societies

MDPI

Editorial

Special Issue on Robots and the Work Environment

António B. Moniz [1,2,*] and Bettina-Johanna Krings [1]

1 Institute for Technology Assessment and Systems Analysis, Karlsruhe Institute of Technology, 76021 Karlsruhe, Germany; bettina-johanna.krings@kit.edu
2 Faculty of Sciences and Technology, University Nova Lisbon, Campus Caparica, 2829-516 Caparica, Portugal
* Correspondence: abm@fct.unl.pt or antonio.moniz@kit.edu; Tel.: +49-721-60824189

Academic Editor: Gregor Wolbring
Received: 24 October 2016; Accepted: 27 October 2016; Published: 28 October 2016

The future development of industries is currently on the agenda of public and scientific debates. Due to new technical options such as artificial intelligence and robots, sensor networks, big data, etc., which are "captured in terms such as the Internet of Things and the Internet of Robotic Things" according to van Est and Kools [1], visions like *Industry 4.0* in Germany, the *Future d'Industrie* in France, or *Made in China 2015* in China are focusing on "new" models of industries. These visions are quite promising and are putting their emphasis (at least in Germany) on a fourth technical revolution with strong effects on social and economic processes all over the world [2]. Stemming from these technical developments, some studies have prominently launched some hypotheses about a dramatic increase of job losses in the industry in the near future [3–5]. One important aspect of this debate refers to the questions about whether increasing automation and robotization lead to the replacement of labor whereas at the same time productivity growth is expected and accomplished. As the long history of industrial developments shows, "there are grounds for assuming that automation and robotization will, as a result of second-order effects, in turn leads to new jobs" [1]. The debate shows, however, that the "side effects" of robotization are complex and that they should be strongly connected with future models of organizational, social, and political models of labor in current societies. These models should be broadly negotiated in stakeholder processes involving unions, politicians, scientists, as well as economists.

However, the debate also shows that there is little knowledge about the real *and* the current effects of automation and robotization in industry and services. As described above, technical innovations are offering visible impulses with regard to new forms of automation processes. This does not seem to be something innovative in the industry. From the very beginning, the industrial sector has been automated and robotized with regard to a rationalization of work. However, it seems that these new robotization processes (should) open up a new era in industry. Therefore, we, the editors, found it extremely worthy to collect and analyze scientific knowledge and empirical evidences about *Robots and the Work Environment* in current societies.

In the call for papers we stated that industrial, service, and social robots are intended as significant "partners" or "co-workers" in human working environments, as several authors already considered in their research [6–8]. The increasing expectation to implement robots in manifold working processes is expressed not only by public debates but also by the orientation of national and international policy strategies [9–11]. Therefore, we invited theoretical and empirical papers and case studies that critically look into the areas of human-robot interaction in work environments and the impact of robots on the work environment. Within the area of human-robot interaction, we asked for the analysis of the potential impact in different work environments. We were also interested in how the application of robots is changing the character of *work* in specific fields, how it offers new developments as well as a new phase of automation, and how the anthropocentric dimension of human-machine interfaces is changing. Furthermore, we asked for the long-term perspective of organizational, social, and ethical implications. Thus, the following Special Issue on "Robots and the Work Environment" offers different perspectives on this relationship. The articles basically focus on industry, but as robotization has already become part of the societal development, it also seems important to get an idea of the social impacts that robotization already has in other sectors.

In the first article, Gregor Wolbring (University of Calgary, Canada) analyzes the relationship of employment, disabled people and robots within the academic literature and the public domain. The purpose of his study is to find out how robots are engaged with regard to the employment situation of disabled people. The empirical results of the study state that robots are rarely mentioned in relation to the employment situation of disabled people. *If* they are mentioned, the focus is on robots enhancing the employability of disabled people or helping the so called abled-bodied people working with disabled clients. The author, however, did not find any article that focused on a potential negative impact of robots on the employability of disabled people. These results should be analyzed, according to Wolbring, in more detail in further studies.

The article on "Robots, Industry 4.0 and Humans, or Why Assembly Work Is More than Routine Work" by Sabine Pfeiffer (University of Hohenheim, Germany) condenses the key findings of qualitative studies on assembly work. Conceptually grounded in some considerations of the role of experiential knowledge and living labor capacity with regard to informal expertise and tacit knowledge in industry, the empirical results challenge the dominant view of assembly work as routine tasks that could easily be replaced by robotics. The empirical basis comprised of 62 qualitative interviews in five assembly plants provides answers to two questions: Are there non-routine aspects to be found in assembly work today? What exactly is the nature of experience in assembly work? As the author concludes, further automation processes certainly aim to change the human quantities on the shop floor and the challenge will be to deal with the complexity and unpredictability of working processes. This cannot be substituted by robots in the long run, according to Pfeiffer.

Astrid Weiss and Andreas Huber (Vienna University of Technology, Austria) and Jürgen Minichberger and Markus Ikeda (PROFACTOR GmbH, Austria) developed an article on the "First Application of Robot Teaching in an Existing Industry 4.0 Environment: Does It Really Work?" In this article the authors report about three case studies on the usability and acceptance of an industrial robotic prototype in the context of human-robot cooperation. The three case studies were conducted in the framework of a two-year project named AssistMe which aimed at developing different means of interaction for programming and using collaborative robots in a user-centered manner. The results showed that close human-robot cooperation in the industrial context needs adaptive pacing mechanisms in order to avoid a change of working routines for the operators and that an off-the-shelf robotic system is still limited in terms of usability and acceptance. Intermediate layers between the user, the robot, and the work place leads to a decrease in productivity. Workers often expressed their fear of being replaced by an improved robotic system. These findings seem to be an important contribution when reflecting on the anthropocentric dimension of the human-robot cooperation, smart factories, and the upcoming Industry 4.0.

António B. Moniz (University Nova de Lisboa, Portugal & Karlsruhe Institute of Technology, Germany) and Bettina-Johanna Krings (Karlsruhe Institute of Technology, Germany) reflect about the concept of social dimensions in human-robot interaction in the industry. The article "Humans working with robots or robots working with humans" issearching for social dimensions in new human-robot interaction in industry focuses on the use of new robotic systems in manufacturing with respect to the social dimension. The hypothesis of the authors is that the application of new robotic systems in the manufacturing shop-floor level is done without the reference of "real" social implications. Due to the cognitive and perceptual workload for new robot operators in complex working systems, the 'social' is currently defined by the issues of developers with much focus on the issues of 'security' and 'qualification'. According to the authors, however, the further integration of such complex socio-technical systems needs further empirical and conceptual research reflecting "real" "social" issues. These issues should strengthen organizational and economic issues on a macro and meso level as well as the quality of work on a micro level.

Finally, Diego Compagna, Alexandra Weidemann, Manuela Marquardt, and Philipp Graf (Technische Universität Berlin, Germany) discuss "Sociological and Biological Insights on How to Prevent the Reduction in Cognitive Activity that Stems from Robots Assuming Workloads in Human-Robot Cooperation". According to the authors, the reduction of cognitive tasks brought about by new developments in the collaboration of service robots with humans in working environments has given rise to new challenges as to how to address safety issues. They reflect upon insights from biology, cognitive/neural sciences, and sociology that can conquer these new challenges. The main focus of their study lies in the development of sociological variables that ensure safe human-robot interaction in working environments rather than addressing biological ones (avoiding bodily harm) or purely cognitive ones (avoiding any signals that are outside the human's sensory comfort zones). Thus, they have developed an approach on how to integrate behavioral patterns into the robotic system in order to prevent the problem of reduced cognition in relation to essential features. That would be necessary to better understand the human-robot interaction with non-humanoid robots.

We very much would like to thank all the authors and the reviewers for their engagement in this issue. With this collection we hope to offer an important starting point for the debate about *robots and work*, specifically about the relationship between robots and the organization of work.

References

1. Van Est, R.; Kools, L. (Eds.) *Working on the Robot Society. Visions and Insights from Science Concerning the Relationship between Technology and Employment*; Rathenau Institute: The Hague, The Netherlands, 2015.
2. Hürtgen, S.; Lüthje, B.; Schumm, W.; Sproll, M. *Von Silicon Valley nach Shenzen. Globale Produktion und Arbeit in der IT-Industrie*; VS Verlag: Hamburg, Germany, 2009.
3. Brynjolfsson, E.; McAfee, A. *The Race Against the Machine: How the Digital Revolution is Accelerating Innovation, Driving Productivity and Irreversibly Transforming Employment and the Economy*; Digital Frontier Press: Lexington, KY, USA, 2011.
4. Brynjolfsson, E.; McAfee, A. *The Second Machine Age: Work, Progress and Prosperity in a Time of Brilliant Technologies*; WW Norton & Company: New York, NY, USA, 2014.
5. Frey, C.B.; Osborne, M.A. *The Future of Employment. How Susceptible are Jobs to Computerization?* Oxford Martin Publication: Oxford, UK, 2013.
6. Kim, Y.; Mutlu, B. How social distance shapes human-robot interaction. *Inter. J. Hum.-Comput. St.* **2014**, *72*, 783–795. [CrossRef]
7. Krüger, J.; Surdilovic, D. Robust control of force-coupled human-robot-interaction in assembly processes. *CIRP Ann.–Manuf. Technol.* **2008**, *57*, 41–44. [CrossRef]
8. Krüger, J.; Schreck, G.; Surdilovic, D. Dual arm robot for flexible and cooperative assembly. *CIRP Ann.–Manuf. Technol.* **2011**, *1*, 5–8. [CrossRef]
9. Ebel, K.-H. The impact of industrial robots on the world of work. *Robotics* **1987**, *3*, 65–72. [CrossRef]
10. Hägele, M.; Schaaf, W.; Helms, E. Robot assistants at manual workplaces: Effective co-operation and safety aspects. In Proceedings of the 33rd International Symposium on Robotics (ISR 2002), Stockholm, Sweden, 7–11 October 2002.
11. Krüger, J.; Lien, T.; Verl, A. Cooperation of human and machines in assembly lines. *CIRP Ann.–Manuf. Technol.* **2009**, *2*, 628–646. [CrossRef]