The Future of Work: How Technology Will Impact the Workplace and HR

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Abstract

This paper discusses how the introduction of new technology, such as artificial intelligence, virtual reality, and big data, will impact work within the tech sector and the role of HR professionals. By conducting semi-structured interviews (N=54), involving CEOs and HR directors from Dutch (high-)tech organizations, it was discovered that tech workers – within five to ten years - will be exposed to unfamiliarly high levels of complexity, uncertainty, connectivity, and interdisciplinary teamwork. Based on these future prospects, it became clear that tech workers require new competencies and smarter ways of working to become and remain futureproof. This requires HR professionals who know how state-of-the-art technology impacts tech workers’ jobs and can

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stimulate tech workers’ continuous development. This article provides HR practitioners with practical suggestions that facilitate the (re)design of processes and jobs in the tech sector and helps tech companies to futureproof their tech workers in both the short- and long-term.

**Key words:**

Fourth industrial revolution, smart manufacturing, smart industry, human resource management, the future of work, human resource development.
Introduction

The fourth industrial revolution, known as ‘Smart Manufacturing’ (Kang et al., 2016), ‘Industrie 4.0 (BRD)”, and ‘Smart Industry’ (NL), can be described as the digitization of the (high-)tech industry and focuses on the merger of three technological developments (Smart Industry, 2017). Firstly, new technologies emerged that can be used in the production process, such as 3D printing and robotics. Secondly, there is the advanced digitization of product and process information using sensor and information technology, which increasingly automates the production process management. For instance, using sensors, machines are capable of determining autonomously which action should be taken on a product at a specific stage in the production process. Third, there is the technology that integrates production equipment and human-beings in a smart way, across the boundaries of the company, e.g. machines that are capable of selecting and ordering parts at suppliers when running out of stock.

The statement that technological developments, such as automation and robotization, will affect work (see for instance Scheele, 1990), has been repeated for a few decades. However, this time, a difference regarding the content and pace of change occurs. The content of change relates to the merger of the aforementioned technological developments, combined with cheap data storage, strong analytical software and fast internet technology. This combination generates possibilities for new developments to emerge, such as: virtual reality, complex production process simulations, and autonomous production machinery.
The pace of change has to do with speed on the one hand, and the increasing penetration strength of new technologies on the other. The pace of change within the fourth industrial revolution is larger than ever before and has a broader and disruptive, rather than an incremental, character (Corporaal, Vos, Van Riemsdijk & De Vries, 2018). Not surprisingly, the discussion about the impact of the new industrial revolution on the future of work and the workforce is mostly about the question which jobs will disappear due to technology (Went, Kremer, & Knotternerus, 2015; Frey & Osborne, 2017). The question how the content of those tech jobs will change does merit much more attention than it gets right now (Ras et al., 2017 for an exception).

As recent studies show, new technologies are expected to make work more complex and require a highly-skilled workforce that is able to design, implement and use innovative technology (Usanov & Chivot, 2013). Furthermore, businesses are discovering new ways of organizing as a result of these technological developments and are adopting new business models, leading to a demand for new skills and competences too. Some (high-)tech organizations for instance already allow customers to operate their manufacturing technology over the internet, enabling same-day delivery of orders. In such fully automated systems, there is hardly any need for operator intervention. The tech workers that still work there are in permanent contact with the customer. They help him through the (digital) production process, translate customer demands into final production, understand machine planning, have an excellent grasp of the supply chain and are apt at using methods of data analysis. Goos (2013) infers that such innovative ways of organizing will
go hand in hand with developments such as self-managing teams, staff rotation, and ongoing training of competences, like co-operation and information sharing.

The aforementioned developments lead to a growing demand for a new set of skills and competences for staff, which are often described as '21st century skills', 'lifelong competences' or 'key skills' (Voogt & Roblin, 2012). These are the skills that allow staff to continue functioning in an environment that is being transformed by technological developments. They include skills such as: creativity, the ability to innovate, adapt and collaborate with other disciplines, and flexibility. Publications about 21st century skills often include abstract descriptions of the expertise, skills and competences required.

The goal of this paper is to specify how work and the required skills of tech workers will be affected by technological developments. As human resource management (HRM) plays an essential role in the optimization of both employee and organizational performance (Wright & Nishii, 2013), it is essential to formulate practical and meaningful implications for human resources (HR) professionals, for them to remain of significant value in a new industrial reality. In order to achieve the formulated goals, this article will answer the following research question: how will work in the (high-)tech sector change due to technological developments in the upcoming five to ten years and how do these changes affect the role of HR professionals?
Methodology

In order to understand and describe how technological developments will affect labour in the (high-)tech sector, a qualitative research approach was taken. 54 semi structured interviews were conducted involving Dutch (high-)tech company’s CEOs and HR directors. Twenty respondents were from large companies (>250 employees) operating in the high-tech industry (“Smart Industry”) and 34 respondents were from small and medium-sized enterprises (SMEs) in the following sectors: installation, mechatronics, construction, electronics, and IT. Companies were selected based on their factory floor technology. This selection criterium was used to generate more possibilities for practical examples during the interviews that would both determine and clarify the impact of technological developments. In total, 141 CEOs/HR directors of 141 companies were approached, resulting in an 38% response rate.

During the semi-structured interviews, respondents were asked to describe the technological developments they expect to have an impact on work in their (high-)tech company for the upcoming five to ten years. The semi structured interviews allowed the researchers to ask for clarification of the technological developments mentioned by respondents, increasing both our understanding and the validity of results. By clarifying these developments with examples, respondents were challenged to describe the impact of technological developments on work in the (high-)tech sector as precisely as possible. To make the impact more tangible, respondents were asked to describe how future work in the tech sector will differ from current jobs as well.
The interviews were transcribed verbatim. The verbatim transcripts were imported into AtlastTI and coded by two independent researchers. In order to increase the results’ validity, inter-rater reliably was realized as both researchers compared their coding structures to agree upon the final codes to use. Next, four researchers used the final codes to determine how technological developments change work. Through a group discussion, the researchers agreed upon five overarching developments that would clarify how the future work in the tech sector is being influenced by technology.

**Results**

Based on the analyzed interview data, five developments were found that show how the future of work in the tech sector is influenced by technology. These findings exceed the boundaries of the tech workers’ workplace as respondents mentioned how the tech workers’ work environment will be affected by technology too.

1. *Tech jobs will become more diverse and demanding*

The merger of smart software, big data, smart machinery, and robotics means that a tech worker’s job will become more diverse and demanding in various ways:

- Technological developments will lead, according to the respondents, to more ‘customized’ products and services and a fast-growing number of product innovations. This means that
tech workers should be more capable of rethinking their job on a daily -or even an hourly-
basis and calls for the tech workers’ ability to rapidly switch between different work
demands, deploy a variety of knowledge and skills, and cope with changing task
descriptions.

- There will be a higher need for smart collaboration between humans and technology. To
illustrate, as a result of technology traditional process operators have to collaborate with
robots and systems that become increasingly complex. This means process operators
should be capable of programming machines and configuring robots in the near future.
Somewhat farther down the line, when the complex technology can be (re)programmed by
the use of a user-friendly tablet computer, or by using augmented reality, operator job
complexity is expected to decrease. The majority of the respondents underline that they
already sense a weak trend towards complexity reduction in high tech production.

- The tech workers’ development will become more important due to the constantly-
changing technology and machinery. Especially respondents from SMEs underlined that
new technological developments will be introduced at a speed the world is as yet not
accustomed to. A large part of these respondents underlined that tech workers should keep
up to be able to use the newest technology and machinery. Furthermore, tech workers
should be better equipped to cope with unpredictable and unstructured situations.
These developments come with an important practical implication according to the respondents: approximately half of the respondents claim that tech jobs require employees with a higher formal educational level. In contrast, the other half of the organizations state that more intense, long-term, and company-specific educational programs and workplace learning should prepare tech workers for future job demands.

2. *Work environments and team compositions will face radical change*

Technological developments lead to faster and more radical change of the tech workers’ work environment: they should become capable of working together in changing teams consisting of colleagues, customers, and suppliers. The respondents provide two reasons why this trend occurs. First, processes within the value chain will be more integrated due to advanced technology and smart machines. This integration increasingly connects companies with each other and facilitates an intense collaboration between them. Second, the respondents expect that there will be more short-cycled projects due to the technological developments. There will be – according to them – an increasing demand for Just-In-Time customization, which requires employees to work in multidisciplinary project teams. These project teams will cross the boundaries of departments and even companies more often: people collaborate for instance in global or virtual teams of suppliers and customers to design customized products.
3. Work will become increasingly automated and robotized

The robotization and automation of the factory floor is happening already and is expected to take over an increasing number of routine tasks. Where larger organizations describe this as the current industrial reality, slightly less than half of the SME respondents expect this to happen in the near future. "Previously, there was someone who placed the product in the machine and pushed the button. That is vanishing more often. We could, like now, install a robot arm, but our series are not big enough for that just yet". Furthermore, respondents from the SMEs describe that automation and digitalization will be reinforced by the demands and expectations of suppliers and business-to-business clients. Respondents from both SMEs and larger organizations see another development: due to the advanced software, machines and systems within the production process will be better connected with each other and adjust themselves to each other. Many respondents, especially from larger organizations, underline that automation and robotization requires tech workers that are capable of interpreting (large amounts of) data, analyzing data, and using data to optimize processes and products/services.

4. Work in production, assembly and maintenance will be supported by augmented and virtual reality systems

Virtual and augmented reality systems and cloud-techniques will generate opportunities to execute work activities at a distance, such as maintenance and even assembly executed by the
customers themselves through augmented reality work instructions. Furthermore, step by step education of tech workers or providing guidance during advanced work activities becomes possible with these systems. “I am coming from a company that operates globally. We can solve issues from a distance (...) by guiding the customer in what he should do, based on what you see on your screen”. Finally, respondents – especially from larger organizations – underlined that virtual reality makes it possible to simulate process designs (digital twinning) and, based on the analysis of the simulations, generate opportunities for radical process optimizations, at a fraction of the costs involved in building a real production line.

5. **New product-market combinations drive worker adaptability and job uncertainty**

Technological developments lead to different product-market combinations, business models, and different ways of organizing, according to the larger companies. One respondent describes for instance a new factory where customers can login on the machines, operate these machines, and receive their customized product the same day. In that process, operator influence is minimized and new questions regarding production planning, data-security, and supply chain management arise. Many CEOs, from both SMEs and larger organizations, stress that the increasing technological pressure forces an organization’s adaptability. This implies that tech workers should be better capable of functioning in teams that can react rapidly and increasingly autonomous to market developments. Finally, mainly respondents from larger organizations mentioned that the
technological developments generate opportunities for the establishment of new business models. Especially the turnaround from traditional production towards service provision (so called servitization) was mentioned, which is being sparked by leveraging large amounts of (machine) data in a smart way.

Conclusions

With this research, a step towards the clarification of the (upcoming) changes in tech labour – caused by an accelerating sequence of technological developments – was taken. The (high-)tech organizations prepare for technological developments that will rapidly and fundamentally change tech labour in the new industrial reality. These organizations describe: (1) Tech jobs will become more diverse and demanding; (2) Work environments and team compositions will face radical change; (3) Work will become increasingly automated and robotized; (4) Work in production, assembly and maintenance will be supported by augmented and virtual reality systems; and (5) new product-market combinations drive worker adaptability and job uncertainty. This study reveals how the discovered technological developments are not exclusively important to larger organizations. In the eyes of the SME respondents under study, it is certain that these technological developments will drastically change their tech jobs as well. The remaining question is not if but when these fundamental changes will occur.
This research confirms findings from previous studies which clarify how labour in the (high-)tech sector is being characterised by three main dimensions, as described by Levy and Murmane (2005): (1) solving unstructured problems; (2) working with new information; and (3) carrying out non-routine manual tasks. This research adds an important fourth and fifth dimension: (4) being able to function in changing and unpredictable work environments or projects; and (5) being able to complement or collaborate with developing technology, such as augmented reality, advanced machinery and (collaborative) robots. Tech labour will become – due to the impact of the five discovered technological developments – very complex and forces tech employees to develop themselves constantly.

Insights in the impact that technological developments have on tech work – as described by the respondents under study – are revolutionary when compared to the ongoing discussion about the impact of automation on work (Scheele, 1999). According to the respondents, this is because technologies such as smart machines, big data, and sensor technology, have been developed to an extent where they become useful and affordable for both larger companies and SMEs. Once one company takes the first step, the consequences for those lagging behind are such that a ‘winner takes all’ market tends to arise. Furthermore, the technologies are merging into new business concepts, such as ‘smart factories’, and advanced (software) systems that exceed the boundaries of individual organizations.
Finally, the findings show how technological developments that are being combined with IT-related developments, become cheaper, smarter, and wider applicable. These powerful technologies start to increasingly penetrate the daily reality of tech companies, leading, according to respondents, to adjustments in: (production) processes, ways of organizing, and business models, that will rapidly and fundamentally change the tech workers’ job and work environment.

However, not only the tech workers’ future of work is being affected by technology. For HR practitioners, the consequences of the aforementioned developments are challenging too:

**From Human Resource Management to Organizational Design Expertise**

First, it is important that HR professionals help design jobs that continuously challenge employees to learn. Tech workers should keep up with the technological developments’ pace and learn to cope with new technologies. However, tech workers do not always have time available (nor the desire) for formal training, are not continuously challenged by their employers to learn, and do not always see the necessity to keep on learning (Corporaal et al., 2015). In other words, these tech workers are currently not being prepared for, but rather confronted with, new technology. Therefore, the HR professional should determine what technological developments will affect work in their companies and how it will impact jobs. Based on these predictions, they could define the required knowledge and skills. Once determined, the HR professional could, together with the (line) managers, help adjust production processes and the content of jobs, in order to – step-by-
step – challenge the tech workers to prepare themselves for what lies ahead. This requires HR professionals’ who can focus on the organization (primary process and job-design) side of the profession suggesting a turnaround from the classical ‘human resource management’ approach to some extent. Much of the current HR job is still rather instrumentally focussed on rules and regulations (the administrative expert) or at establishing employee satisfaction and preventing health issues (employee champion) (Ulrich et al., 2012). We suggest the profession moves more quickly towards expertise in effectuating permanent learning and development through smart work (re)design. In other words, designing production processes and jobs in which tech workers are challenged to learn and develop themselves, should be the number one priority for HR professionals in the (high-)tech sector. Not only will such HR professionals contribute to the competency development of employees, but their tech company will become increasingly attractive for the current and future workforce as well. This is relevant because not only is technical staff increasingly scarce, but tech workers also underline that their current jobs do not invite them to learn and that they experience insufficient room for experimentation and innovation (TechYourFuture, 2016).

The HR Professional as Human Resource Developer

Next to designing better and more stimulating jobs HR professionals should design innovative, multidisciplinary development programs. They have to think beyond the traditional, formal
training programs as prior research reveals that soft-skill training by external trainers, as well as traditional personal development plans, can deter tech workers from engaging in personal development activities (TechYourFuture, 2016). What tech workers need from their employer is: plenty of room to experiment; someone who challenges them to actively work together (on the factory floor); and a manager who guides them and offers flexibility at the right moment. Such a development program incorporating (line) management could contain the following aspects:

- Group sessions, including members from both inside and outside the team, where the technical state-of-the-art is being discussed and tech workers are challenged through assignments to increase their ‘soft skills’, such as: working together with other disciplines, providing and receiving feedback to/from colleagues;

- Executing and evaluating innovative assignments that are related to the tech worker’s job.

This means that tech workers will work on small product or process innovation assignments. During these assignments, tech workers will learn – under supervision – how to design an innovation and how to cope with constraints coming from the organization or colleagues. This aspect is crucial as tech workers state: “everyone underlines that employees should become more innovative and creative, but employees need concrete tools for that”. (TechYourFuture, 2016).

- Sessions with suppliers and representatives from the tech industry on future tools, machines, processes and systems, in combination with assignments regarding the translation of these
developments to implications for the tech worker’s current job and the organization of his work. By working together on these assignments, tech workers will learn how organizational knowledge and skills are related to personal expertise and how they can prepare for the new technology and its consequences.

**Building Bridges: learning communities and skills labs**

Last, but not least, it is important that HR professionals participate in regional collaboration between organizations to stimulate development of tech workers. Not every organization has sufficient expertise or resources to realize the aforementioned practical implications. Because of this constraint, in the Netherlands, various educational institutes, government agencies, and (larger) companies are collaborating in so-called ‘field labs’, ‘learning communities’, and ‘skills labs’. Within these initiatives practical learning environments are built. Companies contribute by inserting state-of-the-art knowledge and technologies (equipment) that are used in practice. There is government funding and education helps build curricula that are didactically sound and suit workers. These learning environments generate opportunities for businesses, students, and educational institutes to – in close collaboration – futureproof the tech worker. In order to create a learning environment that challenges the current tech worker, it is important that the learning environment: (1) is initiated by a group of companies; (2) captures the current state-of-the-art and vision and follow long-term developments; (3) can be used Just-In-Time and in-company by
participating companies; (4) has short-term modules; (5) can be tailored to specific target groups; (6) uses tools, such as simulations, technology, or other equipment, that make it lifelike and recognizable (real) for people working in such organizations. Currently, such learning environments are being established (in the Netherlands) and are still in their infancy. Nevertheless, these environments offer HR professionals and organizations a unique opportunity to bundle their strengths and learn from each other’s best practices, which could lead to powerful learning environments that – because of the close collaboration with educational institutions – hopefully contribute to the recruitment and education of enough new tech workers.

References


