Editorial

Digitalization as the Problem of and the Solution to Vast Amounts of Data in Future Work – Challenges for Individuals, Teams, and Organizations

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Digitalization of Work: Developments and Challenges

The future begins now – and work and organizational psychology have a lot to offer and a lot to contribute to the emergence, design, diffusion, and implementation of digital technologies in organizations. Moreover, psychology can support the development of socio-digital systems with the human in the center of system design and research activities.

The context of Industry 4.0 also known as *Industrial Internet* or *Internet of Things* is closely related to numerous developments: hyperconnectivity (products, services, engineering, and production processes are networked); autonomous systems (e.g., vehicles, production systems); new forms of human–machine interaction through adaptive machines that adapt to the capabilities and needs of users; data-centric business models (i.e., to increase processes on the basis of large amounts of data and generate customer benefits); and platform markets (digital platforms are becoming marketplaces; Jacobs Kagermann, Sattelberger, & Lange 2018).

And while we have been entering the *Second Machine Age* (Brynjolfsson & McAfee, 2014) at a high speed, work and organizational psychology should take the opportunity to actively engage in the discussion of the changing role of humans in this rapid maturation of digital, robotic, computational technology, artificial intelligence, and machine learning.

With the emergence and developments of Industry 4.0, data and information are the new "fuel" for organizational activities. The data and information are shared between "things" and humans at (almost) no cost (Rifkin, 2016). More than one third of humankind is already producing their own data by means of smartphones and mobile devices and shares this information with others. One day, the Internet of Things will connect everyone and everything in a worldwide integrated network, beginning with natural resources, production lines, logistics chains, recycling streams offices, shops, cars etc. (Rifkin, 2016).

To implement Industry 4.0, new fields of technology will be interconnected, such as cyber-physical production systems (CPPS), cloud computing (provision of data and data-related services via the Internet and the IT resources required to control, maintain, and monitor CPPS), augmented and virtual reality, as well as smart robots, which due to their technical equipment can work directly with humans without having to work behind protective fences separated from humans.

Further applications in the context of Industry 4.0 are manifold. Hämmerle, Pokoni, and Berthold (2018) point out:

- Additive manufacturing, for example, 3D printing as a process for the fast and cost-effective manufacture of products;
- Digital twin, the digital shadow of a physical product and its life cycle in the digital world;
- New forms of human–machine interfaces for utilizing gestures and brain waves and their integration into work processes;
- Smart workspace – equipping workstations with digital elements to increase productivity, efficiency, collaboration, and motivation;
- Artificial intelligence in the sense of automation of human-like intelligent behavior;
- Machine learning through the artificial generation of knowledge and experience, pattern recognition, and perception of laws; and

- Digital terminals and wearables – mobile devices for integrating people into the digital world via networking, communication, and localization functions.

Digitalization is changing work processes and requirements. This may also lead to an intensification of work, by an increased processing speed and storage capabilities. Faster information technology allows for the application of increasingly complex software for various tasks. Combined with a higher quality of sensor technology, this results in a growing number of adaptive assistance systems (Harteis, 2018). It shows that the distribution of tasks between humans and technology is shifting. In addition to providing technical assistance systems for the worker, Industry 4.0 applications can take over complete task chains of monitoring, decision-making, execution, and control autonomously. Especially the development of computerization in performing non-routine tasks, and even non-routine *cognitive* tasks, is an amazing and astonishing one (Autor, Levy, & Murnane, 2003; Frey & Osborne, 2013). Technical systems are able to carry out problem-solving and complex communication activities (Autor et al., 2003). From the perspective of work and organizational psychology, the question arises as to how organizations can handle these challenges on an individual, team, and organizational level. The role of humans in these working contexts is envisioned differently by tech pessimists and optimists (Fleming, 2019). The assumed development scenarios vary between:

- Massive job losses ("technical unemployment," Frey & Osborne, 2013), for example, more sophisticated technologies make workers redundant (47% of US employment is at risk; Frey & Osborne, 2013);
- Arguments for no job losses (Fleming, 2019), for example, because of organizational forces that mold the application of technology;
- Arguments for job growth (Brynjolfsson & McAfee, 2014), for example, through the expansion of high-skill employment due to the falling price of carrying out routine tasks by computers, which complements more abstract and creative services (Frey & Osborne, 2013); and
- Optimistic arguments that propagate intelligent and creative combination of humans + computer + outstanding method (Brynjolfsson & McAfee, 2014).

From the viewpoint of work and organizational psychology, we neither follow the idea about the superiority of technology nor can we support the tech-pessimistic fearful thoughts. Our field can draw on a long tradition of joint optimization in socio-technical systems, and thus contribute human-centered design principles to Industry 4.0 for creative combinations of "human + computer + outstanding method." The present special issue on "Digitalization as the Problem of and the Solution to Vast Amounts of Data in Future Work" of the German *Journal of Work and Organization Psychology* transfers the concept of joint optimization to social-digital work systems in which people and systems work and handle large amounts of data.

The Objective of the Special Issue: Perspectives for Combining Human, Systems, and Methods in Data-Intensive Tasks

From all the evolving topics and the plethora of research questions accompanying Industry 4.0, the present special issue focuses on the aspect of growing data quantities and information processing. Digitalization of work requires and generates large amounts of information that are collected, processed, and stored at all levels in modern organizations. Every "technically stored" piece of information is retained in organizations. Although favored by the resource-based view of the organization, which values information as an essential resource that created competitive advantages (Ellwart & Kluge, 2018; Kluge & Gronau, 2018), too much information may also lead to the problem that in situations of high ambiguity the stored amount of information does not lead to less but to more uncertainty.

While large amounts of data and communication of information between humans and objects and between sensors and objects in future organizations is assumed to lead to a competitive advantage, on the individual level a large amount of data also results in problems associated with digitalization such as information overload (Antoni & Ellwart, 2017; Eppler & Mengis, 2004).

However, as introduced in the previous section, the developments of digitalization and data-driven production and business processes lead not only to more problems, but also to innovative solutions for handling high amounts of data. Digital assistants support the organization and structuring of data as well as the processing of information and knowledge. This can be implemented through mechanisms of intentional forgetting (Ellwart et al., 2019) on the individual and team level:

1. Through the filtering of irrelevant or distressful information (e.g., by suppressing, deleting, or selecting);
2. By delegating tasks from humans to digital agents, changing roles, and reorganizing socio-digital work systems; or

3. By means of the systematic (re-)placement of retrieval cues or triggers to generate or suppress information that is supposed to be adapted (Ellwart et al., 2019).

Intentional forgetting in the Work Environment 4.0 may be beneficial in times of change, adaptability, and agility (Schüffler, Thim, Haase, Gronau, & Kluge, 2020).

The special issue aims to reflect critical questions about the design and the implementation of "human + computer + outstanding method" combinations in order to find the best solution for the handling of large data volumes. In four contributions, answers to the following questions are given: How should we design digital companions that assist human work and information handling best? Do human workers and employees trust digital companions and assistants? How can we support humans to flexibly learn and unlearn production routines in agile and data-driven production systems? How do we need to design the implementation and change process, in order to ensure acceptance among employees?

The theoretical contribution of Meeßen, Thielsch, and Hertel (2020) addresses the antecedents of using management information systems (MIS). In their model, it is claimed that the extent to which users perceive an MIS as trustworthy should be a main predictor of their experienced level of trust in the MIS. Actual use of MIS will depend on person-related and situation-related variables, such as perceived trustworthiness of the MIS, the disposition to trust in technology, perceived risks, and contextual factors, such as possible too-costly mistakes and bad usability of the system. The propositions provided are a starting point for more empirical research as well as for the development of measuring instruments in order to investigate the relationship between trust, the use of MIS, and the performance while doing so.

Niessen, Göbel, Sievers, and Schmidt (2020) provide a prototypical conceptualization of an interactive assistive system, a cognitive companion, that supports employees and workers in temporally ignoring or permanently deleting outdated information. Especially in the interplay between humans and technology, new research fields arise in order to develop context-sensitive cognitive companions that support workers in temporarily ignoring, permanently archiving, or deleting outdated information, enabling them to deliberately control their forgetting in the workplace (Siebers, Schmid, Göbel & Niessen, 2017). Their approach is based on interactive learning, where a system can explain its decisions on how to handle the information to the human. Human feedback is acknowledged to adapt the knowledge base of the system. The cognitive companion is conceptualized as a so-called white-box learning system, which combines classic knowledge-based approaches (Beierle & Kern-Isberner, 2003) and machine learning. By applying a critical incident study as a task and context analysis, Niessen et al. (2020) show the value of information sorting and technology-induced forgetting and that the why and when of intentional forgetting in the workplace should inform the design of a user-centered and context-sensitive assistive system.

The article by Schüffler et al. (2020) broaches the issue of the need to flexibly learn and unlearn production routines due to the individualization of products and services (mass customization). Whereas over the past century industrial production processes were characterized by production routines yielding a large number of identical products through mass production, the future-claimed benchmark of digitalization and Work 4.0 is the *lot size one* concept (Werther, & Bruckner, 2018). The purpose of their study is to propose intentional forgetting as a solution to the need for flexibility in the context of an Industry 4.0 production line. Their approach builds on theories and models of knowledge management addressing the challenges of information processing in a digitalized world, as well as the theories and models of the necessity of organizational unlearning (Kluge et al., in press; Martin de Holan & Phillips, 2004; Tsang & Zahra, 2008). Organizational unlearning argues that organizations need to manage forgetting of outdated information and knowledge in order to increase organizational effectiveness. In their experimental study the authors show that the interplay between workers and the technical aspects of a routine performed in an Industry 4.0 context depends on the concrete nature of the change within the action elements in the routine (an element is deleted, an element is added, the element itself is changed) and on the proficiency level with which the routine that changed was performed earlier.

With the implementation of such solutions, new challenges emerge – challenges of managing technical change and technology acceptance. The article by Paruzel, Bentler, Schlicher, Nettelstroth, and Maier (2020) shows the importance of worker participation and involvement in the implementation process right from the beginning when introducing a cognitive digital assistant such as "smart glasses." Workers need to express their fears and expectations, to incorporate and respect their attitudes in order to, for instance, provide appropriate training to handle the new technology, otherwise worker resistance might result. In the survey study combined with work analysis techniques, Paruzel et al. (2020) found that workers, for example, expect opportunities for collaboration, new task requirements, such as problem-solving, and more autonomy. On the negative side, workers express their fear of job loss, high training effort, as well as dependence on and less freedom to decide how to execute

the tasks. Additionally, person-related variables play an important role: Paruzel et al. (2020) found that employees who report high change readiness report weaker fears, whereas technology affinity is not associated with expectations and fears.

In summary, the present Special Issue spans the spectrum from theoretical models on the role of trust in technology, from the development and design of digital assistants and companions to the introduction of these technologies with the need of involvement and participation of employees.

Conclusion

With this Special Issue on "Digitalization as the Problem of and the Solution to Vast Amounts of Data in Future Work," we hope to encourage other researchers to contribute to the exciting field of the development of jointly optimized socio-technical systems in future work systems of Industry 4.0.

Despite all the technical and service-related changes, the requirements for humane work remain unchanged. Work activities must not damage the physical and mental health of an employee, must not impair his or her well-being. Instead, work must be designed according to employees' needs, enable individual and collective participation in shaping working conditions and contents, and contribute to the promotion of personality in the sense of potential and competence development.

Work and organizational psychology can help ensure that these demands are effectively implemented using the possibilities of digitalization and based on existing empirical research. In the sense of prospective work design, socio-digital systems can be arranged in such a way that flow-experiencing and well-being are optimized (by an optimal stress ability balance), and that tiredness and stress are avoided. Through human-centered design, it can then become possible to avoid or at least reduce negatively perceived stress already during the design of socio-technical systems and to design workplaces with a high motivation and learning potential.

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