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Future Challenges in Logistics and Supply Chain Management

SOCIAL NETWORKED INDUSTRY – AN INTEGRATED APPROACH

INNOVATIONLAB
Hybrid Services
in Logistics

■ WHITEPAPER

SOCIAL NETWORKED INDUSTRY – AN INTEGRATED APPROACH

Social Networked Industry puts cooperation between humans and machines at the centre of the increasingly networked world of business and develops solutions to serve humans and benefit companies. This structural project aims to develop an integrated and socio-technical vision of digital logistics and production. It looks into many key questions of the networked economy and is seen as a shared task for businesses, politics and society.

FUTURE CHALLENGES IN LOGISTICS AND SUPPLY CHAIN MANAGEMENT

This series of articles entitled "Future Challenges in Logistics and Supply Chain Management" investigates the latest challenges, comments on trends, and focuses on novel technologies and business models. The different issues in this series aim to showcase the vision of an innovative industry which is being designed and implemented through research and in practice.

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The new dimension of Industry 4.0: the Social Networked Industry

Autonomous vehicles manoeuvre their way through the warehouse transporting general cargo, pallets and shelves. Drones can roll and fly and take care of stock-taking in the warehouse and robots or machines climb along the shelves to do the order-picking. There is very little permanent infrastructure in the warehouse of the future – and right in the middle of it there are humans equipped with electronic devices who don't just control the technology, they interact with it as well. This novel interaction between humans and technology – illustrated by an example of intralogistics here – is made possible by means of digitisation.

Networking and communication via a wide variety of channels are accelerating the development of human-technology interaction exponentially. In tomorrow's networked economy, humans and technology will cooperate to an unprecedented degree and with a completely new quality. The basic condition for successful cooperation is that all the players in the entire system – humans and technology – "understand" that they speak the same language and that they share their knowledge efficiently. In this context, experts at the Fraunhofer Gesellschaft have developed the future vision of a so-called "Social Networked Industry" [1].

> "The Social Networked Industry puts humans back at the centre of production and logistics again and anticipates their specific abilities and requirements – in particular in communication and interaction with the autonomously interacting cyber physical systems of Industry 4.0. A Social Networked Industry stands for industrially-oriented forms of social networks in which humans and cyber physical systems in companies cooperate with each other (vertical networking) but also for new forms of networking in which companies cooperate extensively with each other (horizontal networking)" [1].

The Social Networked Industry sees itself as a further development of Industry 4.0. The focus here is on the human element, without questioning the validity of technology. The Social Networked Industry does not want machines to tell humans what to do, but humans' skills will also have to continue developing in parallel with the technology.

The human-centred Social Networked Industry pursues both economic and social objectives: the economy should benefit from increasing production and efficient resources, from more flexible logistics processes and systems as well as from transparent decisions. Humans and society gain as well, because it creates a socially acceptable structure and organisation for digitised work and by having new working and learning models. The Social Networked Industry is neither an end in itself nor is it going to work all by itself. This is a development task for the whole of society where experts from a wide range of disciplines have to be able to work together on equal terms.

The Innovationlab Hybrid Services in Logistics pays a significant contribution to developing the Social Networked Industry.

More information
about the research project at
www.innovationlab-logistics.com

The Innovationlab Hybrid Services in Logistics is a lighthouse project by the Federal Ministry for Education and Research (BMBF) and is currently the biggest field of experimentation for targeted and innovative human-technology interaction in logistics. The project partners are Fraunhofer IML and TU Dortmund University.

The driving forces behind Social Networked Industry

"Progress causes unemployment" was the title of an issue of the Spiegel magazine in 1978. But the real statistics tell us something different: Between 1970 and 2016 the proportion of working people in the population as a whole in Germany actually increased from 44 per cent to 55 per cent [2]. In the meantime, initial figures are emerging which show correlations between company investments in Industry 4.0 technologies and the development of jobs in companies. A current representative company survey by the Institute for Employment Research (IAB) together with the Centre for European Economic Research (ZEW) states that digitisation has neither led to massive losses in employment at an aggregated level, nor to significant gains over the past few years [3].

> "Positive effects can be found for employees who perform highly-complex expert activities in technology-oriented ICT companies but also in services that were not knowledge-intensive up to now. Losses tend to arise more for employees that perform unskilled tasks in non-knowledge-intensive services" [3].

However, according to IAB, no general conclusions can be drawn from this with regard to gains or losses for certain groups of employees due to digitisation. It remains to be said that the figures are derived from a questionnaire-based survey. In any case, the question is not only about what effects implementing Industry 4.0 technologies has on the development of employment figures. It is much more important to consider qualitative aspects such as improvements in process organisation and in work. The future picture of the Social Networked Industry is geared towards connecting both of these – to serve and benefit people.

ECONOMY 4.0: THE COPERNICAN REVOLUTION IS HERE

Tomorrow's logistics and production can be structured more efficiently by using autonomous entities. The amount of self-organisation will increase as the systems become more complex and dynamic. The classic world of logistics with its deterministic systems, its classic algorithms, central control, classic operations research planning and monitoring has certainly provided guarantees until now. In the new non-classic world with its stochastic systems, probabilistic algorithms, decentral control and ad hoc planning, it is all about managing uncertainty. This means nothing less than a Copernican revolution for logistics research but also for logistics itself.

Deploying new technologies fundamentally changes the way we produce things and work in Germany, Europe and worldwide. The fourth industrial revolution will certainly run its course. Large corporations were the pioneers in the past – but in the meantime, Industry 4.0 technologies are increasingly making inroads into small and medium-sized companies.

Companies in Germany and in Europe are adjusting to the new circumstances so they can stay competitive. They try out new technologies, determine how accepted they are and project the resulting perception onto the development of products and services.

- The positive future image of the Social Networked Industry helps companies to implement one of the biggest challenges for new technologies: cooperation between humans and technology and between companies in networks. Cooperation between humans and technology is essential for companies, particularly in the context of demographic change and securing the next generation of staff: in the Social Networked Industry novel working systems release people from error-prone and physically demanding activities and ensure that they take on more skilled work or that any restrictions on their activities can be taken into consideration.

THE BUSINESS OF THE FUTURE: HYBRID SERVICES

The Social Networked Industry leads to fundamental changes to company service portfolios at many levels: new business models, new products, new markets and a new form of added value are emerging. The further development of classic business models in the networked economy results in services being hybridized: companies become comprehensive solution providers based on linking hardware and software components intelligently.

> "Hybrid services describe pooled services made up of a product and supplementary value adding services made possible by the interaction of innovative technology and novel software. Supplementing this with an appropriate business model complements the hybrid service and ensures consistent orientation to the (future) requirements of the customers. The changes this involves often require a reorganisation of operational performance processes and lead to increased requirements for action for all participants and organisations in the added value network". www.Innovationlabor-logistik.de

Hybrid services are made possible by the rapid further development of new technologies and their penetration of the mass market. As prices drop dramatically, companies are put in a position to deploy technology economically. The transformation which goes hand in hand with delivering hybrid services helps companies to build up a closer relation to the customer and to achieve higher margins [4].

WORK 4.0: MANY SCENARIOS STILL POSSIBLE

Parallel to that, the way we structure work is becoming one of the key questions for a networked economy. The topic is not only discussed in the context of developing new productivity strategies but also, and in particular, with respect to good and fair working conditions.

The way work is structured enables the economy to be changed, but it is still subject to it. Still, there is not just the one scenario for Work 4.0. Experts in industrial sociology differentiate between four possible scenarios. It is not possible to foresee which of these visions or which combination will become reality in future. As a consequence, this provides a chance for business, politics, research and society to become creatively active.

The scenarios cover a wide spectrum of possibilities [5]:

1. **Substituting work.** This scenario (e.g. according to FREY/OSBORNE) assumes that the use of digital technologies means potential redundancies. According to this, only highly qualified and specialised personnel will work in automated plants, especially engineers and skilled workers with additional qualifications. Jobs with simple and routine activities will not be required anymore.

2. **Polarising work.** Automation, according to this assumption, mainly threatens activities at the middle qualification level. According to GOOS/MANNING there are only "lousy and lovely jobs". That means: on a higher deployment level, there are as many highly qualified experts (engineers and skilled workers with additional qualifications) as there are semi-skilled workers on the lower implementation level.

3. **Upgrading work.** Upgrading work (e.g. according to ZUBOFF) is certainly one of the more optimistic of the scenarios currently being discussed. According to this, the requirements for understanding work processes across working places will increase; all employees will have to have the ability to use the information that is now available effectively. All groups of employees – from the manager down to the unskilled labourer – will then benefit from automation and digitisation.

4. **Dissolving the boundaries of work:** The increasing decentralisation and flexibilization of work can help to break down traditional structures for work organisation and deployment. Employment relationships are being transformed into employment assignments (according to HOFFMANN/SUCHY). The extent to which this development has a positive effect for the employees (upgrading work) or a negative one (precarious employment contracts) is still open to debate.

▷ With its human-centred perspective, the Social Networked Industry campaigns strongly for the implementation of technologies providing physiological and IT support for employees which can still make sense economically.

Looking at the big picture: about the need for an integrated structural framework

In view of these structural options for Economy 4.0 and Work 4.0, the complex disruption potential of Social Networked Industry becomes obvious. Societal, economic and technological developments depend on each other like never before. On the basis of these interdependencies, interdisciplinary work on an integrated structural framework is required. The Innovationlab Hybrid Services in Logistics aims to push forward such a development, integrate existing projects and connect all stakeholders. The Innovationlab is, at the same time, a place of fundamental research and empirical investigations where Social Networked Industry is thought out, implemented and assessed.

COMPREHENSIVE APPROACH: SOCIO-TECHNICAL SYSTEM

One essential basis for implementing the vision of a Social Networked Industry is the integrated consideration of the socio-technical system.

"Although not always consistently defined, a socio-technical system is generally understood as a production unit consisting of interdependent technological, organizational and personnel subsystems. It is true that the technological subsystem restricts the structural possibilities of the two other subsystems, but these feature independent social and work-psychological characteristics that again retroact on the functionality of the technological subsystem. Therefore, it is not about the question of "either technology or human", but about the objective of synchronised structuring of equivalent parameters of the entire socio-technical system" [6].

The term "socio-technical system" found its way into discussions about Industry 4.0 a long time ago. This approach by the social sciences assumes that the deployment of new technologies induces organisational and personnel changes and generally requires us to look at the entire system of performance in production and service. Purely technology-centred discourse often reduces the approach to "new" forms of human-technology collaboration or to new work organisations on the basis of intelligent assistance systems [6]. It is important, however, to carry out complementary structuring of the individual system elements and their interfaces to create a synchronised overall system.

Complementarity means that the specific strengths and weaknesses of humans and technology are both considered to the same degree according to the situation. A division of functions between humans and machines will be developed that allows the entire system to function error-free and efficiently. The central structural frameworks of social manufacturing are therefore not so much the functional principles of individual subsystems of technology, humans and organisations but rather their interdependencies. This specifically concerns the interpretation of the functional relations or interfaces between technical, human and organisational systems.

In this context KOPP refers to the concept of social innovation that tries to understand respective innovations not only as the predecessor, support or consequence of technological innovations but to focus on the reconfiguration of social practices [7]. Subsequently, technical and social innovations are dependent on the socio-technical approach.

- The socio-technical (further) development of advanced process and service innovations and their sustainable inclusion in the German working world of production and logistics is the defined goal of modern logistics research and therefore a key approach for structuring the Social Networked Industry.

POSITIVE GENERIC TERM: HUMAN-TECHNOLOGY INTERACTION

"Human-machine communication" or "Human-machine interaction", or "Human-computer communication" or "Human-robot collaboration": there are still a lot of different terminologies going round to describe the cooperation between humans and technical facilities. However, most word pairings only address subsystems or certain features. None of the above-mentioned terms manages to cover the Social Networked Industry as a whole. A generic term which is suitable from both logistical (economic) and sociological points of view is "Human-technology

interaction". The term technology – as an abbreviation for technical facilities – includes machines, computers and robots.

> "Technical facilities are existing and planned devices in the test environment which are able to interact i.e. to act in a synchronised way with one or several interaction partners or players". (www.Innovationlabor-logistik.de)

The focus of the term interaction is the mutual influence players or systems have on each other – which is also a comprehensive definition. The basic requirement for interaction is the ability to communicate, i.e. sending and receiving messages via at least one information channel (visual, acoustic etc.). It is also important to have the ability to react, deal with each other and have a mutual influence – or even to control each other. Interaction can take different forms.

- The use of the term "Human-technology interaction" allows us to see it in an integrated way but it also provides us with a view, unclouded by negative connotations, of the new world of production and work and the Social Networked Industry.

BEYOND THE BOUNDARIES: INTERDISCIPLINARY COOPERATION

For a long time, digitisation has been seen as a technological innovation project. However, it is actually a structuring project for the economy and society. Existing processes can only be optimized by using digital technologies if existing operational and working structures are also stabilized at the same time. So, the interdisciplinary cooperation between engineering and social-science disciplines plays a decisive role for the success of Social Networked Industry. The interdisciplinary competency of logisticians, industrial engineers, mechanical engineers, computer scientists, sociologists and many more disciplines has to be pooled and transferred into customised human-oriented concepts. Development perspectives for the networked economy has to be analysed and developed from both logistical, economic and industry-sociological point of view. Major research projects like the Innovationlab in Dortmund or the Future Work Lab in Stuttgart make it possible to create an interdisciplinary network that includes universities and colleges, non-university facilities and institutions as well as strategic initiatives financed by companies.

In this way, new paths and formats of cooperation can be pursued – for example, combining the methods of social research and engineering. This combination ensures that the technological results will be directly aligned with the sociological perspective and that problem-oriented developments can be initiated.

▷ Only with such interdisciplinary cooperation can the potential of new technological developments be fully exploited with regard to Social Networked Industry.

The way towards Social Networked Industry

Today's society is already a "network society": In 2017, there will be more than 8.3 billion devices connected to each other in the Internet of Things according to Gartner. In 2016, there were already 6.3 billion devices. That means there has been an increase of about 30 per cent within just one year. 3.1 billion connected devices are to be found in business, about half of them at the vertical, the other half at the horizontal level [8]. The major proportion of the connected devices – 5.2 billion – can be attributed to consumers. In the consumer or private sector, one networking tendency stands out in particular: the use of social networks. In Europe, a significant part of the population is active in social networks: in Great Britain, 64 per cent are active, in Italy 52 per cent and in Germany 41 per cent [9]. Worldwide, the number of users is expected to increase to about three billion by the year 2021 [10]. Social networks enable data and news to be exchanged conveniently between several users on a platform. They can communicate and interact with each other. One particular feature of communication in social networks is its speed ("live communication"). Children and adolescents are particularly at home in the digital world and move around it completely naturally: According to a study by the German Institute for Trust and Security in the Internet [11], about half of the eight-year olds (55 per cent) in Germany are online, 37 per cent several times per week or daily. These numbers are so significant because they show us that a whole generation is growing up that is naturally familiar with interacting technology. This will mean that expectations with regard to this technology will increase – not least in professional environments. The Social Networked Industry has to take these expectations into account and has to lay the foundations for an optimal "human-technology balance".

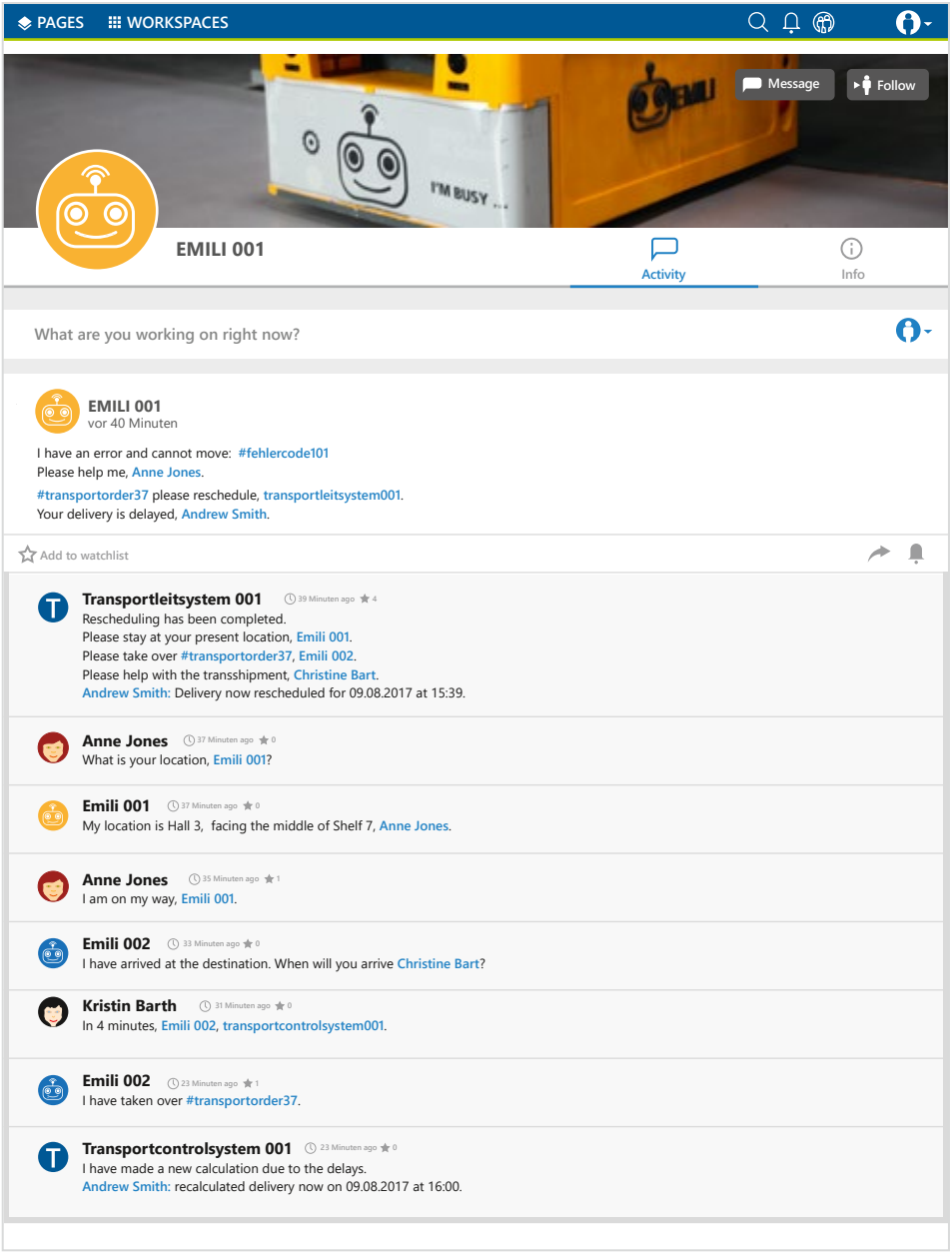
5 COMPONENTS: HOW THE SOCIAL NETWORKED INDUSTRY IS STRUCTURED

By continuing to develop and implement five components – social networks, assistance systems and smart devices, human-technology interaction, digital structuring and horizontal networking – the vision of the future is beginning to take shape.

1. The intuitive handling of social networks and technical systems such as smartphones in the private sector will soon dominate everyday operations. That is the reason why humans and technology organise themselves via social networks in the Social Networked Industry. The novel, cross-company social networks provide companies with the possibility to control complex systems – with all the benefits of technology and with humans as flexible all-rounders. Undoubtedly, social networks also pose risks – as is often mentioned today: the way people are controlled from outside, data abuse or security risks. These topics need to be addressed consciously and to be developed in an interdisciplinary way. In order for the new form of communication between humans and technology to work, there must be an appropriate information model that connects information and metadata and continuously adapts them. Both the employees and the technology are given a virtual entity in a Social Network. That means it is possible to check the profile of a single machine to see, for example, its workload, defects, locations etc. This increased transparency enables virtual communication and interaction to take place [12].

2. The topic of social networks is closely connected with assistance systems and smart devices. They provide people with the right information at the right time so that they can make a certain decision or carry out a certain activity.

3. That involves the development of fundamental models for human-technology interaction and for individual, human-centred development of working systems. That is why research plays a particular role in the area of cognitive ergonomics. The focus is on determining psychological and cognitive work requirements, e.g. by means of psychological and psycho-physiological procedures. The objective is to develop human-technology-interaction responsibly so that it supports rather than overexerts the employee in question.



4. Permanent change is one of the essential characteristics of the future economy: constantly changing customer requirements, the trend towards individualisation – down to batch size one – and the volatility of the markets are just some of the drivers. Logistics systems have to be designed so that agile development and realisation processes are possible. This is the task of digital development. The basic concept is the digital twin as a digital image of a logistics system with all its objects. Via interfaces to the Social Network it will be provided with real time data and always reflect the latest status of the system. Scenarios, such as the simulated future behaviour of a system, can be evaluated "ad hoc" based on data like this. Besides, such simulation systems make an important

contribution to accepting new technologies. The simulation environment not only enables planners to test new projects or changes during set-up and operations before implementation but enables users and employees to try it out as well. Via the virtual world of the digital twin they can be included in the ongoing planning. As a result, the digital twin increases the speed of implementing the Social Networked Industry. At the same time, efficiency increases as the physical conversion and the dissemination of knowledge necessary for operations can take place in parallel. Human requirements are also taken into account when integration is timely.

5. The horizontal networking of different players in an eco-system enables and also drives ahead the development of the Social Networked Industry. Today, we are well aware of the importance of horizontal networking. Admittedly, the foundations for networked digital services are often laid at the vertical level, but the key to radical innovations is at the horizontal level.

The task and objective for all research areas in logistics and associated disciplines is to design research and innovation projects in a way that the developed concepts, models and prototypes contribute to one of these five components. That guarantees that Social Networked Industry will not only be supported by all the players but that "blank patches" on research maps can quickly disappear.

5 USE CASES: AT THE HEART OF THE SOCIAL NETWORKED INDUSTRY

Social Networked Industry is not going to arrive overnight but is emerging step by step. Research projects like the Innovationlab Hybrid Services in Logistics help to develop real use cases from individual functional areas in terms of a proof of concept. All use cases are based on current challenges from particular functional areas and/or industries. They show how each particular overall system made up of employees, technology and organisation can be developed in a specific case. Increasing process efficiency while integrating and unburdening humans sensibly, the organisational impact and economic significance will be analysed complementarily.

1. **Intralogistics/commerce.** The trend towards individualisation, short delivery periods and multi-channel orders are forcing the (retail) trade to adapt its processes, products and services. Due to the demands of efficiency and environmental protection, logistics service providers are faced with the challenge - despite constantly smaller-scale deliveries - of consolidating

transports in a reasonable way and to deliver within tighter and tighter timeframes. Industry 4.0 technologies offer innovative solutions. The deployment of intelligent drones or robots equipped with artificial intelligence is a focus of current discussions. Humans actually continue to be a central element in intralogistics. Yet, they can be supported in their work by both cyberphysical systems and digital assistants – completely in line with the Social Networked Industry. By skilfully combining an employee's practical knowledge with optimisations by means of technical systems, companies can achieve a much improved and more ecologically-friendly result.

2. **Production logistics.** The growing demands of customers and the increasing pressure of competition are forcing production companies to continue developing if they want to remain in the market. And customized products should preferably be delivered "by yesterday". This situation increases the complexity of processes as the production steps vary because of the increasing diversity of variants. Relief can be achieved by means of improved human-technology interaction which is also supported by the Social Networked Industry. By using smart devices via social networks, the employees can access live information, for example about the status of their order situation or the completion of a production step by a machine. Moreover, employees can be enabled, by means of digitised job instructions produced to match up with their qualifications and ability, to perform an increased number of assembly steps correctly without needing any previous knowledge. Autonomous transport systems are deployed in the Social Networked Industry to physically support the work of the employees; assembly workbenches adjust themselves to suit the requirements of each employee on the basis of information available in the social network.

3. **Transport.** External transportation for producing companies is generally conducted by external service providers which include both large service providers and small haulage companies. But, there is no continuous digital exchange of information between all these network partners at the moment. The consequence is that truck drivers often have to put up with waiting for hours and hours in the loading bays. Not only is it vital to interconnect drivers involved in external transportation in the Social Networked Industry, it is also essential to interconnect all the employees and processes involved in goods transfer. Goods transfer must develop – as a connecting link between transport and intelligent production – to become a smart paperless process. All the information that needs to be collected and displayed for forwarders, carriers, production companies and consignees has to be pooled. That also applies to

the devices which support employees in their work: in a Social Networked Industry they can be reduced down to one single, smart device which can be used intuitively.

4. **Maintenance.** In modern industrial production and intralogistics facilities, machines already produce vast amounts of data. In maintenance, these data offer the potential to attain an increased transparency about the condition of machines, their ongoing demand for maintenance and the triggers which lead to breakdowns so that breakdowns and failures can be avoided. In the context of Social Networked Industry, innovative assistance systems enable the human in smart maintenance to handle an increased amount of information in a well-networked environment. Assistance systems on mobile devices, for example, help to identify mistakes. Maintaining and restarting machines can also be supported and documented by mobile devices, for example by means of augmented reality – to improve both the maintenance orders that follow and to give support for training measures. AR technologies help to provide smoothly running and particularly practical interfaces between humans and machines.

5. **Virtual Training.** Logistics centres have to react flexibly to changes in the market, products and new services. At the same time, the working environment has to be constantly adapted to the requirements of the employees and used in a way that makes good business sense. The Social Networked Industry is set up in a way that shop floor employees can design their working environment together with the planners in future planning phases. In Virtual Training Labs you can experience the results of any restructuring in virtual reality and check if it is feasible and practical. Employees affected by changes can contribute to designing workplaces that work in the virtual world and be trained before or parallel to implementation. Virtual training methods mean employees can be trained in a realistic environment.

A shared task: the most important associated topics

This paper clearly shows that, as a structuring project, the Social Networked Industry involves many players and many topics. To conclude, there are four topics that are of particular importance. In some cases, initiatives have already been formed by the science and business communities that provide the necessary framework for what is technically feasible.

THE QUESTION OF »MECHANICAL RESPONSIBILITY«

In the Social Networked Industry humans and technology work more closely together than ever before – not only within one company but also beyond company boundaries. That is why the question of "mechanical responsibility", i.e. the distribution of risk and responsibility between humans and technology, is becoming more important. Humans and robots – as an example: today, they generally still perform their work in strictly separated spaces independently of each other and e.g. safety measures are in place to force the robot to stop if their paths cross. In future, they will work "hand in hand" and each single robot will adjust to the individual person. The robot will also change and evaluate its behaviour when interacting with humans. Similar scenarios dominate the present political and societal discussions about the topic of "autonomous driving" that also poses significant questions for Social Networked Industry. Even though technical measures are tangible, and their economic reasonableness can be demonstrated, it is mainly the ethical questions about software-based decisions made by technology in case of collisions that require further clarification. Because of the complexity of the answers, the Federal Minister of Transport and Digital Infrastructure set up an ethics commission on "Automated and Networked Driving". This commission presented a report in June 2017 in which it lays down 20 ethical rules, for example: "The protection of humans has priority over all other considerations of usefulness." (excerpt thesis 2) and "In cases where an accident is unavoidable, it is strictly forbidden to assess someone according to their personal characteristics (age, sex, physical or mental constitution). Offsetting different possible victims against each other is also forbidden" (thesis 9) [13].

In spite of or even because of the fact that autonomous vehicles are still a long way from arriving on the mass market, expert commissions like these have to establish boundaries for the further development of software technology. The general

importance of "mechanical responsibility" was already emphasised by the Bundesvereinigung Logistik when incorporating this matter in their catalogue of eleven central research questions for logistics [14]. This guarantees that the question is treated in the context of logistics and production. For the success of the Social Networked Industry, this means doing research into which conditions humans feel that reliable and assessable cooperation is possible with technology. Functions, design and software for technical systems can then be derived from the research results.

The entire report of the ethics commission.

ABOUT SECURE AND SOVEREIGN DATA

Communication in the network – and therefore within the Social Networked Industry – can only become possible by intelligently connecting data from all the players within a company and beyond company boundaries as well. Moreover, the consistent use of data represents a considerable competitive advantage for companies. However, at the same time, the companies clearly have an interest in protecting and controlling their own data. If companies reveal large amounts of data, they would like to be sure that these are used for a specific purpose. Industrial Data Space, which is being fostered by both the eponymous research initiative and the Industrial Data Space Association founded in 2016, is already in the process of setting up and developing the infrastructure for secure data exchange and data sovereignty for companies in business ecosystems. The topic of data security plays an important role in the Social Networked Industry, with respect to the humans as well: so, it must be possible to guarantee that people's anonymity and privacy is retained when they use or produce data. Industrial Data Space can point the way ahead here too.

FUTURE FACTOR LIFELONG LEARNING

As already demonstrated in Work 4.0 scenarios, rapid developments in the fields of technology and organisation are associated with a transformation of the working world. Independent of whether the scenarios or any combination of them will actually happen, they all have one thing in common: job requirements will change so the skills and knowledge employees need will also change. Lifelong learning will be a clear success factor for implementing Social Networked Industry. At the same time, the new technologies will offer new possibilities for adjusting further education curricula and formats to suit individual requirements and standards of knowledge. The Kompetenzentwicklungsstudie (competence development study) Industry 4.0 by acatech (German National Academy of Science and Engineering)

shows that it is mainly "data evaluation and analysis", "process and customer relations management" and "IT knowledge" that will be the core competencies of the future, accompanied by interdisciplinary attitudes and actions [15].

ACCEPTANCE THROUGH CULTURAL CHANGE

In order to embed the Social Networked Industry and all its above-mentioned facets in a company, the company culture must undergo some comprehensive change processes, because it is a company's employees that are the key factor of success when it comes to achieving change. It is absolutely essential that employees are prepared to embrace change [16]. This aims at motivating each individual to accept change, it assumes that employees will recognise the need for change and see that the company's targets make sense and understand how the company is progressing. Once again, the importance of communication becomes obvious here. It is about including all parties involved from a very early stage by providing informative, transparent and convincing formats. Because of the rapid development of technology and market activities it is desirable from the company's point of view to see their own readiness to change as a core competency at technical, organisational and personnel levels and to entrench it in the company culture. Networked thinking and behaviour is a basic condition for this; department or section boundaries must not be allowed to constitute barriers.

Outlook

The future vision for the Social Networked Industry is taking shape through research projects such as the Innovationlab Hybrid Services in Logistics in which innovative technologies are explained and showcased in example applications. In addition to interdisciplinary and fundamental research, the focus is on specific implementations and empiric investigations – as well as on enabling people to experience new technologies. The objective behind this is to include future users in the development process from as early on as possible and to give them the opportunity to contribute and have an influence on this process. This makes developments in Social Networked Industry relevant and approachable for people. In this way companies can also get the opportunity to experience and understand the technologies in specific operation scenarios. In the context of Social Networked Industry, a new kind of cooperation will emerge and a "social fabric" will develop which people will take as an opportunity and see as something they can shape for their own benefit.

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