PLATTFORM INDUSTRIE 4.0

IMPULSE

AI and Robotics at the Service of Humanity

A publication by the Working Group "Work and Training" of the Plattform Industrie 4.0

Imprint

Publisher
Federal Ministry for Economic
Affairs and Energy (BMWi)
Public Relations
11019 Berlin
www.bmwi.de

Editorial responsibility
Plattform Industrie 4.0
Bülowstraße 78
10783 Berlin

Design
PRpetuum GmbH, Munich

Status
September 2019

Image credits
ipopba – iStock (title)
Kugler – Bundesregierung (p. 2)
IG Metall (p. 4)
Donald Iain Smith – Getty Images (p. 6)
Georgijevic – iStock (p. 12)
Festo Didactic SE (p. 13, 14)
Trebing & Himstedt Prozeßautomation
GmbH & Co. KG (p. 17)
MetraLabs GmbH (p. 18)
Airbus Operations GmbH (p. 21)
Merck KGaA (p. 25)
Hero Images – Getty Images (p. 29)
Phoenix Contact GmbH & Co. KG (p. 31)

You can obtain this and other brochures from:
Federal Ministry for Economic Affairs
and Energy (BMWi)
Public Relations
Email: publikationen@bundesregierung.de
www.bmwi.de

Central ordering service:
Tel.: +49 30 182722721
Fax: +49 30 18102722721

Contents

Introductory remarks by Federal Minister Peter Altmaier

Many people are currently concerned about how their careers will change in future. What qualifications do they need to give them an advantage in the labour market in the age of digitalisation? To what extent are algorithms changing jobs or putting them at risk?

This publication examines the specific changes that are being brought about by the increasing use of artificial intelligence (AI) and robots in the world of work. It aims to show how technology can be used to the benefit of all and how the organisation of work can be brought more in line with people's needs. It is our firm conviction that people must remain centre stage. After all, any scenario in which our freedom and autonomy are curtailed is simply unacceptable.

Various companies will provide practical examples of the intelligent solutions they are developing in the area of AI and robotics in Germany. Leading German researchers and trade union representatives provide glimpses into the future of the world of work and demonstrate ways in which humans and machines can work together.

When considering the many changes associated with digitalisation, I believe there is one principle that must continue to hold true – that new technologies must be used in ways that support human capabilities, rather than serving primarily to replace them. AI is particularly good at analysing large sets of data. And it can do so at speeds that far exceed what is humanly possible. In certain areas, however, people outperform technology. They will, in all likelihood, continue to do so in future. For example, human capabilities such as creativity, teamwork, leadership and social skills will always be in demand.

A study of around 1,000 companies, conducted by Accenture and published in Harvard Business Manager, demonstrates that this approach also benefits companies. Those companies in the study that used AI at the service of people and handled data responsibly achieved higher sales and greater cost reductions. In contrast, companies that used AI solely to reduce the size of their workforce were less successful.

Increasing digitalisation will continue to radically change the business world and world of work in future. Workers performing simple, routine tasks will tend to be replaced by technology. New positions will be created for highly qualified candidates, such as specialists in Big Data or experts in human-machine interaction. According to the calculations of the Federal Institute for Vocational Education and Training and the Institute for Employment Research, around 2.1 million new jobs will be created in Germany by 2025. At the same time, the institutes expect around 1.3 million jobs to be lost. By 2035, they forecast approximately 3.3 million new jobs with a simultaneous loss of around 4 million jobs. This means that some structural changes will be required.

For the employees of the future, the key to success undoubtedly lies in education and training and, above all, in acquiring digital skills and qualifications. We must ensure ease of access to continuing education and training, especially in areas where robots and algorithms are expected to be used more extensively. Digital media offer a wide range of possibilities through online offerings.

Thanks to the innovative strength and commitment of German companies, we are well positioned to actively pursue Industrie 4.0. This is one of the reasons why we in Germany and Europe have a strong chance of making the social market economy the most successful economic model in the digital future. To ensure our competitiveness in the long term, we aim to make Germany and Europe a leading location for AI. The Federal Government adopted an AI Strategy in November 2018. Within this framework, we promote the responsible use of AI for the common good. Companies should be empowered not only to use AI applications but also to develop them and integrate them into their business processes.

One advantage that Germany offers as a location for business and investment is our tradition of social partnership, which forms one of the cornerstones of the social market economy. Partnership between trade unions and employers' associations is rightly regarded as a driver of economic and social progress. After all, we owe the social partners a debt of gratitude for never losing sight of the interests of society as a whole when steering the country through the financial crisis of 2008 and 2009.

The active involvement of staff is essential when introducing new technologies and social partnership is needed in this context also, i.e. to create acceptance among all stakeholders and thereby boost business success. The most important resource that any company possesses is the innovative capacity of the people it employs. If staff are able to recognise that new technologies can benefit their work, this will contribute significantly to the company's success. However, using AI for the sole purpose of monitoring or replacing staff does not contribute to staff motivation, personal initiative or innovative ideas.

Another strength that Germany offers as a location for business and investment is our networking culture. The meeting of bright minds produces good ideas – this is the principle underlying the Industrie 4.0 platform, one of the world's largest networks, which is actively involved in shaping the digitalisation of society. Around 350 experts from the worlds of business and politics, science and civil society are driving innovative ideas forward and, for example, publishing documents like this one. We need these strong networks to overcome the challenges of our time.

We can choose which aspects of technological progress to embrace based on the benefits they bring to life, work and the economy. Equally, we can choose which to reject because they conflict with our desire to create a sustainable form of society for all people, in line with our German and European value system. I invite you to contribute your own ideas to the debate and I look forward to further exchanges on this topic.

Sincerely yours,

Peter Altmaier
Federal Minister for Economic Affairs and Energy

Introductory remarks by Jörg Hofmann, IG Metall

Digitalisation at the service of humanity

Artificial intelligence presents great opportunities – from autonomous driving to medical diagnostics. AI and machine learning have long since been part of everyday life. Examples include digital translation programs, autocomplete text input or tips generated by algorithms to suggest which books we should read, which music we should listen to and which products we should buy. All of which is based on Big Data – the collection, analysis and use of large sets of data. This means that new business models are developing in all areas, giving rise to opportunities that can be exploited.

Digital infrastructure

However, the Big Data economy is also associated with risks. We only need to look at companies like Google and Amazon to observe how market power and monopolies develop and how they work. In the United States, digitalisation is associated with dominant, unregulated private corporations. In China, meanwhile, "Big Data" is associated above all with "Big Brother", i.e., the all-encompassing control of citizens by the state. We don't want either of those things. Our model, as an alternative to the US and China, is a set of binding guidelines demanding data sovereignty and data privacy, open standards and access within a democratically legitimised regulatory framework.

Germany and Europe must seize the opportunities presented by digitalisation, especially in industry and in the business-to-business area. An independent digital infrastructure is needed as a European alternative to US data corporations.

Skills development and human resource planning

The digital transformation of industry is changing the world of work in dramatic fashion. The Transformation Atlas complied by the Industrial Union of Metalworkers (IG Metall) is based on data collected by the Works Councils of almost 2,000 companies with a total of over 1.7 million employees. It reveals that the digital transformation process has progressed the furthest in the manufacturing area. The use of artificial intelligence is particularly prevalent in the area of remote maintenance and diagnostics for machines. In administrative areas, the use of AI is still in the testing and implementation phase. However, digitalisation is reaching a new level in indirect company areas in particular, through the use of artificial intelligence and robot-guided process automation. These systems are increasingly being used to perform simple, repetitive tasks.

It's hardly surprising, then, that employees assume that technology will have a negative impact on employment and, in particular, that major changes are in the offing. Similar results were found in a study conducted by the Institute for Employment Research of the Federal Employment Agency. It assumes that, by 2025, around 1.5 million jobs will be lost but that the same number of new jobs will be created. However, our Transformation Atlas also demonstrates that companies are not prepared for the changes to come. Only 18% of the companies surveyed have a full strategy in place to manage the challenges arising from the digital transformation. In 19% of companies, the works councils reported that their organisations had only partial strategies in place. Furthermore, human resource planning was found to be lacking in around half of the companies

surveyed. The need to upskill the workforce is only being addressed by 45% of companies – despite the fact that almost all works councils (95%) report that a need for training exists in their companies.

In the area of skills development, policymakers have a particular obligation to build bridges to help employees transition into the new world of work. In this way, technological progress can lead to social progress. A start has been made in this regard with the Skills Development Opportunities Act (*"Qualifizierungschancengesetz"*). Essential agreements have been reached between policymakers and social partners as part of the National Continuing Education Strategy (*"Nationale Weiterbildungsstrategie"*). IG Metall developed a proposal for an allowance payment to compensate for short-time working associated with the digital transformation. The idea behind this is to link short-time working with upskilling in order to safeguard employment. The allowance would be paid in cases where companies encounter problems during the transition from old to new business models.

Co-determination

Against the backdrop of a major need for upskilling, in addition to the frequent lack of company strategies, a right of initiative and co-determination is essential in relation to HR planning and implementation in companies. Works councils also require a genuine right of co-determination with regard to HR planning and measures to safeguard jobs. As well as ensuring that employee interests are taken into account, institutionalised co-determination guarantees the success of change processes – in the interests of the company and its staff alike. From the outset, all parties must be actively engaged in the introduction of new technologies and new ways of organising work. By doing so, they also contribute to making the digitalised world of work both ethical and humane.

Sincerely yours,
Jörg Hoffmann
IG Metall

Examples from science

Fraunhofer Institute for Production Systems and Design Technology (IPK):

AI at the service of humanity

Prof. Dr.-Ing. Holger Kohl, Prof. Dr.-Ing. Jörg Krüger

Artificial intelligence (AI) has been a hot topic in the area of research and development and the subject of public debate in recent years. It is also considered to play a key or indeed critical role economically and politically, in Germany as well as worldwide. The subject tends to trigger hopes and fears as well as opportunities and expectations. With the launch of its artificial intelligence strategy in November 2018, the Federal Government greatly helped promote AI with the "Made in Germany" identity on the world stage. It also contributed to the perception of AI being at the service of humanity. The "world of work and the labour market" and "more efficient services" are explicitly listed within the twelve fields of action of the government's national AI strategy, clearly placing AI at the service of humanity.[1]

According to Gabler, the term artificial intelligence is understood to mean the exploration of smart problem-solving behaviour and the creation of smart computer systems. Artificial intelligence focuses on ways of allowing a computer to solve tasks that require intelligence on the part of humans.[2]

The topic of artificial intelligence is not entirely new. Since the 1980s, for example, the Fraunhofer IPK has worked on developing methods and technologies for digital image processing and pattern recognition in order to teach machines how to "see". During the third industrial revolution (Industrie 3.0), the automation of industrial processes meant that technical systems already needed to be equipped with visual capability. A machine can only work autonomously with a component if it can "recognise" it and assess its position and properties. Machine vision also enables applications that would otherwise be inconceivable, given the limits of human cognition. For example, optical inspection systems examine structures that the human eye can barely see, if at all. These systems are also used in environments where human workers cannot operate, for safety reasons. The same applies to measurement and process control systems. The methods and technologies used to map these capabilities onto computers are mainly classified as being from the field of »machine learning«, a subfield of AI. Another important research field in which AI helps humanity is the use of AI for knowledge management. In general, the aim of knowledge management is to systematically capture and organise knowledge in a company by using coordinated instruments and methods. This should improve the performance of operational processes and thus contribute to the achievement of company goals. AI can provide highly efficient support by analysing information or tasks to be performed using an algorithm and then having the information or tasks addressed or processed by the most competent knowledge provider based on individual experience. The prerequisite for this approach is the ability to structure and identify knowledge within the entire organisation, e.g. by means of a knowledge-based "human twin", which captures both the specialist knowledge as well as customer and product knowledge of the employees and helps to identify the appropriate experts for every question. This increases the company's knowledge base (collective intelligence) and simultaneously reduces hidden knowledge islands. In addition, a smart factory will record the individual and current characteristics of employees and adapt processes in line with an activity, for example, in relation to ergonomics and speed, but also in terms of the information required to carry out the activity based on the experience of employees. With artificial intelligence, processes will in future be capable of tailoring themselves to the skills of employees.

With regard to general changes in the world of work caused by the ongoing digital transformation, studies and analyses carried out, for example, by the Federal Institute for Vocational Education and Training (BIBB) indicate that the nature of work will become more abstract and

1 The Federal Government's Artificial Intelligence Strategy. Internet: www.ki-strategie-deutschland.de (last retrieved: 08 August 2018).

2 Gabler Wirtschaftslexikon. Internet: https://wirtschaftslexikon.gabler.de/definition/kuenstliche-intelligenz-ki-40285 (last retrieved: 08 August 2018).

demanding in the future. While people will not become superfluous in this process, their roles and tasks in the work process will change. Machines will tend to take over routine activities in the future.[3] A study carried out by the Federal Employment Agency's Institute for Employment Research (IAB) from 2018 on the labour market effects of digitalisation up to 2035 concludes that the effects of a digitalised world of work (compared to a world of work that has developed following technical progress to date) will be relatively minor with regard to overall demand for labour in all regions of the Federal Republic. However, clear regional differences are expected with regard to the structural development of sectors, jobs and qualifications.[4]

Even as the digital transformation gathers pace, people will remain the essential factor for corporate success. While the number of monotonous, repetitive tasks will be reduced, people will increasingly adopt the role of experts and problem solvers, idea generators and drivers of greater value creation.

3 Krämer, Heike (2019): *Berufsbildung 4.0 – Fachkräftequalifikationen und Kompetenzen für die digitalisierte Arbeit von morgen: Die Ausbildungsberufe „Mediengestalter/-in Bild und Ton" sowie „Mediengestalter/-in Digital und Print" im Screening.* Bonn 2019. Internet: https://www.bibb.de/veroeffentlichungen/de/publication/download/10167 (last retrieved: 08 August 2018).

4 Zika, Gerd et al. (2018): *Arbeitsmarkteffekte der Digitalisierung bis 2035 – Regionale Branchenstruktur spielt eine wichtige Rolle,* IAB-Kurzbericht 9/2018, Nürnberg: IAB. Internet: http://doku.iab.de/kurzber/2018/kb0918.pdf (last retrieved: 08 August 2018).

TU Darmstadt:

Robots and AI in the working world – scenarios, opportunities and challenges

Ruth Stock-Homburg, Moritz Merkle

Robots and artificial intelligence (AI) are one of the most hotly debated topics in today's working world: humanoid robots are already 'working' in the retail, education, health and hospitality sectors. Like humans, humanoid robots communicate through language, gestures and facial expressions and are developed primarily to interact with customers.

But, as some fear, do robots really pose a threat? Will they take our jobs, raise our children and one day be more intelligent than we are? How realistic are films like *The Matrix*, in which robots rule the world? Somewhat surprisingly, very little information is available about the technological impact that the use of robots will have on employees, corporate culture and customers. Robots are therefore currently being deployed with relatively little consideration given to the potential impact of this technological advancement. A wide-ranging series of studies conducted by the TU Darmstadt, entitled *RobotAcceptance@work4.0*, examines the scenarios, opportunities and challenges of automation.

Science and society are currently engaged in a controversial debate on the use of robots. The controversy arises from the assessment of the technological impact of robots – i.e. the associated changes in the world of work – and the assumptions that are made about how robots will behave. In a qualitative study conducted with 53 participants, we were able to establish that tech-savvy people primarily attribute machine-like characteristics to robots, whereas people who are less familiar with technology tend to attribute human-like characteristics to them. If the two areas of technological impact and assumptions of behaviour are compared in relation to the use of robots, we arrive at four scenarios of how robots could change the future of work.

"Technoversity" scenario: Proponents of this scenario believe that at least in some cases human-like characteristics will be attributed to robots and that they will have a positive effect on the future working world. Social robots are already being used in therapeutic settings, such as caring for children with autism. They are also being deployed as teachers. They are capable of expressing human emotions and have the ability to recognise emotions.

We already credit robots with a certain amount of emotional capability: over 80% of respondents believe that robots can show feelings and more than 30% believe that robots can recognise feelings. In various studies we were able to establish that human users consider humanoid robots to be significantly more than mere machines. Many of the people surveyed compare robots to human colleagues. When it comes to technical competence, such as working accurately or gathering information, we already believe that robots are capable of achieving a fair amount, whereas we only have limited confidence in their understanding of us as humans. We expect robots to have both social and technical skills. However, such development is still at an early stage, particularly in the area of social skills.

"Machine age" scenario: In this scenario, large numbers of existing jobs would be replaced in the future – Quite an attractive prospect when the average staff costs of €40.00 an hour are compared to the operational cost of a robot at around €3.00 per hour. In countries like the US, Japan and Germany, approximately 50% of today's professions are at risk of automation. Robots are particularly effective at performing repetitive and scalable tasks.

A look back in history will show certain parallels between automation and the introduction of far-reaching technologies in various industrial eras, such as the steam engine and the loom in *Industrie 1.0* and the internet in *Industrie 3.0*. There is no doubt that many jobs disappeared during both eras. At the same time, however, many new jobs have been created – and this is where human creativity is required. Creativity is a skill that social robots currently do not have and will not have for the foreseeable future.

"Support" scenario: This scenario approximates most closely the current use of robots. A study conducted by the Federal Ministry of Education and Research (BMBF) concludes that robots will be able to do more in the future to save human lives and to perform tasks that are dangerous for emergency and rescue teams to do. Robots could also provide support in sectors where a sharp rise in burnout rates has been evident for years, e.g. education, healthcare, hospitality and the teaching profession.

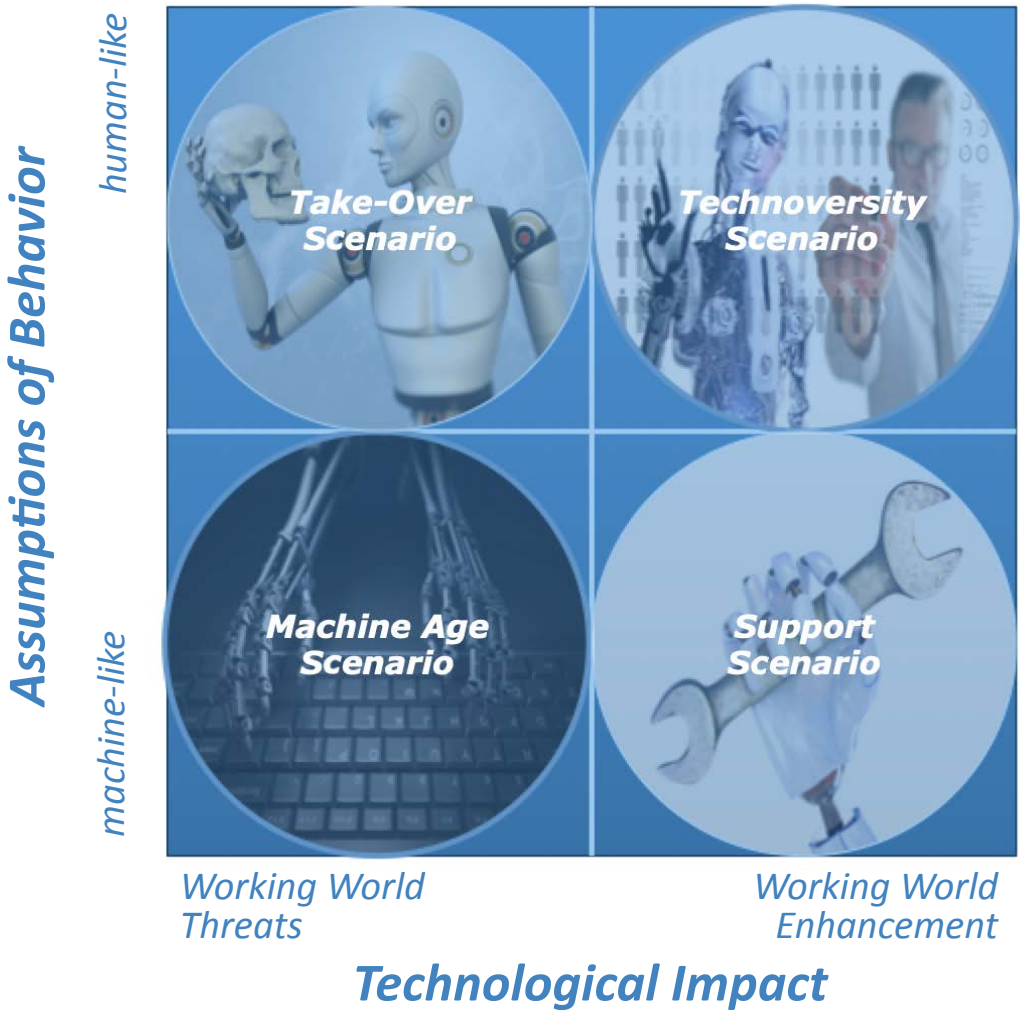


Figure 1: Scenarios examining the implications of AI and robots

Further developments in the area of artificial intelligence will play an important role here: early approaches can be seen, for example, in systems like IBM CELIA, an algorithm designed to support business leaders in making strategic decisions.

In a survey conducted among 300 employees, 60% of respondents could imagine being supported by a robot assistant. However, they believed that this assistant would be used to perform more repetitive, unpleasant tasks or to gather information. For example, the IBM CELIA technology, which is based on the Watson system, envisages a time when humans and machines will work together to make important decisions using large amounts of data. Interestingly, 21% of respondents would trust a robot more than a human colleague due to a lower error rate and greater predictability.

"Takeover" scenario: This grim scenario assumes that, within the foreseeable future, robots will develop their own identity in terms of a consciousness. Even today, people attribute comprehensive identities to a technological avatar. For example, in Japan a man recently married a female virtual reality character. Critically, however, in this scenario is the additional belief, that robots, if necessary, would also strategize and act against human interests. The consequences are vividly illustrated in various films, such as *I, Robot* and *Ex Machina*, and in many ways shape the public attitude towards robots, whereby the characteristics of robots tend to be overstated due to selective media coverage.

The danger seen in this scenario is that working people would be influenced by the human-like, rather tactical behaviour of robots, for example in decision-making pro-

cesses and negotiations. We have established in various experimental studies involving more than 400 individuals that people are capable of identifying programmed emotions in robots and tend to unconsciously adopt them. This opens up the potential for humans to be inadvertently influenced by robots. However, science is still at a relatively early stage with regard to the automated learning of emotions.

As a society, we have control over which of these scenarios come to pass. If we heedlessly use robots and simply focus on cost savings, we will certainly end up in the "Machine age" scenario. If, on the other hand, we concentrate on people, we will probably find ourselves in the "Support" scenario. After all, the follow-up costs of automation will not only have implications for 'soft factors', i.e. corporate and management culture and the demotivation of employees, but could also result in the loss of loyal customers. The follow-up costs are likely to be significantly higher than the cost savings achieved by using robots.

The demotivation of employees can lead to significant quality and service-related costs. Companies will not be able to manage without human talent for the foreseeable future. Moreover, it is sufficiently well known that the communication of positive human emotions is a key success factor, not only when working with colleagues but also when dealing with customers. Robots cannot currently establish emotional bonds with either colleagues or customers. Companies should consider very carefully whether they wish to risk losing talented staff to competitors by rashly replacing employees in all areas of the company.

Bibliography

Asimov, Isaac (1982), *Meine Freunde, die Roboter*, München.

Bauer, Joachim; Stamm, Axel; Virnich, Katharina; Wissing, Karen; Müller, Udo; Wirsching, Michael; Schaarschmidt, Uwe (2006), Correlation Between Burnout Syndrome and Psychological and Psychosomatic Symptoms Among Teachers, International Archives of Occupational and Environmental Health 79(3), 199–204.

Breazeal, Cynthia (2003), Emotion and Sociable Humanoid Robots, International Journal of Human-Computer Studies 59(1), 119–155.

Brynjolfsson, Erik; McAfee, Andrew (2014), The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies, WW Norton & Company.

Frey, Carl Benedikt; Osborne, Michael (2013), The Future of Employment: How Susceptible Are Jobs to Computerization, Working Paper.

Kirby, Rachel; Forlizzi, Jodi; Simmons, Reid (2010), Affective Social Robots, Robotics and Autonomous Systems, 58, 322–332.

Meyer, Jens-Uwe (2016), *Hilfe, ich werde wegdigitalisiert*, Manager Magazin, 04.10.2016, http://www.manager-magazin.de/unternehmen/karriere/so-erkennen-sie-ob-die-digitalisierung-auch-ihren-job-bedroht-a-1113678.html#spRedirectedFrom=www.

Rojas, Raúl (2005), *Gefühle sind entscheidend für Roboter*, Der Tagesspiegel, 26.07.2005, http://www.tagesspiegel.de/weltspiegel/gesundheit/gefuehle-sind-entscheidend-fuer-roboter/627722.html.

Stock-Homburg, Ruth (2012), *Der Zusammenhang zwischen Mitarbeiter- und Kundenzufriedenheit: Direkte, indirekte und moderierende Effekte*, 5th edition, Gabler Verlag, Wiesbaden.

Stock-Homburg, Ruth (2013), Work-Life Balance Coaching im Topmanagement, in: Stock-Homburg, Ruth (Publisher), *Handbuch Strategisches Personalmanagement*, second edition, Gabler Verlag, Wiesbaden, 577–603.

Stock-Homburg, Ruth (2015), Is Boreout a Threat to Frontline Employees' Innovative Work Behavior?, Journal of Product Innovation Management, 32(4), 574–592.

Stock-Homburg, Ruth (2016), Understanding the Relationship between Frontline Employee Boreout and Customer Orientation, Journal of Business Research, 69(10), 4259–4268.

Stock-Homburg, Ruth (2019), Emotional Contagion During Human-Robot Interactions, ICIS Conference, Munich.

Stock-Homburg, Ruth; Bednarek, Marei (2014), As They Sow, so Shall They Reap: Customers' Influence on Customer Satisfaction at the Customer Interface, Journal of the Academy of Marketing Science, 42(4), 400–414.

Real-life examples

Festo Didactic: Artificial intelligence in production and in learning factories

Dr. Reinhard Pittschellis

Introduction

The introduction of artificial intelligence (AI) will radically change production and interaction with machines. Many fear a loss of jobs or the downgrading of employees, especially those working on the shop floor.

However, AI also opens up opportunities to optimise educational and training processes and thus to give people the opportunity to keep pace with rapid technological change. As one of the leading providers of education solutions, Festo Didactic has been working on using AI in this area for several years now.

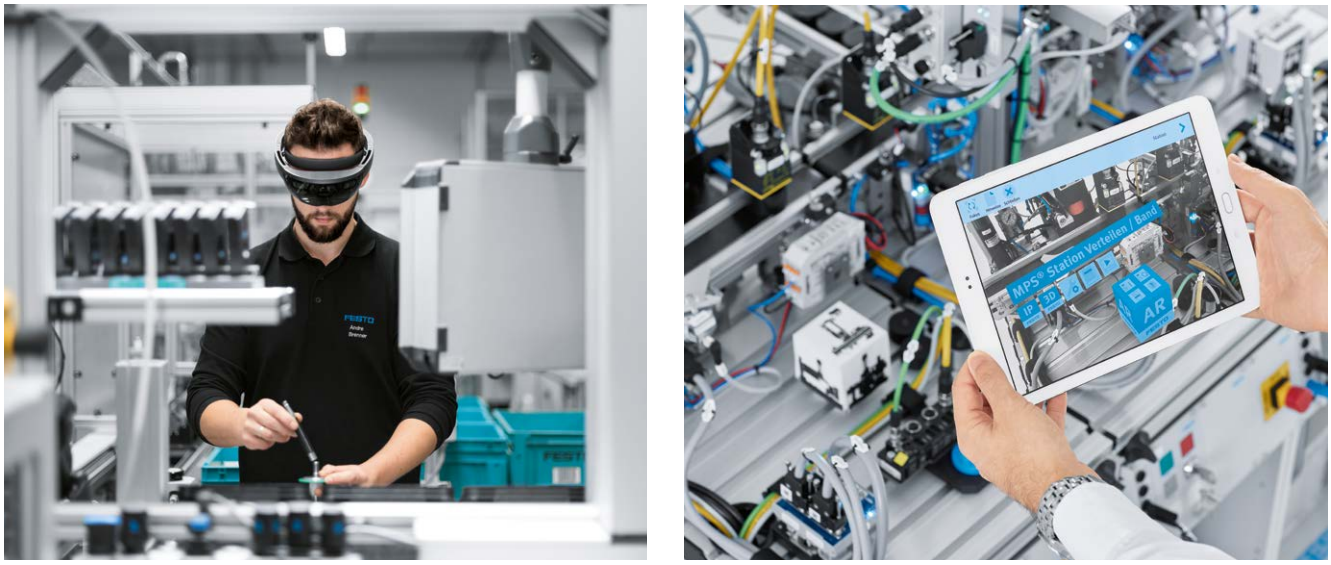
APPsist

Together with other partners, Festo Didactic has been developing an AI-assisted system to support machine operators and fitters under the auspices of the APPsist project, which is funded by the Federal Ministry for Economic Affairs and Energy (BMWi).[5]

APPsist was developed to support employees directly where they work. To do this, the system evaluates data from various sources, e.g. sensor data from the machine on which the machine operators are working but also data from MES and ERP systems. Based on this data, APPsist offers the machine operators supporting information, e.g. assembly instructions in the event of product changes or help with troubleshooting.

If, for example, APPsist discovers that the person has incorrectly executed one of the assembly steps, it provides detailed information on correcting this error. If this step is then performed correctly, the system will display the assembly steps with fewer details. It therefore needs to evaluate information from various sources and link this information together, e.g. machine status and quality data, and based on this information, find the suitable support information.

In principle, APPsist can work with various mobile devices, such as tablets, smartphones or data glasses.



Assisting machine operators in the factory with data glasses and using a tablet in a learning factory

5 Federal Ministry for Economic and Social Affairs (BMWi): *Autonomik für Industrie 4.0*, September 2016, pp. 5–7 (https://www.bmwi.de/Redaktion/DE/Publikationen/Digitale-Welt/autonomik-fuer-industrie-4-0.html).

There is a transition between a mere assistance function (e.g. Which part is fitted next?) and learning (e.g. what is the function of this component in the machine?). APPsist can offer both functions and can act as a mere assistance system and as a learning system. It can also provide information about useful, further training courses.

The system is continually developing. The starting point was a mere assistance system, but powerful editors have now also been developed in order to provide the information quickly and easily. It is used in various applications in Festo production facilities.

Learning factories

The system was installed for the first time on a trial basis in a learning factory. Because it can be used as a support system during the learning process, it complements the concept of the learning factory perfectly. What does the term "learning factory" mean?

'[A learning factory] is a place with a realistic factory environment and direct access to production processes and conditions, which facilitate problem-focused and action-focused learning.'[6]

In the last few years, Festo Didactic has been developing, producing and selling learning factories for various domains. Learning factories are used in vocational schools and universities and, last but not least, in Festo's own plants. The company has established a learning factory in the actual production department of its most state-of-the art factory in Scharnhausen. The learning factory has a small seminar room where short theory courses are taught and a simplified model of the real automated assembly line, which can also "produce" valves in a simplified form (see figure 2). In addition, there are also a number of learning stations on the subject of energy efficiency, safety, etc.

Each new employee participates in initial training here. However, the real value of having the learning factory so close to production is the opportunity to hold brief training sessions precisely when these are needed. Once the

Fully automated valve assembly and the learning factory in Festo's Scharnhausen production facility

6 Abele, E., Tenberg, R., Wenemer, J., Cachay, J., 2010.: *Kompetenzentwicklung in Lernfabriken für die Produktion. Zeitschrift für wirtschaftlichen Fabrikbetrieb.*

team management identifies a training requirement, brief, focused training sessions can be conducted in an environment that resembles the actual workplace but is didactically reduced. The team management can choose from a selection of standard training courses, request a specific training course or conduct the training themselves.

Training initiatives have the greatest effect when the theory that has been learned is put into practice straight away. The learning factory, due to its proximity and the fact that it is integrated into the factory, supports this principle in an optimum manner.[7]

Due to their clear basic structure, learning factories are often used as a demonstrator for research projects. The APPsist and InnoCyfer projects are perfect examples of such projects.[8] Another current example is the German-Chinese CaMPus project, which is funded by the Federal Ministry for Economic Affairs and Energy (BMWi). The aim of this project is to develop a learning factory for cloud-based services.[9] This is where the circle is completed: research projects use learning factories as demonstrators, but at the same time also help to improve learning factories themselves, also through the use of AI.

7 Federal Ministry for Economic Affairs and Energy (BMWi): *Shaping the Digital Transformation within Companies – Examples and Recommendations for Action Regarding Basic and Further Training*, March 2017, pp. 12–13 (https://www.plattform-i40.de/PI40/Redaktion/EN/Downloads/Publikation/digital-transformation-training.pdf).

8 Federal Ministry for Economic Affairs and Energy (BMWi): *Shaping the Digital Transformation within Companies – Examples and Recommendations for Action Regarding Basic and Further Training*, March 2017, pp. 12–13 (https://www.plattform-i40.de/PI40/Redaktion/EN/Downloads/Publikation/digital-transformation-training.pdf).

9 https://www.produktion-dienstleistung-arbeit.de/de/projekte.php?PN=11050695.

Trebing + Himstedt:

Assembly 4.0 before your very eyes Factory staff control and record work progress using gaze and gestures

In production, the trend is clearly shifting towards lot size 1. As a result, factory staff need to refer to assembly instructions more frequently and must also document work steps for quality assurance. The use of gaze and gesture control in operator guidance can lead to increased efficiency. In the area of office applications, efficiency has been shown to increase by around 12%.

The technological developments behind smart factories are being driven by the need to meet new and demanding customer requirements such as making customised products available in a short time. Consequently, the focus is on finding methods, systems and technologies that help factory staff to produce individual series quickly and without errors at the customer's request. Meanwhile, gaze and gesture control have gained acceptance on the factory floor as a robust technology that supports natural movement and that can be learned quickly. Operational ergonomics play an important role in the acceptance of assistance systems.

All that is required for gaze control is a commercially available eye tracker such as the Tobii Eye tracker and the software Nuia Productivity + from startup 4tiitoo. The eye tracker emits a weak infrared light, which is reflected by the user's eyes and used by the device to determine the viewing direction. A short calibration by the user is enough to get started and takes less than 30 seconds. In principle, the software is transparently placed over the program to be controlled without changing it. The software detects the arrangement of buttons and menu bars on the underlying user interface. Two options are now available. For non-critical functions, you simply need to glance at the button. The duration should be in the millisecond range in order to correspond to natural human behaviour: you should not have to stare at a button for an unnaturally long period before something happens. At the same time, the quick response time also increases effectiveness. A gaze selector is used for double confirmation. In this process, the destination key is first highlighted with a quick glance. Another button then appears in the immediate vicinity and must also be clicked for confirmation. Animated assembly instructions can, for example, be started with the help of gaze detection and automatically stopped when you turn your gaze away from the screen and back to the assembly workpiece. If you look back at the screen, the instructions are continued.

Workers who traditionally use visual display units such as accountants, software developers and users of CAD programs have already increased their effectiveness by up to 12%, according to the manufacturers.

If the user is a little further away from the screen, gesture control offers a way of making production and service processes more efficient. Using a wristband from Startup Kinemic, which contains sensors for acceleration, position and rotation, the factory staff provides the system with feedback, which is acknowledged by the wristband with the help of vibrations. The appropriate software now translates the movements into function controls of the program to be operated. The wristband has a battery life of approximately ten to twelve hours and communicates with the computer via the standard Bluetooth interface.

The wristband itself is linked to a workplace rather than a specific user and therefore does not collect any other vital personal data. To prevent every hand movement from triggering a command, an intelligent algorithm differentiates between the specific desired gesture and everyday movements. The algorithm is continuously adapted with the help of machine learning.

The advantage of gesture control is that factory staff do not need to put down the workpiece or tool in order to operate a mouse or touchscreen display. Users can simply swipe to go back and forth in the work instructions, and to start and end work processes. To mark a work step as completed or a part as OK, users simply need to draw a tick in the air. Conversely: If a problem needs to be documented and the user draws a cross, a dialog box will appear, for example, with the error causes. If a mouse is needed to carry out an operation, it can be simulated using the AirMouse function. For this purpose, the user's arm is moved slightly up or down.

At present, the wristband can be used to make up to twelve gestures, each with a different function depending on the context. However, more than six gestures are normally not required, since the factory floor operations are generally not that complex. This also prevents staff from being overwhelmed.

An operator uses gaze and gestures to navigate through an SAP assembly assistance system

To prevent unintentional commands during work, a short pause of less than one second is required before a dialogue. Safety-related feedback can also be combined with a confirmation gesture.

Pilot customers include, for example, Deutsche Bahn AG, which uses the wristband in combination with smart glasses in its service environment. With the help of gesture control, maintenance technicians are supported in carrying out the digital documentation of work steps.

Trebing + Himstedt, SAP consultant for digital transformation in production, has integrated technologies from startup companies 4tiitoo GmbH (gaze control) and Kinemic GmbH (gesture control) into the standard process of a SAP Manufacturing Execution operator guidance for a manual assembly process and thus demonstrated their feasibility at the Hanover Trade Fair. According to Steffen Himstedt, Managing Director of Trebing + Himstedt, "Our cooperation was greatly aided by the fact that these startup companies are also members of the SAP Startup Accelerator for Digital Supply Chain. This meant that close integration with SAP standard products was guaranteed".

About Trebing + Himstedt

Trebing + Himstedt are experts in the digital transformation of value creation systems with MES and IoT solutions based on SAP software. Trebing + Himstedt focuses especially on the core issues of transparency through production key figures, paperless production for customised products through varied manufacturing and product traceability, as well as avoiding downtimes through smart maintenance and new customer experiences through smart assets.

As an SAP Silver Partner, Trebing + Himstedt implements solutions from the SAP Digital Manufacturing Suite and the SAP Asset Intelligence Suite, which are powered by SAP Leonardo.

SAP Startup Accelerator for Digital Supply Chain

The SAP Startup Accelerator for Digital Supply Chain is a globally accessible innovation support programme for selected B2B startups in the areas of digital supply chain, manufacturing, asset management and Industrie 4.0. It focuses on joint innovation between startups, SAP and shared customers. The SAP Startup Accelerator is based in Berlin and Palo Alto. In 2018, the support programme received the IoT Global Award. It was also recognised in 2017 and 2018 by the German magazine Capital with the Best Accelerator Award and in 2019 as a digital newcomer as part of the Digital Leader Award.

MetraLabs:
TORY robot automates stock control for the Adler fashion store chain, freeing up employees

MetraLabs are specialists in mobile service robotics with many years of practical experience in the field. In 2007, the company launched the world's first interactive shopping robot. Since then, we have deployed over 250 robots in various applications worldwide. Collectively, they have accumulated more than 70,000 km of driving experience.

At the core of the products is a specially developed autonomous navigation software that dynamically recognises environments. The software teaches the robot how to see and helps it navigate independently along its route. Every robot delivered is designed to be a safe and user-friendly service robot that will lighten employees' workload, optimise processes and make a good impression on people.

Milestone in fashion store digitisation

The inspiration behind TORY, a service robot that takes over the tiresome task of inventory independently and automatically, was conceived in 2011. Working together with Adler Modemärkte AG, MetraLabs developed a solution that could guarantee the availability of goods inexpensively and precisely. "After an initial test phase, 'TORY' has proven its reliability and economic value in five ADLER fashion stores in the past three years," said Carmine Petraglia, Chief Commercial Officer of Adler Modemärkte AG.

Automated inventory carried out in Adler fashion stores by TORY from MetraLabs

Enabled by intelligent software: autonomous navigation and inventory

TORY automatically starts inventory after the shop closes. The robot moves independently through the sales area and automatically scans the RFID tags affixed to the goods. In this way, the number and exact position of the products are recorded. Shortages are recognised daily and necessary re-orders can be triggered.

Using MetraLabs' navigation software, TORY orients itself along existing shelves and independently avoids obstacles. Its built-in sensors have no trouble working in busy stores or narrow aisles. The capture rate is 99%, well above the average for alternative solutions. There is thus no need to call on external service providers for key date inventories. TORY is also up to ten times faster than manual inventory. Once inventory is complete, the robot is returned to the charging station without human intervention. The battery will be fully charged in four to six hours and the next inventory sequence can begin. This all takes place without manual intervention.

European robot rollout: Less manual work for Adler employees

In 2019, Adler began the roll out of TORY in 40 fashion stores with the aim of freeing up employees and creating more space for customer service through innovative technology. The technology reduces the employees' manual workload and increases the availability of goods for customers. In addition, inventory costs are also reduced.

No special modifications are necessary in the shops to install TORY. The employees in the various branches are briefed on how the robot works. The daily autonomous inventories are then started. The results are logged into the Adler ERP system via WLAN and actively used for ordering processes. In this way, TORY enables a meaningful division of labour: While the robot takes care of stock, the employees have more time to spend with customers.

Ongoing development: new options for product recognition

In future, inventory carried out by TORY will also function without RFID tags on the products. The robot captures images of shelves, thus highlighting shelf gaps and incorrect placement. Application areas for the robot are constantly undergoing further developed and testing. For example, its use as a product guide in retail stores is becoming increasingly popular – the robot guides customers to the products they are looking for.

The further development of new applications and improvement of robots in cooperation with retail stores and universities is vital for MetraLabs. Only in this way can the company create marketable and useful robot applications.

MetraLabs GmbH at a glance

- Specialists in mobile service robotics for over 15 years
- Over 250 robots installed worldwide – in retail, industry and research
- Safe robots, inspected under the German TÜV certification system
- Self-learning navigation software developed in-house
- Cooperation with universities on various research projects, including rehabilitation support/support after orthopaedic operations
- 18 employees (2018)
- www.MetraLabs.com

Adler Modemärkte AG at a glance

- Clothing retailer
- Turnover of €507 million in 2018
- 173 market outlets in Europe
- 3,600 employees (2018)
- www.adlermode.com

Airbus Operations GmbH:

Human Relations 4.0 in aviation – example of social partnership in action

The digital transformation of industry is fundamentally changing production processes in all economic spheres. Moreover, the technological changes are being accompanied by organisational changes. New data-driven and digital business models are emerging. This technical and organisational transformation is also placing new demands on employees – in terms of qualifications, skills and abilities. It looks very likely that automation, robotics and artificial intelligence will, to an unprecedented degree, allow machines and algorithms to adopt tasks that have only been performed by humans to date. Employee skills may become irrelevant or disappear entirely. Knowledge is increasingly becoming context-relevant and its half-life is decreasing.

Airbus Operations GmbH applies the latest technological standards in order to pursue the strategic development of the company and its internal processes, while ensuring a basis for maintaining its position in international competition in the long term. This basis includes the role played by the company and its German locations in the expected growth of the aviation industry as well as the opportunity to actively shape new future markets.

At Airbus in Germany, both the company and employees believe that the technological transformation taking place can only be managed if the social partners work together on solutions. Against this background, the employer and works council have agreed to support this transformation in the interests of all, the company and employees alike, and to implement it within a regulatory framework.

The Human Relations 4.0 project bundles together the activities with a focus on future qualification requirements and workplace design within a social partnership exchange. In this way, the parties pursue the common goal of sustainably securing and developing qualified employment at the offices of Airbus Operations GmbH. The company employees should be offered the prospect of secure employment and personal development in conjunction with health-promoting and age-appropriate work arrangements. At the same time, questions of competitiveness and increasing efficiency in an increasingly transnational context are also raised.

The parties to this agreement are partners in the “Alliance for the Future of Industry” and support the declaration “Towards a modern and sustainable industrial policy in Germany”. A constructive dialogue on the operational design of this technological progress, which takes into account both the interests of the company and its employees, is in the common interest of the parties. The dialogue includes the subjects of technology, productivity and employment, with the aim of achieving an appropriate balance between all three.

The cooperation is founded on an open exchange, transparent information about progress as well as the joint design and positive communication about projects and sub-projects between employers and employee representatives with the common goal of achieving a high level of acceptance and participation among employees.

The stated goal and specific theme of the project is to analyse future needs for training and further education as well as the further development of job profiles and the resulting consequences. Determining these requirements is an essential part of the evaluation of all projects and sub-projects.

The parties agree that the projects and sub-projects described in the project profiles should be carried out and implemented promptly, under the framework conditions agreed here. Once created and concluded, the project profiles regulate the management of employees and the general conditions of their participation.

The parties agree that the productivity gains achieved while implementing the projects should serve the interests of employees and the company alike, taking into account the necessary investments. This includes in particular shaping of the workplaces to meet future challenges and upskilling of the employees of Airbus Operations GmbH.

In order to trial new technologies and test their suitability for introduction into the company, Learning and Exploration Factories (LEF) have been launched at all German Airbus locations. These are designed to allow new technology and its effects be learned and experienced. The employees affected by this technology are proactively involved in the

introduction process. In June, Airbus received the BPM Award (Federal Association of German HR Managers) for the LEF concept in the large corporation category.

Context-based learning against the background of changing business conditions is the basic requirement for maintaining and expanding individual employability. New forms of learning should also be used in this process. E-learning, learning by doing, on-the-job training and above all workplace-integrated forms of learning will require different learning skills in the future. All employees will be provided with access to the new learning methods.

Employees are prepared for the future tasks through qualifications and targeted further training. Line managers play an important role in this process in that they are responsible for providing the resources required. However, to achieve this goal, the managers must see the benefits for themselves. The corporate culture must place a high value on training and qualifications. In this context, the topic of "New Leadership" plays a prominent role.

The three factors of competitiveness, new technology and employees need to be analysed in a balanced manner and all issues treated equally.

The task is an ambitious one: Employees must be engaged and any scepticism they have about new technologies greatly reduced by directly involving them in change processes. Further education and context-related training programmes are key to successfully shaping this task.

HR 4.0 is therefore a conceptual project with more than just a project-related dimension: It addresses the future viability of aircraft construction in Europe and the future of co-determination.

"Exoskeletons" are tested at the "Learning and Exploration Factories" at Airbus.

Deutsche Telekom:
AI in HR applications

Maike Scholz, Ute Kathrein, Markus Lecke – Deutsche Telekom AG

For Deutsche Telekom, educating employees about the opportunities and threats associated with artificial intelligence is of vital importance. The company is increasingly developing AI-based systems itself, in areas including HR.

This development takes the form of a new skill management process, which aims to ensure that employees and managers discuss current and future professional requirements. They agree on the specific upskilling measures required to develop a high level of professional skill in current or other functions.

The assignment of suitable training courses to the required skills and possible skill differences was initially carried out manually. However, automation of this matching process was made possible with the help of a self-learning system. The quality of the training proposals was thus improved.

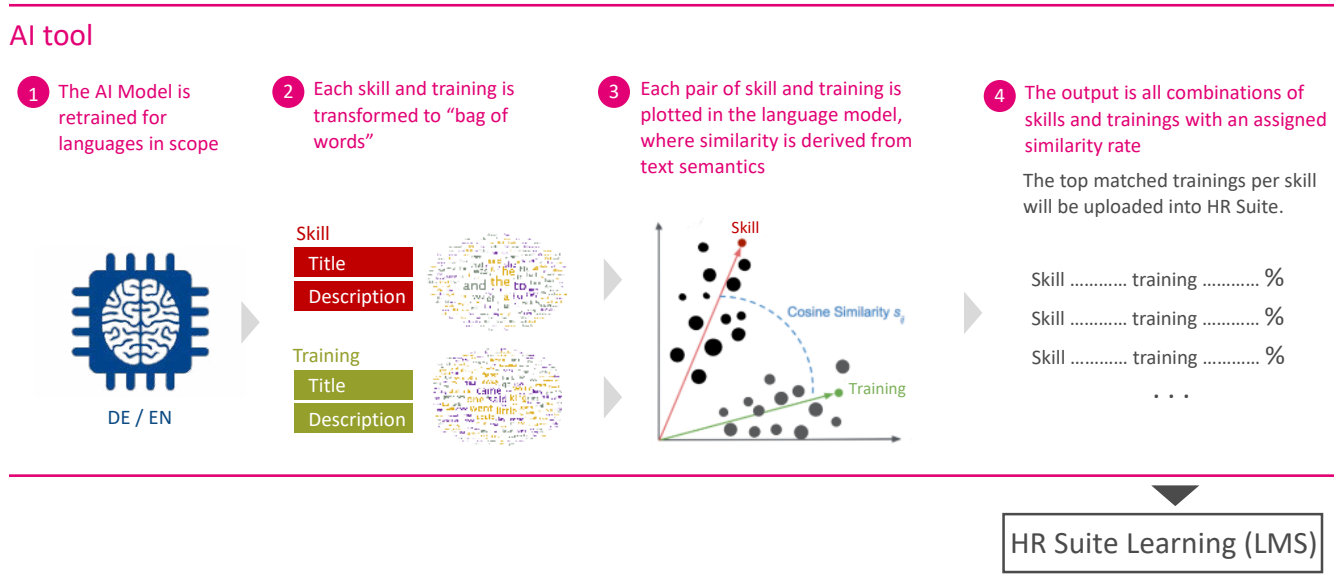
Specifically, this AI-based process draws on the existing skill and training catalogues that are used in the company. The figure below shows the specific steps involved in processing a large volume of skill and training data:

For employees, the skill management tool has the advantage of significantly improving the accuracy of matching skill requirements to appropriate training courses in order to eliminate any discrepancies.

There are additional advantages for the company, e.g.

- Less use of resources compared to manual assignment;
- Improved matching results, the more the tool is used (self-optimisation of the system by AI);
- Improved measurability and analysis of new skill requirements and recommended training programmes and
- Easy integration into the existing system landscape.

These first developments mark the beginning of the application of AI-based systems in HR. Future systems can be further developed by linking them to other data sources (e.g. to other learning platforms as well as external sources and job exchanges) and taking the learning histories of users into account.



Semantic assignment of skills and training courses

AI and ethics

The use of AI tends to trigger many questions as well as some fears. Deutsche Telekom was one of the first companies in the world to develop guidelines on the ethical handling of AI.[10] The topic of "digital ethics" is an important unique selling point for our products and services: Deutsche Telekom is committed to clarity, transparency, security, responsibility and trust – in relation to our customers and our employees. Our AI guidelines are based on Deutsche Telekom's business model as well as extensive discussions with internal and external AI experts, our employees, customers and various representatives of our civil society.

It is crucial that our AI systems and solutions are designed to be compliant in accordance with the applicable laws and regulations in Germany. The use of AI in our company should, for example, respect employee data protection, while also taking into account the participation rights (stipulated in the Works Constitution Act) of our employee representatives, such as the works council's obligation to co-determine the introduction and use of facilities that allow employee performance and behavioural controls. Our AI guidelines, for example, also require clear definitions of who is responsible for which AI system and which AI function. Given the virtually unlimited and inestimable possibilities of AI in reality, this is a very ambitious undertaking. As a company, however, we are committed to an awareness of the responsibilities attached to the development and use of AI and to appropriately cautious and high-quality management of the life cycle of AI systems. Empowering the users of AI to apply the new technologies independently is therefore one of our main priorities. The programmers and technicians who deliver and develop these technologies must do so responsibly and with clear goals and guidelines in mind. In addition, self-learning systems need defined limits, which are initially set by the developers and within which they can operate. We thus combine the support options for our employees as part of their development, while also integrating their own self-determined support through AI systems.

The implementation measures of the AI guidelines for our employees are accompanied by an eLearning "Digital Ethics" module and "AI Roadshows", which are held nationally and internationally with lectures on AI topics. We have an intranet website which is continuously updated with comments from Deutsche Telekom board members, management staff and internal and external expert groups on issues relating to AI. The AI guidelines are first established through face-to-face training courses for data scientists and then looped back to the operational business as part of the further, strategic implementation.

For the purposes of quality assurance, the internal approval processes for IT products and solutions are used. For example, applications deploying AI are checked for compliance with the AI guidelines. In order to implement our AI guidelines sustainably, a professional code of ethics for AI engineering and use was developed with experts from Deutsche Telekom. The code of professional ethics, which is enshrined in binding internal guidelines and specifications, fleshes out and operationalises the AI guidelines. The target readers are those employees who work with or develop and design AI products and solutions. The code of professional ethics is also based on our Code of Conduct, which provides the framework for all of our employees to act lawfully and with integrity in their everyday work. It is also based on our Human Rights Code & Social Principles, through which Deutsche Telekom commits itself to respecting and promoting human rights and social principles.

10 Available at: https://www.telekom.com/de/konzern/digitale-verantwortung/details/ki-leitlinien-der-telekom-523904

Merck:
Intelligent robots – How Merck is preparing for the future of work

Hello, my name is Elenoide. How may I help you?

Whether we are considering chatbots, the use of artificial intelligence or humanoid robots as employees, the next big revolution in the working world is just around the corner. For many scientists, this is the dream. However, many employees find the idea unsettling.

Research on artificial intelligence in the workplace is still in its infancy. So far, there are only a few practical studies that examine possible uses and applications. The TU Darmstadt and Merck have therefore been researching a humanoid robot since May 2018. "Elenoide" is 1.72 metres tall, with blue eyes and blonde hair: a robot built in Japan with a female human likeness. She can speak, laugh and convey emotions through facial expressions. Elenoide can interact with her interlocutor: she can process what she hears and provide appropriate answers and questions using the machine-learning system programmed into her design. In this process, she gesticulates to convey emotions to people. This is a unique ability, not yet found in any practical application.

Purpose of the study

Working together with the scientists at the TU Darmstadt, Merck wants to explore how people react to intelligent robots, how robots should be designed and programmed and which application areas could be possible. No one can yet estimate how quickly or comprehensively AI and intelligent robots will change our working lives. However, as a vibrant science and technology company, Merck wants to be prepared for this change. This study is also an example of how cooperation between research and industry can tackle major social challenges.

"We use Elenoide to test which practical applications are possible," says Dietmar Eidens, Global HR Manager at Merck. The focus is on automated processes, data processing, repetitive processes, but also on more complex work in research and development or in human resources. In this case, for example, intelligent chatbots could guide candidates through the application process. "The question is not whether, but when this technology will arrive," he adds.

The use of humanoid robots is also intended to make employees' daily work easier and thus free up time and space for more highly qualified activities and skills. Dietmar Eidens has no doubt that intelligent computers can support us in many areas. We must be prepared and help shape this development – rather than be caught off guard. "I believe that at Merck we possess the necessary natural curiosity to respond and also that we must be open to these issues."

Engaging employees at an early stage

The introduction of "Elenoide" to the public last summer generated a lot of interest, and not just from the media. Many Merck employees were also curious. At that point, it had already been announced that Merck would be involved in researching how human beings interact with a humanoid robot.

In addition to researching possible applications, the study will also focus on the response of employees to the robots. How can Merck best prepare its 52,000 employees worldwide for the introduction of AI in the work environment? The study should also allow employees to gain experience of new technologies and thus create acceptance at an early stage. Only by understanding what lies behind these trends can employees develop their own ideas about how the technologies can create added value for their work environment and thus for Merck as a company. The introduction and successful application of new technologies cannot be prescribed abruptly from the higher echelons. Instead the process should be started early and take place in a spirit of mutual exchange.

Cooperation based on social partnership

One success factor in the study is cooperation between the social partners. The works council and data protection officer were actively involved at the planning stage.

Elenoide

In addition to joint coordination of the study design and application, this involvement also included regular exchanges of information and experience. The aim, in particular, was to address worries or fears among employees in good time.

Steps were taken to ensure compliance with all necessary data protection regulations. For example, employees were able to test the robots in a protected room. This interaction was not subject to evaluation. Information that is used for research is evaluated anonymously.

Initial results

Some 331 colleagues from a wide range of company areas and group functions were available to participate in the study. In the arranged half-hour meetings, they talked to Elenoide about topics related to further education and received advice on development opportunities.

Feedback from the participants ranged from keen enthusiasm to downright discomfort. The discussion mainly revolved about which technical aspects are already working well and which areas of the technology still need to be developed. Overall, however, the response of the vast majority of participants in the study was positive. In particular, participants welcomed the opportunity to test new technologies in the field of artificial intelligence at an early stage and come to their own conclusions.

The complete study results will be available in early 2020 and will then be presented to employees and a wider public.

Legal Tech Lab: An industry in transition – Artificial intelligence in the legal profession

cand. iur. Lara Hucklenbroich, cand. iur. Nils Böhm[11]

Slowly but surely, the increasing mechanisation of the world of work is also affecting the legal consulting industry. Opportunities are opening up for law firms of all sizes and orientations – these need to be recognised and grasped.

"My contracts are all one of a kind." – "My work is too specialised for automation." These are the types of statements that come up sooner or later when you talk to legal advisors about the possible uses of technological aids in their daily work.

The attitude of in-house legal departments, on the other hand, is surprisingly receptive. These departments are under most pressure from increasing costs and their initiatives are therefore correspondingly comprehensive. Bosch, Daimler, ING, Wolters Kluwer and ZF, for example, support the "Reinvent Law" initiative, the first legal innovation hub in continental Europe. In this co-working space, lawyers, syndicates, legal tech start-ups and students are collaborating to solve the problems of the future through mutual exchange: liability issues relating to autonomous driving, law firms as software houses, legal advice and "new work" – all of the current hot topics in the sector are under discussion.

This discussion is also necessary: new technical solutions often generate concerns. One possible reason is that the traditional legal profession has long resisted any technical innovation. Even the study of law is still largely paper-based to this day. Lawyers are analogue players in a digital world.

This is a huge problem. Much has changed on the market in recent years. Naturally the goal is to make processes more efficient and effective. In concrete terms, this means that lawyers can devote themselves to their core legal skills, thanks to the support of artificial intelligence (AI) and machine learning (ML). AI tools can perform repetitive tasks that do not require extensive legal knowledge.

A chatbot is a computer program that conducts a conversation using auditory or textual methods and is designed to convincingly simulate a human interlocutor.[12] In the B2C area, the chatbot can establish initial contact with clients, for example. The problem can then be communicated directly to the lawyer. Chatbots save time, but they also give lawyers a better understanding of the needs of their clients.

Various providers are available for drafting documents. Analysis platforms include Luminance, Kira and eBrevia, for example. These software-as-a-service platforms can be used to "skim" contracts if hundreds or even thousands of rental, delivery and employment contracts need to be reviewed for due diligence. The software recognises the content of clauses and creates an overview of the documents' contents. The evaluation can be output in Word, Excel, Access or platform-independently as a CSV file. The programs are also capable of learning; the greater the variety of formulations that appears in the input documents, the better and more reliable the programs become. This helps lawyers to get a useful first impression of where problems may arise in the document, and to pinpoint which areas are worth scrutinising further or not.

The notion of virtual assistants is still a long way off. This concept is based on collaborative work between humans and computers, where each party carries out the kind of "smart" activities for which they are best suited.[13] Developments in the areas of natural language processing and data analysis are paving the way for the first generation of virtual assistants. These do not have to be perfect, since they are autonomous systems intended to support rather than replace the work of lawyers. Lawyers will still be assigned responsibility for solving complex legal tasks.

11 The authors are students of law at the Johann Goethe University in Frankfurt am Main. Lara Hucklenbroich is a student trainee at TPR Legal, the law firm and IT consultancy. Nils Böhm works as a research assistant at Baker & McKenzie in the area of legal innovation, among other things. Both are board members of Legal Tech Lab Frankfurt am Main e.V.

12 Margaret Rouse *IM Bot* Tech Target 2019, https://searchdomino.techtarget.com/definition/IM-bot (last accessed 26 July 2019).

13 Kevin D. Ashley *Artificial Intelligence and Legal Analytics: New Tools for Law Practice in the Digital Age* Cambridge University Press 2017.

Consequently, the use of AI saves time and therefore efficiency in law firms. The time-consuming task of searching and inserting the necessary data, formatting and writing the texts and the bothersome chore of searching and comparing sample contracts and other documents are no longer necessary. Staying up all night to revise drafts will therefore also soon be a thing of the past. For lawyers, this means they can leave repetitive work steps to AI, while clients benefit from an efficiently managed work process.

At the same time, access to justice is improved: If "simple" areas of legal advice (claims for damages, for example) can be reliably assessed by the algorithm in the future, there will be no need for you to visit your solicitor to in order to pursue damages arising from a traffic accident – just a few clicks will suffice. Being able to afford legal advice will no longer be a prerequisite for accessing justice.[14]

However, the image promoted of AI, especially in the legal field, is often one in which the technology does not act in the service of humanity. The area of contract software is a case in point: the "*Subsumptionsautomat*" (judicial robot)[15] much feared in the industry conjures up an algorithm that can solve cases just as well as a highly qualified lawyer.

The trends emerging today indicate that the processes of research, proofreading and draft review, document and knowledge management will take a different form in a few years from now. Understandably, this raises questions about the future of the job itself. Will the legal profession become a thing of the past?

This will not happen. While routine work is increasingly disappearing, the creative work is still there. Automated contract analysis is replacing the manual, expensive, tedious and unreliable review of papers by lawyers. Each completed analysis improves the tools' performance. The tools learn quickly and thus become a greater help to users. Users and tools work with each other, rather than against each other – they enhance each other's complementary strengths. However, lawyers also need to invest time dealing with these tools.

One very positive trend is the increasing demand for legal operation managers for in-house legal advice. Their task is to analyse the work processes in the legal department and to identify possible approaches for process optimisation. The legal operation managers are thoroughly familiar with their own assigned departments and can also take the time to consider the application options in detail.

The new opportunities opened up by technological progress can be used to improve working conditions. Sometimes this improvement will take place by itself, as unpleasant tasks are eliminated and the overall workload decreases as the tools become more powerful. The industry's very high average working hours can therefore be increasingly reduced.

The digitalisation of the work environment associated with the use of AI will also make working from home much easier. In this case, "home" can also be any place with an internet connection. More flexible working hours and more flexible planning of operations in general will be enabled to a greater extent than previously. Achieving a work/life balance will be greatly facilitated: rather than informing employees of organisational restrictions, companies will be able to help them to plan their family lives and thus retain them long-term.

Overall, we hope that the welcome trend from the in-house legal departments towards using more AI in the world of work gathers pace and helps shift the entire industry in the right direction. Hopefully the urgently needed changes will then be implemented not just partially, but across the board.

14 This is not some distant dream of the future. The German consumer advice centre has provided a tool that allows those affected by the diesel emissions scandal to check whether they can join a collective lawsuit: https://www.musterfeststellungsklagen.de/klage-check

15 Friedemann *Interdisziplinäre Ansätze im Zeitalter der Mediatisierung zwischen Introspektion und Automaten* De Gruyter 2015; Kramer *Mehr als nur Subsumptionsautomaten* LTO 19.10.2011; Ogorek *Richterkönig oder Subsumptionsautomat?* Klostermann 2008.

Medical Centre of the University of Munich (LMU): Artificial intelligence in diagnostic imaging

Michael Ingrisch, Bastian Sabel, Clemens Cyran

Radiology and nuclear medicine, two pillars of modern diagnostic imaging, were established following the discovery of X-rays and radioactivity thanks to technological innovation. Since then, technological breakthroughs have enabled these areas of medicine to continuously evolve and transform. The breakthroughs include, for example, the development of cross-sectional imaging (tomography) and the digitalisation of image acquisition, post-processing, analysis and archiving. The next transformation of diagnostic imaging (i.e. the twin disciplines of radiology and nuclear medicine) by artificial intelligence has already begun.

Future radiologists and practitioners of nuclear medicine will use AI systems as a matter of routine, just as they use digital archiving systems and digital display today. New therapies and personalised medicine indicate that diagnostics will come to play a much more significant role in future. The ever-larger data sets generated by imaging technology require supporting AI algorithms to ensure an efficient and productive application of the diagnostic information that determines treatment in a rapidly changing health system. Nevertheless, areas of conflict are emerging in radiology, as well as in all other medical disciplines, whereby the opportunities presented by AI must be weighed carefully against the potential risks. As a particularly technology-oriented discipline, diagnostic imaging can undoubtedly be regarded as blazing the trail for the use of AI in medicine.

AI is already much further advanced and more established in the automotive industry than in medicine. Driver assistance systems are almost commonplace in newer cars, while the dream of autonomous driving is taking vital steps towards becoming a reality. The automotive industry has structured the automation of driving into five levels , which can equally be applied to medicine (see "Deep Medicine" by Eric Topol) and to radiology[16] in particular. In this contribution, we draw parallels between the five levels of autonomous driving and the use of AI in radiology. We also discuss the form in which AI can most benefit radiology and how AI will transform the everyday working practices of a radiologist.

The starting point is level 0. The driver always has complete control of the vehicle and determines direction and speed. There are no systems to intervene. However, informative assistance systems can still be used at this stage, such as a system to warn the driver about blind spot hazards. This level largely corresponds to the current stage of development of automation in radiology. The radiologist is always in charge, organises how the images are displayed and writes up a free-text report of the findings. Even at this level, there is huge potential for purely informative AI-based assistance system. For example, it would be conceivable to have such a system organise images based on the clinical objective ("hanging protocol"), supply any pre-existing images of the patient as appropriate to the context or supplement visual-manual findings with automatic measurements, e.g. of angles and diameters. In everyday clinical practice, these systems would be able to perform redundant or standardised tasks in an efficient manner, freeing up time for radiologists to focus on other tasks, in particular structural tasks that are part of the central diagnostic role they play as members of the patient's clinical treatment team.

When driving automation reaches level 1, the driver continues to control the vehicle at all times but an assistance system may be responsible for direction and speed.[17] These types of speed regulation, proximity control and lane assist systems are frequently used in newer vehicles. However, the driver must continue to pay attention to traffic at all times and can intervene as needed – these systems may not function reliably if conditions are less than ideal. There is huge potential for assistance systems to develop at the corresponding level in radiology. At this level, the radiologist retains full control but is supported by the system when making decisions. For many years, radiologists have already been using computer-aided diagnosis (CAD) systems to facilitate the detection of pulmonary nodules, narrowing of the coronary vessels or intestinal polyps. Research and

16 https://webstore.ansi.org/Standards/SAE/SAE30162018, retrieved: 2019-08-02.

17 Elad Walach, AiDoc, Radiology Today.

development are currently focused on solutions to detect cerebral haemorrhage, bone fractures and pneumonia.

At level 2 of driving automation, the specified assistance systems are capable of interacting with and supporting one another. For example, an integrated speed regulation assistant maintains a pre-defined speed but adjusts this if the radar sensors detect an obstacle ahead or a slower vehicle in front. Likewise, in radiology, results from various algorithms have begun to be merged to assist radiologists, e.g. by highlighting any noteworthy findings in the heart, lungs, aorta or spine as an external second opinion, thereby optimising the sensitivity and specificity of the findings. Automated segmentation and quantitative measuring of anatomical structures enable radiologists to work quickly and with precision. As with communication between assistance systems in a car, linking this data enables the AI image-based prioritisation of patients with suspected acute, life-threatening results on the radiologist's results list, which would otherwise be ordered consecutively. This means that patients who are urgently in need of treatment are automatically identified at an early stage so that they can be helped earlier and more effectively than would otherwise be possible. At this level of automation, radiologists, like drivers, are required to be conscientious and attentive at all times. AI provides support as a decision-making tool and optimises the workflow. However, the radiologist makes all final decisions and is solely responsible for the outcome.

At level 3 of driving automation, the vehicle can be driven automatically under certain circumstances, e.g. on a motorway when the flow of traffic is steady. In the absence of complicated intersections, oncoming traffic and pedestrians in the driving environment, the car can take control of steering, accelerating and braking. However, the driver is called upon to take back control in more complex situations. Considerable functional safety is required in conjunction with a range of redundant assistance systems to temporarily allow the driver to take a complete break

from driving. This level demands, in particular, a seamless interaction between several independent systems. Similarly, achieving this level of automation in radiology is associated with huge technological complexity. However, it would mean that, under certain clinical conditions, assistance systems would be able to evaluate simple imaging of more common and unambiguous symptoms. However, the radiologist would still be required to check the results of algorithms, as well as to evaluate and diagnose more challenging cases. Huge technical effort and financial input are required to develop such systems, even for specific clinical objectives. The legal framework is yet to be clarified.

Levels 4 and 5 are the stated goal in the development of autonomous driving. At these levels, the vehicle is driven autonomously at all times and under all circumstances, so that the "driver" is no more than a passenger. At present, it appears that an equivalent level of automation could only be possible in the more distant future in radiology. Due to the high degree of variability, complexity and the significance of rare cases, AI will primarily serve to support human expertise for the foreseeable future. The greatest benefit that can be anticipated in the short term is greater efficiency and higher quality in the results of diagnostic imaging.

For the most part, radiological diagnosis is currently at level 0 in terms of automation. In other words, support from AI-based systems is minimal to non-existent. In routine radiological practice, a great deal of time is spent on relatively simple tasks such as the detection of pulmonary nodules in CT scans or radiological monitoring (e.g. checking the position of catheters or breathing tubes on x-rays). We believe there is huge potential for the use of relatively simple level 1 or level 2 assistance systems that could handle repetitive tasks and analyses that can be standardised, while simultaneously boosting productivity and reducing error rates. Radiologists could then use the time that is freed up in this way to focus in depth on complex cases and communicating with patients and colleagues on the relevant treatment teams. In time-critical situations (e.g. a full-body CT scan following a traffic accident, which generates several thousand cross-sectional images of the entire body within a very short space of time), systems with level 2 or 3 automation are conceivable, as these could pinpoint and document life-threatening findings within the large datasets generated.

Overall, we anticipate that the introduction of simple AI-based assistance systems similar to those used in the automotive system will ensure algorithm-based support for repetitive tasks that can be standardised. The resources that are freed up in this way should enable radiologists to devote more time to complex cases, as well as to focus more on patients and on patient-doctor interactions. As they would no longer have to concern themselves with the relatively simple and automatable task of pattern detection, the occupational profile of radiologists would be transformed into that of information specialists[18], responsible for extracting diagnostic information from image data, supplementing it where necessary with additional analyses, making this information available to neighbouring clinical teams and placing it in a clinical context. A special role is played here by data integration, i.e. the collection and extensive evaluation of complementary and supporting data, for example, data from laboratory analysis, pathology, molecular biology, genetics and diagnostic imaging.

Just as in the automotive industry, the gradual establishment of simple assistance systems will build trust in AI-driven technologies in medicine, create additional resources, foster the necessary acceptance among doctors and patients alike and ultimately improve the quality of treatment to benefit the patient.

18 Jha & Topol: https://jamanetwork.com/journals/jama/article-abstract/2588764

Phoenix Contact GmbH & Co. KG:
Artificial intelligence and helping humanity

Angela Josephs M.A., Director Corporate Communications,
Phoenix Contact GmbH & Co. KG, Blomberg

Phoenix Contact is a family company with a history spanning nearly 100 years. It employs over 17,000 people internationally and develops and produces components for electrical installations, electronic connection technology and automation systems in devices, machines and plants. Half of the company's workforce is employed in Germany. The family company owners have always been committed to keeping jobs in Germany, despite dynamic growth and production abroad.

Given that 40-year work anniversaries at the company's head office are not uncommon, maintaining close relations between the company and its staff has always been a priority, even during times of changes. Both company management and the works council agree that the digital transformation will be a crucial factor in the company's continued success. It will be critical in maintaining competitiveness and thus employment. The corporate culture instilled in the employees by the founders and shareholders should be safeguarded. It is highly valued by all stakeholders and explicitly anchored in the corporate strategy.

The digital transformation represents a profound shift and will bring about change for all employees, from management to bookkeepers and machine operators. Jobs may also be displaced in some areas where automation and AI are capable of operating seamlessly, quickly and without errors. This makes it all the more important to seek the engagement of all employees, provide information on the transformation and identify future changes. Bringing employees on board also means systematically training them to acquire new skills.

New skills such as IT knowledge in all areas of work, new types of work such as mobile work or project work in interdisciplinary teams also require new management principles. Another consideration is that younger generations have different life values and view of the role

of work. Therefore, not only the workforce, but also the entire management must be engaged: All management staff must internalise the transformation process and be open to another management culture in which hierarchies and instructions no longer apply. This is a big ask for those used to specifying requirements and checking results. Since almost 50% of Phoenix Contact's workforce is now from generations X, Y and Z, a new management culture is clearly required. The company has actively addressed the subjects of engagement, new employee skills and defining a new management culture. The process of engagement is long underway.

At Phoenix Contact, engagement is primarily linked to strong, effective communication. Since 2015, the corporate communication team has reported on projects via the company newspaper, defining terms and interviewing managers from specialist departments, including the chairperson of the works council. In order to include everyone, complex content must be presented clearly and technical terms explained. Meanwhile, the management team launched an extensive communication campaign in 2018: For a comprehensive demonstration of the process, over 400 executives were trained in "Future Now Days" to disseminate their newly acquired knowledge – to everyone within their own departments and workshops, including administrative staff and machine operators.

Managers are conducting interactive workshops for their employees for this purpose. At the heart of these workshops is a "dialogue picture" that illustrates the digitisation process across the company and is intended to stimulate conversation. Presenting the concept in this way makes complex topics much easier to grasp and is also more conducive to interaction than tedious texts or long lectures. The "explanatory picture" of a customer visit passing through different areas of the company shows how digitisation is implemented in development and production, administration and sales. Detailed descriptions are provided at each point along the way so that the audience knows exactly what is happening. One important area is that of education and training, where employees train new knowledge models or develop their own knowledge by means of e-Learning.

The works council in Blomberg wasted no time in its efforts to understand Industrie 4.0 and measure the effects of the consequent transformation. Uta Reinhard, chairperson of the works council, believes it is important that the transformation process already underway is carried out in a spirit of close exchange and with the greatest possible transparency. The digital transformation has been a regular topic at company meetings for some years now. Initially she explained the term 4.0 herself. The change process is being made increasingly transparent to employees through different communication formats such as discussion groups including company and works council representatives as well as trade unionists.

It is especially positive when employees suggest their own ideas for new training content. This clearly shows their involvement and motivation. With regard to changing areas of work and workplaces, it is important for the works council that solutions are found for everyone and that older employees are not left behind. In particular, ergonomic improvements will be implemented in workplaces as part of the restructuring.

Fully internalised social partnership is important to the company – on both sides. This is obvious not only in the company itself but also externally. Experts from company management and the works council chairperson are actively involved in working groups of the national initiative Platform Industrie 4.0.

The digital transformation is an extensive and ongoing process. If all stakeholders participate actively and work together to implement the transformation, the company – and its employees – will be set for the future.

This publication was produced by the working group on Work and Training in Industrie 4.0 (Plattform Industrie 4.0).

www.plattform-i40.de