the largest Airbus site in Germany. It plays a key role in the development and manufacture of all Airbus programmes, in fuselage and cabin design. The site also features a large training centre where hundreds of aircraft mechanics sent by airlines from all over the world are trained every year.

**Insight from research – No. 8**

## Companies can 'do' the future – Study reveals high level of flexibility in the digital transformation
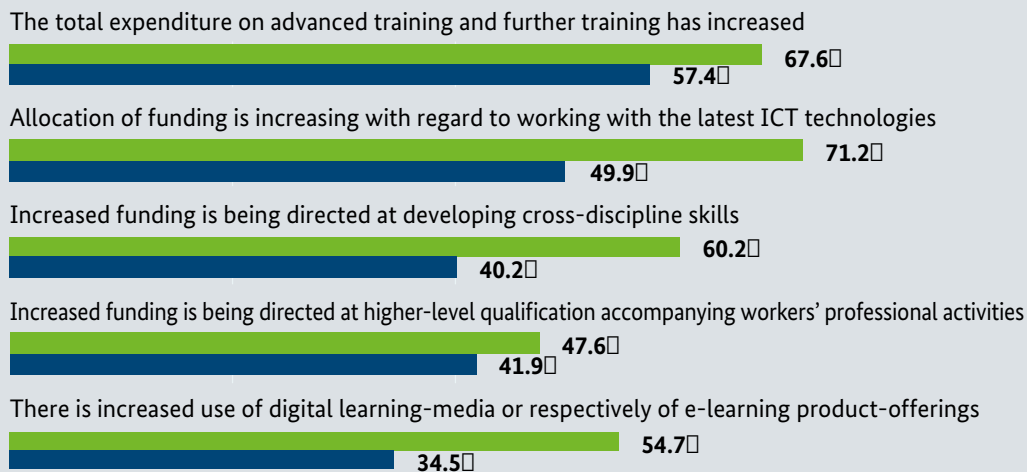
The 'World of Work 4.0' project for the future prompts the question of whether today's vocational education and further training matches the new requirements generated by the digital transformation. A current study concludes that, in principle, it does.

Based on a representative sample of companies, a study by the Centre for European Economic Research (ZEW) and by the Institute for Employment Research (IAB) throws light onto changes in basic training and further training, as digitalisation moves forward. The study states that, in the digital world of work, there is a shift in requirements, with regard both to competence (e.g. creativity) and to employees' qualifications (e.g. type of professional traineeship completed). At the same time the companies acknowledge that the dual-training system provides a high level of flexibility in dealing with the digital transition.

The IAB and the ZEW have examined the issue of how intensively companies are already applying 4.0 technology, and simultaneously studied how individuals' places of work, as well as competence-related and qualification-related requirements that they face, are changing. Beyond this, attention is directed to companies' vocational education and further training, against the background of working processes and elements of training content that are undergoing changes. The analyses are based on the representative survey of 2,032 production-based and service-based enterprises, carried out by the IAB and ZEW in May 2016.

**Illustration 5: Companies: assessments regarding advanced training and further training**

Proportion of those who agree (per cent)

The total expenditure on advanced training and further training has increased
- 67.6 %
- 57.4 %

Allocation of funding is increasing with regard to working with the latest ICT technologies
- 71.2 %
- 49.9 %

Increased funding is being directed at developing cross-discipline skills
- 60.2 %
- 40.2 %

Increased funding is being directed at higher-level qualification accompanying workers' professional activities
- 47.6 %
- 41.9 %

There is increased use of digital learning-media or respectively of e-learning product-offerings
- 54.7 %
- 34.5 %

Has the company invested in 4.0 technologies over the last 5 years?   ■ Yes ■ No

Reading-guide: 68 per cent of the companies that have invested in 4.0 technology (uppermost green bar) agree with the statement that their expenditure on advanced training and further training has increased. Even among the companies not making investments in 4.0, 57 per cent agree with this statement (uppermost blue bar).

## Trend towards fully-automated business processes

The results show that half of all businesses are already using 4.0 technology. However, only five per cent of the working funds can be allocated to 4.0 production and only eight per cent to 4.0 administration. Even if the degree of automation and digitalisation remains at a low level, with regard to companies' working funds, the changes clearly indicate a trend towards fully automated processes. In this context, the advance of automation is changing the activities at the workplace; there is a reduction in routine tasks and (as regards Production) in manual tasks. By contrast, abstract tasks are gainly strongly in significance; indeed, the increasing cognitive burden can entail a health risk. As digitalisation progresses, work is becoming more demanding, more diverse and more complex, the study's authors note.

## Cross-discipline competences are of growing significance

The change to work processes is also reflected in the requirements that the employees must meet. Thus there is an increased need for competences such as process know-how, an interdisciplinary way of working, and problem-solving.

As a result, greater flexibility is demanded of the employee of the future, as is the readiness to constantly adapt to meet new requirements. The changes are accompanied by an increased cognitive burden, while simultaneously the trend points towards a reduced physical burden at the workplace.

As regards qualification-related requirements, a differentiated development can be seen. In the companies' administrative work, automation is bringing about a shift away from simple tasks not requiring completion of a traineeship and towards subject-specialist knowledge, also including knowledge gained in higher education; simultaneously, in production a polarisation is making itself felt: both higher-qualified and also simple activities – such as the work of supervision and checking – are experiencing increased demand.

**Illustration 6: Companies' assessments on vocational education**

Proportion of those who agree (per cent)

Increased funding of cross-discipline skills

88.6

71.3

Increased funding on working with the latest ICT technologies

79.6

64.5

We have changed the content in work forming part of vocational education

72.7

57.7

Increasingly, the content in vocational education no longer matches requirements

23.3

22.8

We are providing vocational education for different professions than was previously the case

23.4

11.2
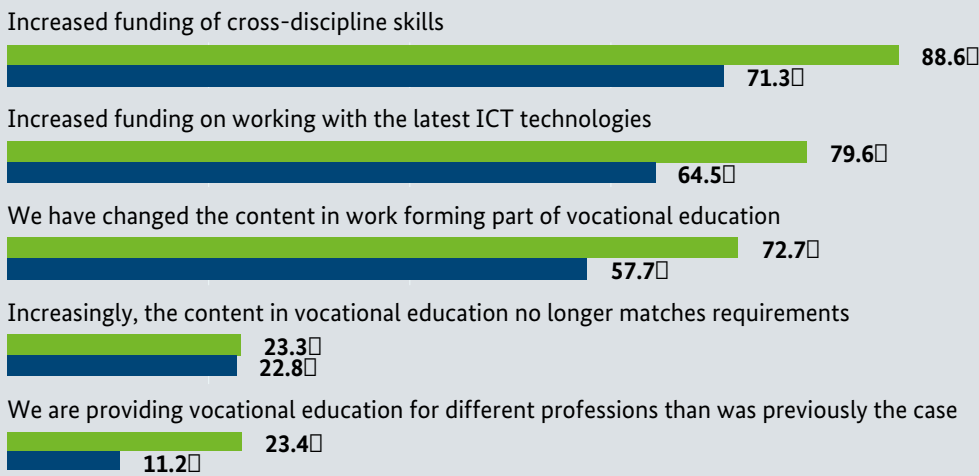
Has the company invested in 4.0 technologies in the last 5 years?   ■ Yes   ■ No

Reading guide: 80 per cent of the companies making investments in 4.0 technology are of the opinion that, in vocational education, there is an increasing need to fund development of competence in working with ICT technologies. This opinion is even shared by 65 per cent of companies not making investments in 4.0 technology.

## The German vocational education system is proving to be flexible

As the companies see it, in principle the existing vocational education system is flexible enough to adapt education activities' content and individual professions' profiles to suit the digital age. Accordingly, most companies are not providing vocational education in different or new professions for which vocational education (now) exist; rather, they are changing their current vocational education arrangements so as to engage more frequently both with the most modern information and communication technology (ICT) and with cross-discipline skills, such as personal, social and problem-solving competence. This applies equally to companies' in-house vocational education and further training, with additional opportunities emerging from the use of digital learning media (see Illustration).

The results form part of a study conducted on behalf of acatech. Further results have been compiled in the document 'acatech POSITION paper – Competences for Industrie 4.0', with recommendations for action to be taken by politicians, the business community and society as a whole, directed at the development of relevant competences.

**References**

Arntz, M., Gregory, T., Jansen, S. und Zierahn, U. (2016), Tätigkeitswandel und Weiterbildungsbedarf in der digitalen Transformation, Studie des Zentrums für Europäische Wirtschaftsforschung (ZEW) und des Instituts für Arbeitsmarkt und Berufsforschung (IAB) im Auftrag der Deutschen Akademie der Technikwissenschaften (acatech). 'Transition in Activities and Further-Training Requirements in the Digital Transformation: a Study by the Centre for European Economic Research (ZEW) and by the Institute for Employment Research (IAB) on behalf of acatech (National Academy of Science and Engineering).'

acatech (2016), Kompetenzen für die Industrie 4.0. Qualifizierungsbedarfe und Lösungsansätze (acatech POSITION), München: Herbert Utz Verlag. 'Competences for Industrie 4.0: Qualification Requirements and Approaches to Solutions (acatech POSITION Paper), Munich, Herbert Utz Verlag (publishing house).'

Arntz, M., Gregory, T., Lehmer, F., Matthes, B. und Zierahn, U. (2016). Arbeitswelt 4.0 – Stand der Digitalisierung in Deutschland: Dienstleister haben die Nase vorn. IAB Kurzbericht 22/2016. 'World of Labour 4.0 – Current Status on Digitalisation in Germany: Service-Providers are in the lead. IAB Short Report 22/2016.'

# Long version of the recommendations for action, working group 5

Digital information and a technical working environment are the key characteristics of the world of work today and in the future. New business models and innovations are changing career patterns, working tasks, job profiles, customer relationships and last but not least the competitiveness of the companies themselves. Humans and machines will work even more closely together in future. Complex inter-disciplinary and software-driven jobs will increase, jobs that can be replaced by technology will decrease. Development cycles will be shorter, the dynamic role of knowledge will grow and the half-life of knowledge will be shorter. Production and development will be more individualised and less dependent on the location. Even sales and customer relationships will change. The international division of labour in globally distributed production and service networks will be intensified as a result.

This will change the nature of work, career biographies, procedures and organisational structures. Even the distinctions between unskilled, semi-skilled and skilled workers, master craftsmen and engineers will become more fluid. At the same time, the design of the work location becomes more important. New forms of digitised work allow cooperative action in new value creation networks, and this will have a decisive effect on many forms of paid employment in the future. The standards for these changes are on the one hand the competitiveness of the companies and on the other hand the motivation and perceptions of the employees in relation to the quality of their work. The changes in the world of labour must be mastered and shaped by the employees who already work in the companies. Building on a solid apprenticeship or basic course of academic study, continuous further and advanced vocational training, especially in the workplace, is therefore more important than ever.

New forms and the independence of work bring up new questions for companies, managers, employees and employee representatives, not only on competence and qualifications but also on leadership, change management, the design of work tasks and the possibilities for co-determination. Industrie 4.0 brings opportunities and risks at the same time. On the one hand, it offers great potential for self-determined and ambitious labour in which employees can be given more responsibility. On the other hand, employees face the risk of being left out of the development, seeing their work devalued or even losing their jobs. It must not be overlooked that the consequences of Industrie 4.0 are still difficult to understand for many people and therefore create fear. Such fears must be refuted by the practical working procedures within the company. Industrie 4.0 can only really be successful if the employees can see the direct benefit, develop a positive basic attitude to the innovation activities and contribute to the success of the company. The basic requirement is trust, which can be created by transparency, information, training, sharing in the design of in-house solutions and not least enjoyment in the implementation and testing of the new system. The employees are interested in the personal outlook which is created, how their prospects for career development and attractive workplaces can increase and how secure their jobs are. Digital change must benefit both the company and the employees.

**It is clear: Industrie 4.0 creates new qualification requirements, and the education and training opportunities and their implementation must be adapted accordingly. The workforce can then be prepared comprehensively and in time for the future of work. That involves changes in the whole vocational education and training system.**

The working group "labour, vocational education and training" has intensively studied the consequences of Industrie 4.0 for vocational education and training. The participating companies and works councils have the conviction that they should first face the challenges at the company level and only appeal to the political stakeholders where it is unavoidable. They see the role of politics especially in creating a framework in the following areas:

- Continuation and development of the dialogue formats in politics, science and the economy (trade associations, employers, unions, works councils and employees);

- Exploration and testing of concepts by which technical innovations can be more systematically linked with the necessary changes in occupational, organisational and educational structures;

- Acquisition of skills, expert knowledge and process design knowledge;

- Inter-disciplinary coordination of these activities with the participation of the most important stakeholders from politics, the economy and society.

On this basis, the working group's aim is to enable companies and employees to cope with the requirements of

digitisation. These recommendations are meant for them as well as for the politically responsible stakeholders in the national government and the federal states.

The working group has repeatedly observed that companies and employees have been looking at digitisation for a long time and discussing its consequences for vocational education and training. But it is becoming apparent that Industrie 4.0 is rapidly bringing a new dimension of changes in the quality of labour. Therefore, companies are currently in a process of upheaval. They need to form an impression of the necessary qualifications that is as realistic as possible, use the existing scope in a responsible way and develop solutions. These company activities were the starting point for the working group. Its recommendations for employees, companies and political stakeholders are a reflection of the current approaches in business companies

and an important pointer for future vocational training and qualification. Even more important as a basis for development are the recommendations proposed by the parties who are directly involved – company representatives and works council members.

# A  Recommendations for action for companies and employees

The changes brought about by Industrie 4.0 and digitisation are happening at different speeds and in varying intensity in different companies. Therefore, the working group believes that it is important now to develop customised solutions, which are drawn from and directed towards the practical situation in the company, for each individual case. Therefore, these recommendations should not be seen as a "one-size-fits-all" solution, merely as guidance for decisions that must be made in the necessary reorganisation of vocational education and training. This guidance is especially important for small and medium-sized enterprises. They need comprehensive support in the transition to Industrie 4.0. Good practice examples from SMEs and large corporations, which have already started this development, can act as a pointer.

The working group "labour, voacational education and training" therefore regards the following recommendations as guidelines for a "vocational education and training road map".

## Analysis of the changes

At present, the level of maturity of digitised products, processes, systems and plants in business companies varies widely. Many possible applications are still at the trial stage. Digitisation and networking are taking place step by step. A digital strategy for the whole value creation chain only exists in a few individual instances, mainly in larger companies. In practice, companies are increasingly looking for the best possible steps they can take to try out and develop Industrie 4.0. In this constellation it is often still unclear what the new qualification requirements are and how they can be linked with the existing personnel, education, training and organisational development: What new qualification requirements will arise? What qualifications are needed, and when? Who needs which qualification level in what framework? What opportunities can be offered to equip employees for new tasks? How can employees with low qualifications be supported better and sustainably integrated? Many employees still do not know which developments are likely to occur and how their own workplace might change. The working group recommends using instruments which help to give a real and differentiated picture of the qualification demands. The examples given in this brochure show different approaches and the varying scope of such analysis. They include trend analysis, skill management, extensive competence analysis and even company road maps which facilitate a comparison of different processes and departments, both within the same company and between different companies.

## Implementing training in the company

The dual vocational education system is a central key to success of the model used in Germany, but academic education seems to become more attractive compared with apprenticeships and vocational education. The working group sees it as a major challenge to increase the attractiveness of the dual vocational education model again.

The competence, professionalism and experience of skilled employees will continue to be the foundation of their own successful vocational development and the competitiveness and innovative ability of their companies.

If the dynamic force of technological change increases due to digitisation and Industrie 4.0, this will also make career biographies more diverse and dynamic. The falling half-life of knowledge requires new answers to questions about acquisition and preservation of knowledge. Innovative training and qualification models can cushion the requirements for flexibility in training, qualifications and life-long learning, for example by combining a solid and recognised basic qualification with subsequent specialisation.

Innovative qualification structures and modern career descriptions have been developed in the metalworking and electrical industry and in information and communication technology. They are process-oriented and based on customer relationships. Currently, they constitute an appropriate solution for the increasing networking and complexity of Industrie 4.0.

These job and career descriptions can be dynamically adapted and developed to take the changing requirements and new vocational opportunities into account. The training curricula define the minimum content requirements. They provide the necessary scope for business companies to enable them to cover the specific qualification requirements for Industrie 4.0. The working group suggests that the given possibilities should be used even more to adapt the vocational education to the specific company requirements and processes.

- The innovative vocational education structure allows the core and specialist qualifications in occupations affected by Industrie 4.0 to be closely linked with the operational requirements and working processes. In typical career-related competence areas, the training content which is relevant to Industrie 4.0 can be combined in a way that is appropriate for the process. Optional areas of application – which are selected or defined by the company – allow a flexible development of skilled personnel in line with technical and organisational developments.

- The competence-based training curricula define the minimum content. But the structure and timing of the content can be varied by the companies in the interest of vocational education based on the conditions in the individual company.

- Even in the final examination, the companies can decide on the form of the examination within the framework of the defined standards. The candidate can prove his vocational competence by presenting a company-based assignment or project in a way that shows his ability to deal with technical challenges in a real-life operational context.

In addition to the structuring and adaptation of current vocational education in companies, the most important task for business companies is a continuous review of the portfolio covered by apprenticed trades and education curricula. The decision of which careers and trades should be taught in the context of Industrie 4.0 in the future may also be helped by reference to career training patterns in other industrial sectors.

The expansion of dual and on-the-job bachelor and master degrees, especially in the MINT subjects (mathematics, information technology, natural science and technology), can help in the successful further development of the dual vocational education model – adapted to the rising qualification requirements – and thus offer an efficient solution to the lack of specialist personnel. The close links between theory and practice mean that dual vocational education will offer ideal conditions for students and apprentices to gain useful practical qualifications at an early stage. The working group therefore suggests that the existing possibilities for creating dual vocational training courses should be exploited even more within the company.

## Facilitating flexible and constant further vocational training

In the development of vocational competence for a digitised world of work, new forms and programmes in vocational education and training and in-service learning will become significantly more important. And the proportion of informally acquired competence will increase. Learning by digital media will also become more and more important.

Further vocational training merely to fulfil the company's short-term needs is not enough. It is an intrinsic task of business companies, and therefore important, to inform employees about their personal prospects for their future career development – on the basis of solid information, structured participation and open training opportunities. In addition, however, each employee must also take the initiative. Therefore, it is essential in the future that employees must be kept informed about the company's business model and strategic decisions. This will help them to recognise the necessary personal further training requirements themselves at an early stage. Only then can (and should) the further vocational training opportunities offered by the company or on the market be actively and systematically used. Digitisation is an open process, so the adaptation of the training content and opportunities should also be structured as a flexible and shared process.

## Coping with major changes

Companies and their employees face up to the increasing and sometimes fundamental changes in the demands for qualification and training and develop new solutions. The examples presented in this brochure show a number of approaches. Often this involves the relationship between general and inter-disciplinary competence on the one hand and special knowledge and in-depth expertise on the other hand. The specific requirements are changing very rapidly, so there is an increasing demand for training courses, further vocational education, adaptation and in-depth knowledge. At the same time, however, fundamental abilities and soft skills are becoming increasingly important, especially the ability to be organised, work in a team and communicate and cooperate with customers – across technical and departmental boundaries. The working group believes that the combination of work and learning, theory and practice, training and competence development should be improved and that this should be transformed into new models for

apprenticeships and further vocational training, including aspects such as training for mixed-age teams.

The working group believes that the general qualifications needed by all employees in future will include not only economic skills but also basic IT knowledge and a greater competence in the use of the media which is worthy of the name and goes beyond the mere ability to "wipe and click". This especially applies to managerial staff because they will increasingly need to make decisions about the specific implementation of the digitisation requirements. Ignorance or half-knowledge at the management level can lead to intransigence or technical naivety, and thus to dangerously wrong decisions.

The fundamental changes, which the working group expects, also include an increasing demand for qualifications which transcend career and subject boundaries and "hybrid" qualifications. IT security, for example, will play an ever more important role in future as a topic that is relevant across the board. Service and process orientation will also become more important in almost all subject areas, so in addition to their skills in production (or administration), employees will increasingly need skills in customer contact and cooperation.

Informal learning in the workplace will play a greater role alongside systematic and guided learning. For example, this could include the acquisition of competence through cooperation in inter-disciplinary groups, or experience gained by solving company-related tasks.

The working group therefore recommends that qualification, vocational education and training and competence development should always be designed flexibly with reference to the applicable business process to ensure that it keeps up with continuous change. The operational requirements for vocational education and training are often similar, so the working group considers that greater cooperation between the two areas and a stronger link between their teaching content and teaching organisation is necessary.

The working group also recommends that the competence centres for small and medium-sized enterprises should be used as an important learning and experimentation resource for companies, work council members and employees, and that this role should be strengthened.

## How can (further) training and qualification be promoted in the company? Promoting learning in the workplace

The working group encourages businesses and employees to work together to develop new learning cultures in the company. This should lead to working structures that facilitate learning and a culture of lifelong learning which unlocks personal development potential, greater employer attractiveness and competitive advantages. Companies should develop to become learning organisations in which the employees have better learning opportunities – for example due to intelligent organisation of work – and can themselves contribute as knowledge providers. Continuous learning is becoming increasingly important. This means that it is also necessary to develop customised training opportunities for semi-skilled workers. Up to now, this groups of employees has only been taken into account in exceptional cases. Employer and employee representatives have a special responsibility for the development of a new learning culture, because a cultural change cannot be created by an order issued from above, and it will only be sustainable if it is jointly developed and supported and if the managerial staff model it in their own approach. The collective agreement on part-time work to allow for education between the metalworker union IG Metall and the metalworking employers is a first step in this direction.

The working group is convinced that a new learning culture also requires the right sort of leadership culture in the companies. It must increasingly be based on communication, cooperation, self-directed responsibility and participation, not on detailed hierarchical regulations. Transparency is an important concept here. The leader of the future will share knowledge, give constructive feedback, trust the strengths of the employees and systematically promote these strengths. This leader will also have a strongly developed social competence and will use this to motivate the employees to support each other in the learning and working process. At the same time, the employees will have greater scope for action and to structure the workplace so that they can make full use of their strengths and constructively apply their experience.

Information and participation are essential to defuse people's fear of change. This is especially the task of the responsible stakeholders within the company. Against this background, it is one of the strengths of the platform Industrie 4.0 and the working group "labour, vocational education and training" that they bring company representatives and works council members together in close cooperation. Co-determination and a negotiating partnership between the management and the workforce are important elements to ensure that the working conditions are conducive to learning and that the available training is up to date.

The working group encourages businesses to create a framework for more leaning in the workplace, and thus for in-service training, to make working procedures more conducive to learning for employees of all age groups and to make increasing use of flexible forms of learning that can be integrated into the workplace.

The introduction of a new learning culture is a process which companies must plan in the light of their own business needs and the individual training needs of their employees. The discussions in the working group show that the transition to sustainable and socially responsible solutions needs solid dialogue processes and guidance mechanisms in the companies to facilitate the participation of employees and their representatives in the process. Thus, companies not only promote acceptance and motivation, but also help to discover and test good solutions. That requires employee participation, intensive cooperation and new competence for all parties involved. Not only the management and the people responsible for training need access to expert knowledge in areas such as training

and occupational research and future technology, in the dynamic process of change this access must also be given to works councils.

## Effective use of new media

The use of digital media and associated training resources can provide effective support in the transition to a learning culture which is appropriate for Industrie 4.0. Fundamentally, learning is increasingly taking place "on the job". In educational research there is a growing assumption that employees learn 70% of their competence by facing challenging tasks and solving sophisticated problems in their daily work, 20% from and with other people (e.g. their own supervisors) and 10% by formal learning through books and courses. Under the slogan "everybody is a teacher, everybody is a learner", the exchange of experience with colleagues and systematic mentoring or coaching relationships become an important knowledge resource, with the advantage that the newly acquired knowledge is directly applicable. Learning via in-house or external social platforms is also becoming more important because it allows real-time discussion of the subjects. To organise the varied learning opportunities, including mixed-age learning teams, and to document learning achievements, it is possible to use "learning road maps" which the learner can compile in consultation with the supervisor and then use for guidance. And global access to knowledge irrespective of the location can take place by scalable learning opportunities such as MOOCs (Massive Open Online Courses). Classical classroom formats with a teacher-pupil structure are becoming rare, but can be used systematically for specific teaching content.

Before digital media such as learning games, simulations, assistance systems or instruction films are used to a greater extent, careful thought should be given to the teaching or learning processes in which they can effectively be used, in order to bring in-service training closer to reality and integrate it more into the working processes. The mere fact that media are digital does not automatically mean that they are effective Similarly, it must be determined where traditional learning environments (e.g. attending seminars) are no longer in step with the times and can be replaced by digital learning opportunities. It is important that digital resources should be designed to be available to all employees simply and flexibly – irrespective of the time and place of work – and that regular feedback is given by the employees to facilitate the adaptation and improvement of the resources.

# B Recommendations for political action

In the light of their own role, the companies and work councils involved in the work group especially expect the political stakeholders to create a framework that will ensure constructive cooperation between all parties and facilitate the acquisition of abilities, expertise and design knowledge for Industrie 4.0. This includes changes in the entire education process.

## Promoting media competence in schools

The national government and the federal states already promote media competence in general and vocational schools, although this is not the same as media affinity. The work group suggests that this goal should be extended. IT skills such as programming should be regarded as an important cultural skill for the 21st century, and supported accordingly. Therefore, steps must be taken in schools to ensure that this knowledge and these skills are sufficiently promoted. The work group believes that there is a special need for extra treatment in teacher training. Basic information technology knowledge should become a binding element in teacher training and in-service courses. This would

make the sensible use of information and communication technology and digital media, and the use of data a normal part in all school subjects. Technology as a separate school subject (including broad coverage of computer science) would still be necessary, but could be reserved for those who want more in-depth knowledge.

Schools also need to change in the interest of the demand for a closer link between learning and work. If the workplace becomes a place of learning, then the school classroom should also become a place that is linked to the world of labour. The work group therefore suggests that career choice processes, trainee placements, practical learning and vocational guidance should become a standard element in all schools. Grammar schools in particular have ground to make up here.

## Making vocational education more attractive

The national government and the federal states need to strengthen the dual system. The dual vocational education system and dual studying are successful models which the

work group believes should be preserved and extended. Joint efforts are necessary to make vocational education more attractive so that they are preserved as a basis for new employees, especially for SMEs.

The work group does not believe that new apprenticed trades are necessary for Industrie 4.0 or that existing trades need to be formally changed. But some of the vocational education regulations and career profiles need to be adapted and made more flexible in their content. The employer and employee representatives (the Federation of German Employers' Associations in the Metal and Electrical Engineering Industries, the union IG Metall, the Mechanical Engineering Industry Association VDMA and the German Electrical and Electronic Manufacturers' Association ZVEI) are currently preparing to adapt the vocational education regulations and curricula in the metalworking and electrical trades so that their content can be adapted to meet the current challenges of digitisation. They are also checking whether any further demand could arise.

The work group calls on the responsible stakeholders in the national government and the federal states to consider

the cancellation or at least modification of the prohibition of cooperation so that a "programme of action for vocational schools in 2020" can begin. This includes greater investments to ensure that vocational schools are available everywhere, the development of new educational concepts, improvements in the training of teachers and an intensification of contact between vocational schools and business companies and between SMEs and large enterprises. Similarly, inter-company vocational education centres should be developed further.

To cope with digital change, the work group believes that assistance ("tool boxes") for the design of vocational education for Industrie 4.0 should be developed for instructors, teachers and business companies on the basis of the existing vocational education and training curricula. It would also be helpful to create a setting in which business companies can exchange information about good practice and also about negative experience. Here, teaching materials that have been successfully used in one company can be made available to others in digital format. The work group therefore suggests that the responsible stakeholders in the national government and the federal states should consult

with employer and employee representatives to ascertain the extent to which this is possible in existing meetings. Perhaps – especially in view of the rapid pace of change – new settings or even digital and networked resources must be created.

The range of dual courses offered should be increased to match the rising demand for highly qualified experts, and the cooperation between higher education institutions and business companies should be encouraged.

## More advice on further vocational training for business companies

The working group suggests that the national government and the federal states should consider providing financial support for further training advice for businesses (especially SMEs) and employees, because the existing demand for advice is not being sufficiently met. The aim would especially be to help companies to find ways to develop the competence of their employees either on their own or with outside support. Public subsidy programmes for further vocational training and career development must be made more transparent and accessible.

The work group sees a significant need for research projects and advanced training subsidies for the study of teaching methods in further vocational education and media teaching strategies in the workplace, with similar provisions for managerial staff. The necessary key competence areas for digitisation and Industrie 4.0 should be the main content.

## Linking different areas of education and training

The work group "labour, vocational education and training" believes that the need for courses that transcend career boundaries and for hybrid training courses will increase significantly in order to cover the complexity of the world of work. In this context, vocational education, further vocational training and higher education institutions must be more closely linked. The work group suggests that revised and new curricula in all areas of education and training should be increasingly inter-dis-

ciplinary and based on real working processes in order to do justice to the increasingly fluid transitions between different areas, e.g. between electronics, mechanics and IT or between production and service. In the last resort, the goal is to create better recognition and credit allowance mechanisms for the transition between different educational levels and institutions.

The demand for advanced and further training for all groups of employees at all qualification levels will increase dramatically across the board. To cope with this, the work group believes that a better cooperation between in-house, private and state training programmes and institutions is necessary. The goal must be to link further vocational training and education programmes, including the relevant courses of study, more closely with practical work. If general schools, vocational schools, private and state advanced and further training institutions, adult education centres, universities and applied science universities are to cooperate better, the work group believes that they must be more strongly networked in future. This requires the appropriate formal and legal regulations.

## Using test beds and competence centres for training and qualification

In the Industrie 4.0 competence centres and "test beds", the work group believes that workplace design, vocational education and training should play a significantly greater role. The work group also recommends that the competence centres for small and medium-sized enterprises should be used as an important learning and experimentation resource for companies, work council members and employees. The work group suggests that it should be checked whether and how the competence centres can be more systematically geared to the work and training structures. Here, changes must be made to promote sustainable implementation and solution strategies. This also applies to "test beds" in companies which have so far only been able to test technical solutions.

# Members of the Industrie 4.0 Plattform's working group 'labour, vocational education and training' | authors and editorial team | supporters

## Group management

**Dr. Constanze Kurz,** IG Metall

## Companies' representatives

**Jan Balcke**, Airbus Operations GmbH
**Markus Bell,** SAP SE
**Bernd Brennenstuhl**, Hewlett Packard GmbH
**Silvia Buchinger**, KUKA AG
**Siegfried Czock**, Robert Bosch GmbH
**Dr. Peter Dern,** Software AG
**Dr. Kathrin Heckne**r, Wittenstein AG
**Thomas Koch**, Benteler Deutschland GmbH
**Dr. Heike Kummer**, Daimler AG
**Christoph Kunz**, Siemens AG
**Markus Lecke**, Deutsche Telekom AG
**Karlheinz Müller**, EABB Consulting
**Dr. Reinhard Pittschellis**, Festo Didactic SE
**Andreas Schneider**, TRUMPF Werkzeugmaschinen GmbH + Co. KG
**Reinhard Spilker,** IMA Klessmann
**Hermann Trompeter**, Phoenix Contact GmbH & Co. KG

## Employees' representatives

**Klaus Ahlborn**, Airbus Operations GmbH
**Armin Kolb**, KUKA AG
**Olaf Bolduan**, **Oliver Mauer**, Siemens AG
**Uwe Hußmann**, IMA Klessmann
**Carsten Kemmer**, **Jürgen Drung,** Festo AG & Co. KG
**Christa Lang**, IG Metall Baden-Württemberg
**Dieter Lochbihler**, Robert Bosch GmbH
**Uta Reinhard**, Phoenix Contact GmbH & Co
**Daniela Schiermeier**, ABB AG
**Dieter Seidel**, Daimler AG
**Mathias Staiger,** TRUMPF Werkzeugmaschinen GmbH + Co. KG

## Permanent guests

**Dr. Jörg Friedrich**, Verband Deutscher Maschinen- und Anlagenbau e.V.; Mechanical Engineering Industry Association (VDMA)
**Juliane Peterich**, Bundesverband Informationswirtschaft, Telekommunikation und neue Medien e.V. (Bitkom; Germany's digital industry association)
**Marius Rieger**, Zentralverband Elektrotechnik- und Elektronikindustrie e.V.; ZVEI; German Electrical and Electronic Manufacturers' Association
**Dr. Volker Fürst**, Federal Ministry of Education and Research (BMBF)
**Dr. Anette Rückert**, Federal Ministry for Economic Affairs and Energy (BMWi)
**Heike Zirden**, **Michael Maschke**, Federal Ministry of Labour and Social Affairs (BMAS)
**Sabine Bergmann**, *Industrie 4.0* Administrative Office
**Konrad Klingenburg**, IG Metall
**Dr. Irmhild Rogalla,** Institut für praktische Interdisziplinarität (Institut PI, Berlin) (institute for practical interdisciplinarity)
**Prof. Dr. Hartmut Hirsch-Kreinsen**, TU Dortmund University (for the scientific advisory council)

MEMBERS OF THE INDUSTRIE 4.0 PLATTFORM'S WORKING GROUP 'LABOUR, VOCATIONAL EDUCATION AND TRAINING' | AUTHORS AND EDITORIAL TEAM | SUPPORTERS

**65**

## Core team of authors and editorial team

**Sabine Bergmann**, *Industrie 4.0* Administrative Office
**Dr. Jonas Gobert**, *Industrie 4.0* Administrative Office
**Norbert Hüsson**, independent journalist
**Konrad Klingenburg**, IG Metall
**Dr. Constanze Kurz**, IG Metall
**Dr. Irmhild Rogalla**, Institut PI
(Institute For Applied Transdisziplinarity)

## The editorial team thanks the following co-authors and other individuals who provided support:

**Frank Mühlon**, **Dr. Erhan Serbest**, **Marcus Braunert**,
**Daniela Schiermeier**, ABB AG
**Jan Balcke**, **Merle Hasenkamp**, **Klaus Ahlborn** and
**Pierre Freyber**, Airbus Operations GmbH
**Moritz Niehaus**, **Carsten Kemmer**, Projekt APPsist
**Thomas Koch**, Benteler Deutschland GmbH
**Gabi Schilling** (IG Metall NRW), **Daniel Wollny** (Achenbach Buschhütten GmbH & Co. KG); (company site-map in the context of the project 'Labour 2020 in North Rhine-Westphalia state')
**Dieter Lochbihler**, **Siegfried Czock**, Robert Bosch GmbH
**Dr. Heike Kummer**, Daimler AG
**Jan-Peter Krauß**, **Dipl.-Ing. Ute Poerschke**,
Elschukom GmbH
**Dr. Reinhard Pittschellis**, **Manfred Zahn**, Festo Didactic SE
**Jan Chaberny**, IG Metall
**Silvia Buchinger**, **Armin Kolb**, KUKA AG
**Magdalena Münstermann**, **Dirk Münstermann**,
Bernd Münstermann GmbH & Co. KG
**Bastian Bröckling**, **Eugen Heinrich**, **Norbert Wrede**,
**Birgit Baumeister**, Phoenix Contact GmbH & Co. KG
**Markus Bell**, **Susanne Müller**, **Clara Marie Japing**, SAP AG
**Christoph Kunz**, **Erik Engwer**, Siemens AG
**Dr. Peter Dern**, Software AG
**Markus Lecke**, Deutsche Telekom AG
**Dr. Terry Gregory**, Centre for European Economic Research
(ZEW)

www.plattform-i40.de