Les Cahiers du Digital

#2

Industry 4.0: the 4th Industrial Revolution

Volume 2 – Organizational and Societal Challenges

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The aim of the *Les Cahiers du Digital* collection is to enrich the teaching provided at HEC Liège, thanks to the contribution of experts who possess proven field knowledge on key topics related to digital transformation.

The handbooks are written in a clear and accessible style, in order to allow our students to correctly grasp the major challenges of digital transformation and to arouse their curiosity, so that they wish to explore the topic further, including through their theses.

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Following on from the first *Cahier du Digital* dedicated to the technological and economic challenges of Industry 4.0, this second volume on its human and organisational challenges will analyse the geopolitical dimension of digital transparency and continuity within the production sectors.

We will also examine here the both promising and dreaded impacts of Industry 4.0 on employment, work and its organization, as well as the new fields of competence.

This volume will end with a warning against the techno-determinism that too often underpins work on Industry 4.0, and an emphasis on the importance of steering a transformation that is being built in real time, in the very moment in which we are experiencing it.

Beyond Factories: the Political Challenges of Industry 4.0

CHAPTER 1

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Chapter 1 - Beyond Factories: the Political Challenges of Industry 4.0

When the technological building blocks of the Industrial Internet of Things and artificial intelligence are combined, a digital continuum emerges, with strong economic and political stakes. These stakes have 3 levels:

- the cybersecurity related to digital systems,
- the redistribution of power along value chains in a context of increasing transparency on production activities
- the maintenance of a sovereignty understood as the ability to preserve the autonomy of economic and political decision making in the face of the dependence created by the solutions proposed by digital players.

Cybersecurity, a Diriment Requirement for Industry 4.0

The multiplication of communicating elements, flows, interfaces and the increasing control exercised on production via data transiting outside the company raise the question of the security of communications and computer systems.

The multiple dangers do not only come from isolated hackers or criminals, but also from teams acting under the control of States that seek to destabilize certain companies, certain industries or to steal industrial secrets.

Security needs involve confidentiality (data theft), availability (malicious takeover of all or part of the company's control systems, equipment shutdown, data loss) as well as equipment integrity (equipment degradation).

However, the protection of interconnected equipment poses new problems. First, the increasing convergence between industrial and traditional IT multiplies the number of entry points and sources of threats. Supervisory control and data acquisition (SCADA) systems are rarely sufficiently updated, even if such updates would be possible given the age of certain equipment. And industry protocols have often been defined without considering security.

Secondly, the culture of cybersecurity risks is still very rudimentary and many manufacturers are not aware of the threats. They feel protected until the day the first attack occurs.

Finally, industrial organizations where the "office" and the "workshop" remain separate experience a dilution of responsibility that is detrimental to the treatment of the cybersecurity issue: is it the responsibility of production or of the IT department?

Hence the importance of encouraging awareness and supporting industrial companies in an approach that allows them to understand the IT risk and to learn new things[1].

One answer to this cybersecurity challenge is to develop secure interoperability languages for industry. This is one of the objectives of the OPC Foundation, which is developing OPC-UA (Open Platform Communications Unified Automation), a secure interoperable language dedicated to

[1] On these subjects, see the websites of the Agence Nationale pour la Sécurité des Systèmes Informatiques (ANSSI) and the Bundesamt für Sicherheit in der Informationstechnik (BSI).

industrial connected objects. OPC-UA is independent from the data management infrastructures it uses and benefits from a service-oriented architecture[2].

Digital Industry and the Redistribution of Power within Sectors

To be deployed, digital requires software, computing power and storage power. The generalization of digital is leading to a concentration of information systems in companies, with an increasingly strong interweaving of product conception and production line conception, encouraged by the use of integrated software suites. This trend considerably strengthens the power of software publishers. Manufacturers are already grumbling about the costs of licensing and upgrading their software tools. But what will happen in the future when they have a single partner whose products will largely guarantee their real time operational efficiency?

As far as computing and storage power are concerned, this question of industrial digital technology is taking on a geostrategic dimension with the irruption of American and then Chinese Internet companies into the industrial game. These giants have considerable resources at their disposal, with the market capitalization of firms such as Apple or Google seven to ten times greater than that of the largest German industrial groups: $774 billion for Alphabet (Google), $920 billion for Apple, compared to nearly $78 billion for Volkswagen[3].

> The Microsoft Azure and Amazon Web Services booths at the Hannover Messe are expanding year after year and rivaling the Siemens booth in size.

A giant like Amazon, a major player in logistics, is also one of the main stakeholders in the cloud, along with Microsoft. The migration of all industrial IT applications to outsourced platforms that offer not only enormous storage power but also the computing power required for industrial operations has begun. The Microsoft Azure and Amazon Web Services booths at the Hannover Messe are expanding year after year and rivaling the Siemens booth in size.

This evolution towards the cloud allows significant gains for companies, freeing them from the costly management of IT teams and infrastructures. But at the same time, it makes them dependent on huge service providers with whom their bargaining power will be greatly reduced. The States have obtained from the national telephone operators facilitated change processes for private customers. But will they be able to impose easier migration from one provider to another for industrial companies when faced with multinational digital giants?

In short, what room for maneuver will SMEs or mid-sized companies and perhaps tomorrow large groups have in the face of stakeholders who will hold the keys to customer relations via the capture of usage data, product and goods flows, via their logistics infrastructure and production data, via their cloud platforms[4]?

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2 A service-oriented architecture (SOA) refers here to the notion of service in its IT sense, i.e. an autonomous set of software functionalities. This type of architecture allows the interoperability of OPC-UA once it is deployed on different systems.

3 Data as of July 9, 2019.

4 Extract from the article written by Dorothée Kohler & Jean-Daniel Weisz, « Le numérique industriel, enjeu géopolitique: le cas de l'Allemagne », *Hérodote* 2019/4 (N° 175), pp. 215-224.

The Challenge of Digital Sovereignty

In the capital goods industry, machine manufacturers typically earn margins of 25% on services and spare parts, while their machines are sold with margins of less than 15%. In other words, the sale of machines alone is no longer sufficient to finance their development and investments. However, the threat is real if their spare parts are put on sale on e-commerce sites capturing a share of the margin, if their maintenance contracts are “uberized” by ingenious start-ups and if the IT services linked to their machines are captured by industrial service platform operators.

In this area, the Americans are savoring their victory. At the Siemens-Mindsphere booth at the Hannover Messe in April 2018, SAP disappeared from the core partners, giving way to Amazon Web Services. Amazon, known for its packages and warehouses, generates more than €20 billion in revenue from a completely different business: IT infrastructure. Amazon sells data storage and computing power. The battle for platform infrastructure has been won by the Americans. German (SAP, Telekom) and even European players do not yet have the capacity to offer services of the same quality in terms of scalability. Perhaps one day we will see a Chinese competitor to Amazon and Microsoft emerge. We would like to believe in Europe’s ability to create a giant of the cloud.

Europe is facing a formidable digital sovereignty problematic. Even if these players ensure that the data of European customers remain stored in centers located in Europe, there is no guarantee that the authorities of their country of origin will respect confidentiality. The US has become a master of extraterritorial law, and the controversy over the banning of Chinese Huawei’s components in 5G telecommunication terminals underlines the extent of the threat.

How Will Industry 4.0 Impact Work and Employment?

CHAPTER 2

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Chapter 2 - How Will Industry 4.0 Impact Work and Employment?

> *The technology in itself is neither good nor bad. It is the use which human beings make of any technology which determines both the nature and extent of the benefits.*
>
> Christopher Freeman

The other major political challenge posed by Industry 4.0 is to support changes in work and jobs. Each industrial revolution has resulted in a transformation of organizations, production and management methods, and vast job transfers between professions and sectors.

What can we anticipate today with Industry 4.0?

In the debate on the expected impacts of Industry 4.0, we find the same fear as for automation: that of a massive loss of jobs resulting from the replacement of humans by machines. With artificial intelligence[5], the scope of these tasks extends to functions that were previously preserved. Industry 4.0 also raises fears of increasing polarization. On the one hand, employees who master industrial IT and have a critical approach to algorithms and proposed solutions. On the other hand, those who, for lack of appropriate learning and consideration of the impact of AI on the company's business model, skills and work organization, risk being excluded from this industrial revolution.

Towards the End of Routine Tasks in Offices and Workshops?

Frey and Osborne's 2013 study on the impact of digitization on the U.S. job market had a resounding impact in Europe and quickly focused attention on the social risk of digitization[6]. It first concluded that 47% of American jobs were likely to experience a strong impact due to digitalization. It also showed that the most affected activities were to be found less in the production sphere than in administrative services and sales functions.

Make no mistake: the eviction of routine work is as much about blue collar workers as it is about white collar workers. As Jerry Kapplan points out in his book *Humans Need Not Apply*: "Automation is now blind to the color of your collar[7]."

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5 In her article entitled "*Répercussions juridiques de la robotique et de l'intelligence artificielle sur le lieu de travail*" (Legal Implications of Robotics and Artificial Intelligence in the Workplace), Isabelle Wildhaber reminds us that AI is a field of computer science devoted to the creation of computers and systems that perform operations analogous to human learning and decision-making. The "Association for the Advancement of Artificial Intelligence" describes AI as "the scientific understanding of the mechanims underlying thought and intelligent behavior and their embodiment in machines". John MCCarthy, *Basis questions, What is Artificial Intelligence?*, Stanford University, 12.11.2007.

6 Dorothée Kohler, Jean-Daniel Weisz, *Industrie 4.0 – Les défis de la transformation numérique du modèle industriel allemand*, Paris, La Documentation française, 2016, p. 55.

7 Luc Soete, "Destructive creation: explaining the productivity paradox in the digital age" in Max Neufeind, Jacqueline O'Reilly, Florian Ranft (dir.), *Work in the digital age, Challenges of the fourth industrial revolution*, Policy Network, 2018, p. 26.

An analysis by Georgios Petropoulos[8] estimates that jobs that require manual routines and cognitive skills are the most at-risk jobs especially in industries like automotive, where automation and the introduction of AI are changing the mapping of skill profiles[9].

Other studies have calculated a net effect of digitization on employment[10] with very variable results. These first studies had the virtue of provoking a major mobilization of actors in the political, economic, social, trade union and social science spheres, particularly in Germany, with key questions: What jobs will emerge in the next 10 years? What are the skills to be developed? Which work organization will be the most appropriate for these new production modes? What are the risks of labor shortages?

In order to reassure the anxious or to provoke awareness, the German Institute for Employment Research[11] has developed a website: “Job Futuromat” which allows you to know if your job will still exist tomorrow and welcomes you with the question: “will digital technologies change your job? “. After entering your job title, you get a real-time answer on the routine tasks that could be automated tomorrow and the benefits you could get from it. The site also indicates the number of people working in your profession, the number of job openings since 2012 and the evolution of the unemployment rate, specifying the trend for these three indicators. The site includes videos meant to help you develop a critical view of automation.

This type of communication runs counter to the work that conflates jobs, work and occupation. A job is not automatable in itself; only a task is automatable. The ZEW’s studies[12] distinguish between analytical and interactive content for each type of work, the latter being difficult to automate. This type of approach means that the impact of digitization on the evolution of jobs and on the forward-looking management of jobs can be addressed in a much more precise way in a company.

> A job is not automatable in itself; only a task is automatable.

8 Georgios Petropoulos, “The impact of artificial intelligence on employment”, in Max Neufeind, Jacqueline O’Reilly, Florian Ranft, *Ibid.*

9 Erik Brynjolfsson, Andrew Mcafee, *The Second Machine Age* – Work, Progress, and Prosperity in a Time of Brilliant Technologies, New York, W. W. Norton & Company, 2014.

10 IAB, „Industrie 4.0 und die Folgen für Arbeitsmarkt und Wirtschaft“, *IAB Forschungsbericht*, August 2015, 68 p.

11 Institut für Arbeitsmarkt und Berufsforschung (IAB).

12 ZEW, „Übertragung der Studie von Frey/Osborne (2013) auf Deutschland“, *Bericht an das Bundesministerium für Arbeit und Soziales*, 2015, 50 p.

Fig. 1 – Job Futuromat

Source: www.job-futuromat.iab.de.

The “routine” approach can also be a trap. The work of Sabine Pfeiffer, professor of sociology at the University of Erlangen-Nuremberg, shows that tasks described as routines can require a lot of experience and know-how, and that their value remains poorly known. This observation leads her, as we point out in our book on Industry 4.0, to propose an alternative evaluation using an index of work ability[13] (*Arbeitsvermögen-Index*) that takes into account the ability to handle complex situations, uncertainty and to mobilize one’s experience.

The analysis of these works shows that it is advisable to avoid a “techno-optimistic” approach, which would quickly lead to the conclusion of the reality of a “fully automated” utopia.

Have the technological innovations of the last twenty years led to the expected productivity increases? Confirming that Industry 4.0 has significantly increased productivity can be a difficult task. Robert Gordon points out that our model is at the limit of its capacity with respect to the hoped-for productivity leaps. He calls for caution against “techno-optimists” and their “tunnel effect” approach, which does not take into account the critical situation of the health and education sectors, the very low social mobility and the inflation of the cost of pensions[14].

Industry 4.0: the Opportunity of a New Field of Competence

Industry 4.0 can be understood as an “extended automation” of the workspace that leads to the elimination of work positions. It is also seen by the German trade union IG Metall as an opportunity to develop new skills.

Bringing together all the elements involved in production must be based on the ability to understand, design, implement, support and manage this new system and the multitude of interactions. Having

13 Pfeiffer Sabine, Suphan Anne, *Der Mensch kann Industrie 4.0 – Kurzfassung. Der AV-Inde. Lebendiges Arbeitsvermögen und Erfahrung als Ressourcen auf dem Weg zu Industrie 4.0*, Working Paper n°1 (draft v.1.0 vom 13.04.2015), Universität Hohenhein, Fg. Soziologie.

14 Robert J. Gordon, *The Demise of U.S. Economic Growth: Restatement, Rebuttal, and Reflections*, NBER Working Paper n°19895, 2014.

a global vision of the production process is generally the privilege of the production manager. With digital continuity, this ability moves down to the workshop.

The implementation of the production program, its optimization as well as the resolution of problems also call for new skills that require a mastery of both the relationships within the physical world and a solid understanding of the digital world, which can no longer be the exclusive responsibility of the information systems department. For example, the production technologist training program introduced in 2008 is meant to give industrial mechanical technicians solid competence in the production process[15].

This three-year interdisciplinary program aims to train employees at the frontier between engineering sciences, information technology and organization to set up production processes in the company. The spectrum of this new profession, which emerged in 2008-2009, goes beyond the skills of a mechanic, mechatronics engineer or electronics engineer (see Figure 2).

The production technologist is not a computer scientist, but a specialist who makes the link between product and process development and their implementation in the factory. He is above all a process person whose scope is much wider than that of a mechatronics technician[16].

Fig. 2 – Initial and Ongoing Training Courses in the Context of Idustry 4.0

Functions	Details
Production Technology Process Manager	• **Scope: from development to production** • Process management for production • Management of complex projects
↑ Access through continuing education	
Application expert	• **Scope: between development and customer** • Focus on customer dedicated applications and process optimization
Process expert	• **Scope: between development and production** • Focus on missions related to technical processes
↑ Access through continuing education	
Production technologist	• **Scope: workflow between production and development** • Mission to reduce time to market • Participation in process development • Experimentation of production processes • Support for production start-up • Guarantee of quality standards and process robustness • Optimisation and improvement of processes • Securing data related to products, processes and projects
Qualified worker	• Production, control, monitoring and maintenance tasks
↑ Access through initial training	

Source: Dorothée Kohler, Jean-Daniel Weisz, Industrie 4.0. Les défis de la transformation numérique du modèle industriel allemand, op.cit., p. 81. Figure based on Karlheinz Müller, Aus-und Weiterbildungskonzepte für Industrie 4.0, VDMA Veranstaltung, July 25, 2013.

15 Dorothée Kohler, Jean-Daniel Weisz, « Industrie 4.0, une révolution industrielle et sociétale », *Futuribles* n° 424, May-June 2018, pp.62-63.

16 Dorothée Kohler, Jean-Daniel Weisz, *Industrie 4.0 – Les défis de la transformation numérique du modèle industriel allemand*, *op.cit.*, p. 79.

This polycompetence between the physical and digital worlds is coupled with the necessary development of relational skills. The 4.0 worker must be able to interact with all of the company's lines of business, understand their challenges and constraints, and know how to work collectively to achieve continuous improvement and problem solving. The training programs for the production technologist curriculum take into account this relational dimension. The collaborative dimension with stakeholders (technicians, engineers, suppliers, service providers, customers, etc.) is particularly emphasized. This program allows students to become specialists and then managers of "production technology processes" (*Prozessmanager/in Produktionstechnologie*) within the framework of continuing education.

> In this world 4.0, it is less a question of the color of the expert's belt than of his or her ability to think outside the box, to be open to other industrial

Finally, the qualities of creativity, open-mindedness and curiosity are also highlighted. In this world 4.0, it is less a question of the color of the expert's belt than of his or her ability to think outside the box, to be open to other industrial contexts. They are not so much asked to apply proven recipes in model sectors such as the automotive or aeronautical industries as to seize opportunities by going out and finding new ideas in sectors that are sometimes remote.

The introduction of 4.0 technologies in the workshop is, for example, an opportunity to upgrade the skills of operators or journeymen who can enhance their skills as part makers. At the Bosch factory in Mondeville, Normandy, an employee has developed a 3D printing activity. Initially focused on supporting production by manufacturing spare parts for certain machines, it has become a full-fledged activity, with the site offering other companies an introduction to additive manufacturing, including training and the provision of a machine.

The evolution of sought-after skills also appears in the ranking of the top 10 expected skills published by the World Economic Forum. Critical thinking and above all creativity are in the top 3 places in 2020 (see figure 3).

Fig. 3 – Top 10 Skills

in 2020	in 2015
1. Complex Problem Solving	1. Complex Problem Solving
2. Critical Thinking	2. Coordinating with Others
3. Creativity	3. People Management
4. People Management	4. Critical Thinking
5. Coordinating with Others	5. Negotiation
6. Emotional Intelligence	6. Quality Control
7. Judgment and Decision Making	7. Service Orientation
8. Service Orientation	8. Judgment and Decision Making
9. Negotiation	9. Active Listening
10. Cognitive Flexibility	10. Creativity

Source: World Economic Forum, Future of Jobs Report 2016.

As some slogans claim, Industry 4.0 can, in this vision, appear as an opportunity to put “the human being at the center” by mobilizing higher value skills. But what is the other side of the coin?

Physical and Data Protection at the Core of the Interactions with Robots

In a number of Industry 4.0 approaches subsidized by public authorities, the first act encouraged is the purchase of a new generation robot. Equipped with sensors, light in weight (7 to 14 kg), sensitive with an AI system that does not require programming and costing less than 22 K€. Hand-guided, the robot learns the task by reproducing the operator’s manual gestures. The new generation of collaborative robots, also called cobots, promotes a new concept of work in the factory and at the workstation.

Robots have come out of their cage to assist the operator. Beyond the technological prowess, this robotic evolution poses new requirements for the prevention of occupational safety, as Isabelle Wildhaber[17], doctor of law, lawyer and professor at the University of St. Gallen, points out.

Robots can contribute to the safety of a work environment if it is necessary to intervene in dangerous areas by detecting the risks in advance. The use of exoskeletons can facilitate the transport of heavy loads and avoid the multiplication of musculoskeletal disorders. Isabelle Wildhaber cites the example

17 Wildhaber Isabelle, « Répercussions juridiques de la robotique et de l’intelligence artificielle sur le lieu de travail », in Jean-Philippe Dunand, Pascal Mahon, Aurélien Witzig (dir.), *La Révolution 4.0 au travail*, CERT, Schulthess Editions Romandes, 2019, p.223 and following.

of the industrial exoskeleton from Esko Bionics or the Swiss company Colas, designed for use on construction sites. Reducing health risks is a facet of the subject that is most frequently put forward.

The other facet, which concerns the risks linked to the multiplication of these interactions between workers and robots, is generally scarcely addressed, even if this new context requires the development of new safety standards. Isabelle Wildhaber alerts us to certain issues: Exoskeletons can cause injuries when they are poorly adapted to the body, when they are improperly implemented or when the worker overestimates his or her physical abilities. These new work environments mean learning a new legal risk assessment for workplace safety for the robot manufacturer and the employers who use them.

In addition to the issue of physical protection of workers, there is also the issue of data protection. With augmented reality glasses attached to the head, the operators receive a signal, click on a virtual screen and start the next production step. They supervise and execute. The different sensors inform them of the order of the tasks to be carried out, tell them in which bin to pick a particular part and allow them to follow the productivity indicators.

This type of tool, which combines AI, video and recording, can be seen as a digital assistance that allows the user to perform their job with the guarantee of total reliability and productivity monitored in real time. By networking all the machines on an Industry 4.0 production line, the company's hierarchy can thus know the status of the parts being manufactured at any time and has very detailed data on the individual performance of employees.

“This “assisted execution” raises the question of constant surveillance of the operator, who becomes “as transparent as a glass”.”

From the employee's point of view, this “assisted execution” raises the question of constant surveillance of the operator, who becomes as “transparent as a glass” (*gläserner Mitarbeiter*), to use the expression adopted by the German trade unions. They are concerned about the new forms of behavioral control and increased pressure on performance that new technologies allow. At Amazon, portable GPS computers sound the alarm when a worker takes a break outside the scheduled break times[18].

At the 2015 Hannover Fair, Professor Sabine Pfeiffer, a sociologist at the University of Hogenheim, showed a film made by the Institute for Machine Tools and Industrial Management (*Institut für Werkzeugmaschinen und Betriebswissenschaften - IWB*) at the Technical University of Munich about the factory of the future. In this factory, the pulse of older employees is measured and recorded. If it exceeds a critical threshold, a replacement operator is automatically called in to assist the employee, or the system prompts the employee to switch to less stressful tasks. While Henning Kagermann, one of the fathers of Industry 4.0 in Germany, sees this innovation as useful, (“we want to make sure that employees work in the place that is most appropriate for them!“), Constanze Kurz, a member of the Vorstand of IG Metall disputes this intrusive form of surveillance.

In a 2009 report on IoT and RFID technologies published by the Hans-Böckler Foundation, it is recommended that works councils (*Betriebsrat*) be mobilized within companies of the same industry and along the entire value chain for the protection of operators and their production data.

18 Dorothée Kohler, Jean-Daniel Weisz, *op. cit.,* p. 76.

Finally, a last risk concerns the possible delegitimization of middle management. Operators promoted to manufacturing “line managers” in some companies modify the logic of power. Intermediate levels with less technical skills may find themselves marginalized. This transformation process is sometimes difficult to implement when it involves a shift in power towards the field. This shift is all the more difficult when, in the past, this intermediate level was essentially built on supervisory tasks focused on writing and respecting processes and procedures dedicated to certifications. The technical legitimacy of middle management can be overtaken by the digital appetite of lower levels and new generations.

Towards New Workplaces, New Organizations, and a Management Reset

CHAPTER 3

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Chapter 3 - Towards New Workplaces, New Organizations, and a Management Reset

In his book *The End of Work*, Jeremy Rifkin warned us in 1995 of the destruction of work by technology and recommended massive investment in social economy. The Covid-19 crisis has catapulted our fears onto another ground and changed their focus. The impact of Industry 4.0 on labor has shifted from specter to hope: how can we automate the production tool faster so we don't have to rely on fallible humans or lines that are deported to Asia or India? The size of our factories and the related workforce appear more and more out of sync in a world where, to escape health risks, states can decide to freeze the economy overnight. It is likely that a new industrial landscape will emerge that is less space consuming, more sober and mobile. The emergence of mini-factories, the miniaturization of machines, the domination of platforms, the increased possibilities of home office work with the Covid-19 crisis, question the new forms of places and work and, by extension, management.

The Emergence of New Production Sites: Container Factories

The emergence of the Internet of Things in the industrial world is considerably changing the organization of production processes inside and outside the factory. The new digital technologies associated with those of three-dimensional printing (3D) allow for a different configuration of manufacturing circuits, and interactions between customer demand, design and manufacturing. Real-time manufacturing is becoming one of the components of customer experience. It is both a link in the value chain and an element of competitiveness. It is a structuring parameter of new business models.

The integration of design and manufacturing functions within a container would allow certain types of manufacturing to be relocated closer to demand. The 2010-2020 decade has seen the blossoming of container-sized factory prototypes and projects, from Adidas' *Speedfactory*, which produces customized sports shoes, to Nokia's *Factory in a Box*, which enables the assembly of cell phones

Adidas' *Speedfactory* project[19], launched in Ansbach, near Nuremberg (Bavaria), Germany, with support from the *Autonomik 4.0* program of the Federal Ministry of Economics and Energy, brought together a project team from Adidas, Johnson Controls, an automotive supplier, KSL Keilmann, an expert in the manufacture of robotic chains, and two research institutes, one specializing in textile technology and the other in technology transfer. This miniature and experimental factory has the capacity to manufacture the smallest series up to single items of sporting goods. It combines various technological innovations: digital, robotics, 3D printing, welding techniques..., to produce in real time personalized sports shoes and respond to the demands of fast-fashion as quickly as possible.

19 Dorothée Kohler, Jean-Daniel Weisz, *op.cit.*, p. 48.

Fig. 4 – Adidas' Speedfactory

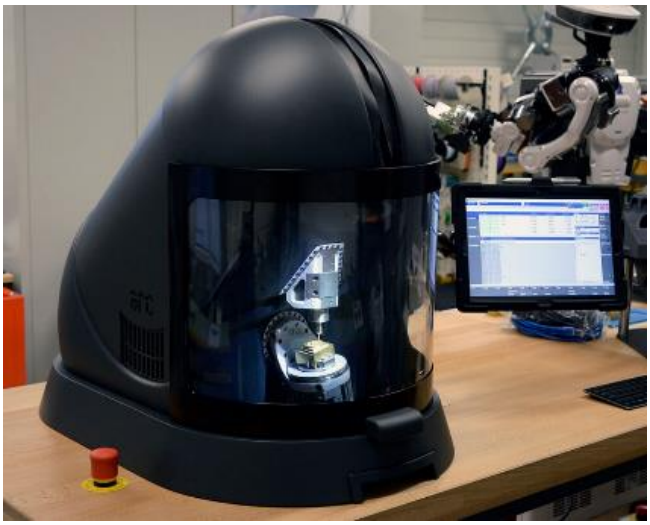
Source: Adidas.

Machine Miniaturization and the Temptation of a Return to a Putting-Out System?

The example of the Adidas *Speedfactory* mentioned above illustrates how the miniaturization of a production site, possibly integrated with sales sites, will reshuffle the cards in terms of the location of industrial jobs and possibly the emblematic figure of the factory, as a place of centralization of means and resources. Beyond the factory's capacity to adapt (to become "scalable"), it is the change in the size of production tools that leads to a rethinking of the geography of jobs and the capitalistic form of the company.

Projects are also underway to reduce the size of production equipment, such as the Micro5 5-axis machining unit developed by the Haute Ecole Arc Ingénierie in Neuchâtel. Dedicated to the watchmaking industry and designed to machine watch cases, it looks like a large Nespresso machine, takes up five times less space and consumes 10 times less energy than conventional machines (25-30 kWh compared to 400 kWh).

Fig. 5 – The Micro5 Machine



Source: Haute Ecole Arc Ingénierie de Neuchâtel.

Beyond the technological prowess, this innovation questions the future of the traditional work organization. For small and medium-sized parts, the justification for centralizing the work force around machines in the factory is put into perspective. Can't the implementation of decentralized workshops, linked by a logistic infrastructure, be an answer to the problems of mobility and adaptation of working time?

Fig. 6 – The Putting-Out System

Source: https://webs.bcp.org/sites/vcleary/modernworldhistorytextbook/industrialrevolution/preindus.html.

The emergence of third-party production sites where the manufacturer's machine is stored in a remote workshop or in a part of the housing, suggests a return to the proto-industrial organization of the putting-out system[20] where workers produced at home and were paid by the piece (see figure 6). Mainly developed in the textile industry, the foreman was in charge, in this system, of distributing the materials, and then collecting the finished or semi-finished products from the craftsman/worker. In the 19th century, these workers were independent and not part of the company's staff. As Isabelle Daugareilh[21], points out, "it is then that the question of the mode of remuneration was also at stake. It was then that it was decided that piecework remuneration would be the symbol of independent work. Thus, in the factory that employed other textile workers, it was the time-based remuneration that prevailed because they were employees who submitted to the factory clock[22]".

Today, doesn't the decentralization of the workplace thanks to the miniaturization of machines coupled with the extension of platforms create the conditions for a resurgence of the putting out system? Then, what will be the employment contract for this growing active population composed of freelancers, self-employed, "makers" (prototyping, design, developers, data scientists, logisticians...)? Platforms' business models are based on self-employment. This new organization of intermediated work thanks to digital reopens the debate on the qualification criteria of the employment relationship, on the notion of legal subordination, of economic dependence,...Digital raises the question of the scope of application of labor law, warns Isabelle Daugareilh. In this context, what future is given to the negotiation of collective labor agreements that guarantee a balance of power? To perpetuate the opposition between autonomy and salaried workers risks to hinder the reflection on a new labor law for a long time.

These digital artisans are a huge challenge for states, companies, unions and lawyers to adapt labor laws and social protection for these communities, which, as mentioned above, are reminiscent of 19th century day laborers.

> This uberization of work can have virtuous aspects if it favors entrepreneurship […] provided that the status of self-employment is less exposed to the risks of casualization.

This uberization of work can have virtuous aspects if it favors the entrepreneurship of certain professions (computer scientists, designers,..., data analysts) provided that the status of self-employment is less exposed to the risks of casualization[23]. In this booklet, we will not discuss in depth the links between uberization and the emergence of a new precariat, which would merit a booklet of their own. But it is worth emphasizing, in the words of Robert Boyer, the extent to which "the 'freezing' of the economy has accelerated the spillover of

20 The putting-out system was a form of proto-industry present especially in the textile sector where peasant-workers, working on a permanent basis or in workshops, received the raw material from the trader and then sold it back to them as a finished or semi-finished product.

21 Isabelle Daugareilh is Director of Research at the French National Centre for Scientific Research (CNRS) and at the Centre for Comparative Labour and Social Security Law (COMPTRASEC) of the University of Bordeaux.

22 Isabelle Daugareilh, « Révolution 4.0 et droits collectifs du travail », in Jean-Philippe Dunand, Pascal Mahon, Aurélien Witzig, *La Révolution 4.0 au travail*, CERT, Schulthess Editions Romandes, 2019, pp.182-183. Translated by the authors.

23 Jon-Arild Johannessen, *The Workplace of the future. The fourth industrial revolution. The precariat and the death of hierarchies*. London and New York, Routledge, 2018.

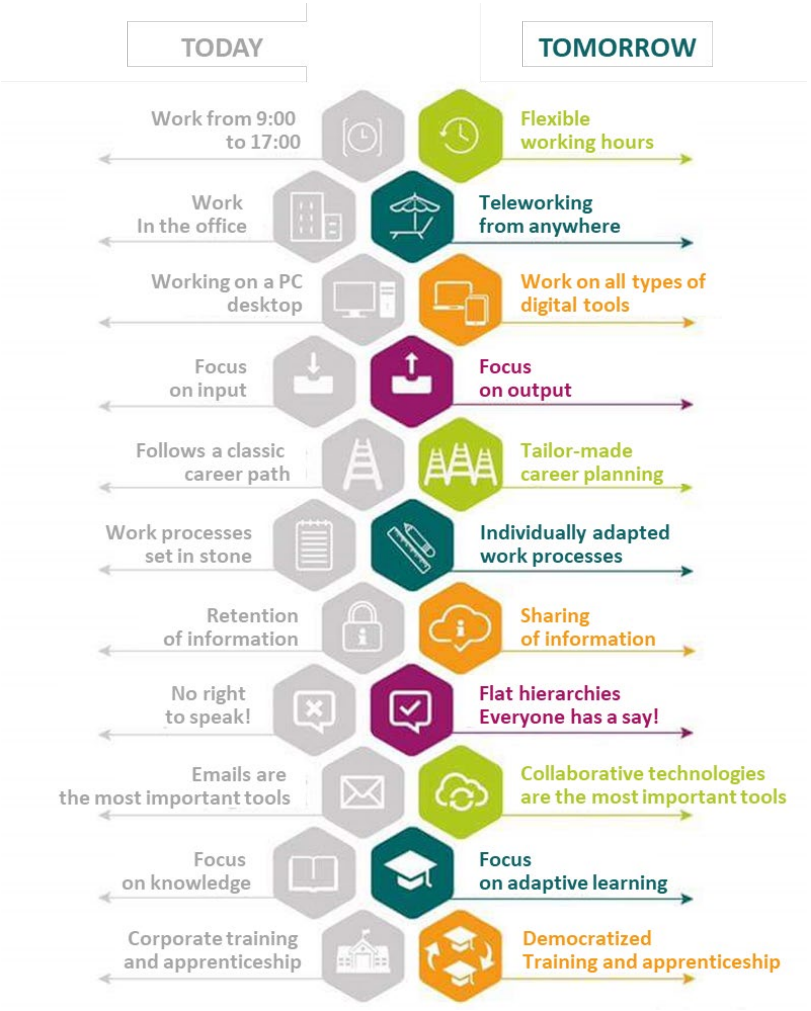
value from declining industries to a rapidly growing platform economy - to use an image, the passage from aeronautical engineer to Amazon deliveryman. Yet this economy offers very little added value, a mediocre level of qualification for the majority of those who work in it, and generates very low productivity gains[24]".

This observation reinforces the importance of measuring the social and societal scope of the digital revolution and of not limiting ourselves to a technocentric approach that creates a tunnel effect.

Towards Which Types of Work Organization?

Ask a manager of an industrial SME to describe their organization, in its simplest form, and they will distinguish between the offices and the workshop, then will detail the lines and the sites dedicated to the different types of production, whether it is large or small series. The organization has been structured for several decades according to the tasks that are performed there but not according to the customer. The complaints of the teams rather invariably concern a deficient communication between the different departments.

Fig. 7 – Working Yesterday, Working Today



Source: Chess Media Group.

24 Robert Boyer, « Le capitalisme sort considérablement renforcé par cette pandémie », interview of Antoine Reverchon, *Le Monde*, October 2, 2020. Translated by the authors.

Paradoxically, the blurring of responsibilities has also thickened over the years, making the decision-making process more cumbersome. Everything goes back to the head, who often manages the files in fire-fighting mode, struggling to meet the responsiveness required by the client. Each person plays a role and it is often difficult for them to explain the results that are expected of them according to the context. They rarely know the reasons why a case is a success or a failure. This hierarchical model of reporting to the leader is based on the assumption that the leader is omniscient regardless of the context. The diagram in Figure 7 illustrates the changes that are taking place in the way work is done: the production of a result rather than a task, the focus on continuous learning rather than on the diploma, are clearly visible in the graph as trends in the evolution of work today and tomorrow.

A Change of Purpose in the Organization of the 4.0 Company

The representation of the organization of a company in the 20th century is matrix-based, with each component having its own function, each function its own department, and each department its own objectives, which are managed separately from the rest. The presupposition, as Steve Denning points out, is that in the 20th century, the firm is run like a machine, regardless of the context (*the firm as a machine*[25]). The objective is to make a profit for the shareholders. The firm sells its products and responds to calls for tender. It is a legible management mode, standardized by ISO standards, processes and procedures. To overcome the changes, control operations have usually been reinforced, organizational charts have been changed, processes have been rewritten, staff has been reduced, entities have been bought out, others closed. For these companies, the conversion to 4.0 has generally been considered, from a technical point of view, as an upgraded version of “lean management”.

Faced with accelerating innovation, evolving customer demands, and the emergence of new competitors, the transformation was particularly difficult when it came to moving from a technical approach to a strategic approach of deciphering customer needs. Few teams know how to describe their customers’ needs or the problems they are trying to solve. They describe the product they are selling to the customer.

The Covid-19 crisis represented for these companies a deep state of stupefaction, a loss of direction. So how can we achieve an upgrade of these organizations? For Steve Denning, the management of the 21st century is embodied in the transition from “making money for the company” to “creating value for the customer” and to recall Peter Drucker’s motto in 1954, “there is only one valid purpose of a corporation: to create a customer!”. Amazon, Apple, Netflix but also the Chinese conglomerate Haier are mentioned as examples. By changing the purpose of the organization, management principles and practices change radically, as illustrated in the table below.

25 Steve Denning, « What 21st Century Management Looks Like », *Forbes*, 20/09/2020.

Fig. 8 – Principles, processes and practices of 20th and 21st century management

A. PRINCIPLES that drive the processes and practices of the organization		
	20th Century Management	21st Century Management
1. Ideology, goal	Making money for the firm and its shareholders	Obsession with creating more value for customers/users; profits are the result, not the goal
2. Architecture of work	Individuals report to bosses, fill roles	Drawing on full talents of staff, often through sma self-organizing teams working in short cycles
3. Dynamic	Vertical hierarchy of authority	Horizontal network of competence, with balance between top-down, bottom-up, and horizontal; ide can come from anywhere
Key indicator	Delivering short-term profits	Delivering instant, intimate, frictionless, incremental value for customers at scale
PROCESSES that support the principles		
4. Leadership	Leadership from the top; transactional; manipulative	Leadership at every level; based on human-to-human relationships
5. Strategy	Static, backward looking, defensive, building moats	Dynamic, interactive, value-creating; ecosystems
6. Innovation	Protecting the existing business	Enhancing existing business and creating new businesses
7. Sales and Marketing	Inducing the customer to buy the products to meet firm's targets	Seeking to make a real difference in the lives of customers and users/.
8. People management	HR controls workers as the firm's resources	Attracting and enabling talent to add value to customers
9. Budget	The budget is typically a major battle among silos for resources	Budget mainly reflects decisions taken in strategy
10. Measurement	Measures decided *ex post*	Measures decided *ex ante*
11. Risk management	Risk managed as threat	Risk viewed as opportunity

Source: Steve Denning, "What 21st Century Management Looks Like", Forbes, 20/09/2020.

As highlighted in chapter 4 of *Cahier du Digital #1*, the organization is moving from a monolith to a constellation of archipelagos with self-managed, responsive teams whose skills are faceted by the ability to interact, to create value for the customer, to cooperate with other companies, to create new ecosystems. Few companies that enter a race alone will succeed in building these new archirectures. These new ecosystems are built on cooperation between several players, where each one is able to conceive their contribution as a lego that fits into a larger architecture.

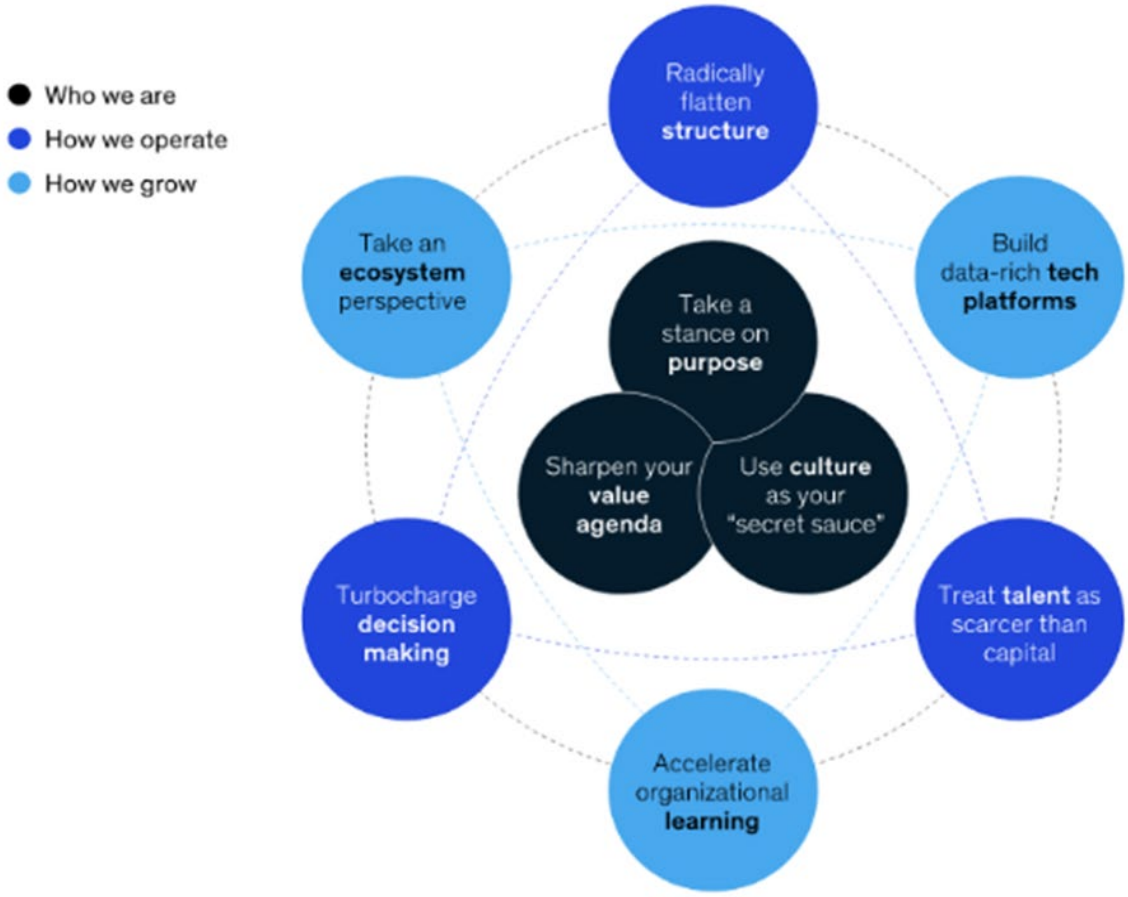
A Change in the Architecture of Organizations

In the first *Cahier du Digital*, we showed how command functions were decentralized as we moved from a pyramidal structure to a networked organization. We have illustrated the different variations of Factory 4.0 according to their hybridisation stage between mass production and mass customisation and creation of value for the customer. The breakdown of the value chain into a constellation of archipelagos revolving around the customer directs the driving forces towards customer experience. To illustrate in an operational way the principles underlying the change in the architecture of the company's internal organization, we draw on McKinsey's work (figure 9).

Three main lines of force structure the graph below: 1/ who are we, 2/ how do we operate and 3/ how do we contribute to our growth? The company's identity and vocation will determine the sense of belonging, the feeling of being part of a group and the confidence in the company's culture. Growth is fueled by the teams dedicated to creating value for customers. Operational excellence concerns

the teams in day-to-day business, where the execution of the business and the monitoring of quality, deadlines and costs are paramount.

Fig. 9 – Nine organizational imperatives will separate future-ready companies from the pack



Source: McKinsey, Organizing for the future: Nine keys to becoming a future-ready company, 11/01/2021.

From Pyramid to Rhizome

In the transition from chain to constellation and from pyramid to network, management teams question their exercise of power, their fields of decision and their own added value. They are thinking about how to rebuild their legitimacy and their authority. It is no longer a question of organizing the company by dividing each business into processes, but of thinking of the company as a horizontal network, as illustrated by the rhizome. If we look at the definition of a rhizome, it is a structure that is constantly evolving, in all horizontal directions, and devoid of levels. It aims to oppose the pyramid hierarchy. “Any point of a rhizome can be connected with any other, and must be connected”. If we refer to Deleuze and Guatttari, a rhizome is a “space” or more exactly an “environment” communicating, resonating, “real multiplicity of heterogeneous elements (lines and signs), endowed with an absolute capacity of connection[26]”.

[26] « Livre de philosophie » in Gilles Deleuze and Félix Guattari, *Capitalisme et schizophrénie 2 : Mille Plateaux*, pp. 20-32. Translated by the authors.

Fig. 10 – The Rhizome Organization

Source: Richard Giblett, Recent work: 2006-2009, 21. Mycelium Rhizome, 2009 Pencil on paper 120 x 240 cm Collection of the artist Represented by Galerie Dusseldorf.

The rhizome metaphor to qualify the company's architecture underlines the organic, evolutionary and adaptive character of these new entrepreneurial structures. It is the creation of interconnections and their diversity generated by new modes of internal and external cooperation that can respond to a work with complex requirements. Companies will be increasingly confronted with situations of radical uncertainty such as the one we are experiencing today, where it will be necessary to experiment with new solutions that have not yet been tested. However, only the mobilization of network intelligence and cooperation can create a fertile ground for emerging practices.

> Only the mobilization of network intelligence and cooperation can create a fertile ground for emerging practices.

This cooperative work is often disruptive for management teams accustomed to having a predefined solution before they have really defined the problem to be solved and the field of interaction concerned.

On the other hand, in adaptive organizations where human involvement is strong, the ability to cooperate becomes a competitive advantage. This "cooperative advantage" is defined by Leon C. Prieto and Simone T.A. Phipps as "the advantages that an organization possesses and accumulates as a result of its people-centered approach to generate a spirit of care and community, meaningful

dialogue, and consensus building, for the benefit of employees, customers, and the community[27]". The Covid crisis highlighted how much companies needed to demonstrate this spirit of care and community if they wanted to maintain their brand awareness and employer brand.

The resolution of complex situations will depend on the ability to generate these new collectives outside the organization. This is the strength of the 4.0 demonstrators in Germany and of the projects initiated by the Federal Ministries of the Economy and Education and Research, which involve a dozen private and public players each time. In contrast, the *Industrie du futur* showcases in France label a company, not a collective.

In environments driven by high-volume production where repeatability is the rule to achieve high productivity rates, automation and algorithms are relevant and facilitate design, simulation, control, maintenance and infeed/outfeed operations of production lines.

This analysis shows how essential it is to qualify upstream the context and the environment in which we operate, in order to opt for the most appropriate Industry 4.0 approach.

[27] Leon C. Prieto & Simone T.A. Phipps, "Cooperative Advantage: Rething the company's purpose." *MIT Sloan Management Review* 15/09/2020. This passage also refers to the working paper produced by Daniel Atlan on "Collaborating and Cooperating at Work".Translated by the authors.

Beyond Techno-Determinism

CHAPTER 4

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Chapter 4 - Beyond Techno-Determinism

The vision of Industry 4.0 as an industrial revolution could lead one to believe that humans remain relatively passive subjects to the introduction of cyber-physical systems. However, previous industrial revolutions as well as the more recent process of automation have taught that technology is not enough on its own and that the most complex and sophisticated systems still require human supervision. Clint Eastwood's film "Sully" shows that if he had trusted the algorithms, the Airbus procedures and the orders from the control tower, Captain Chesley Sullenberger would have clearly created a sub-optimal situation. He would never have succeeded in landing his Airbus A320 on the Hudson River and saving all its passengers, but would most certainly have crashed into New York.

How to Create the Learning Effects of Industry 4.0?

The dream of automation that would make up for human shortcomings has often run up against harsh reality. Machines need humans to make up for their failures. This is not just a matter of maintenance and troubleshooting, but above all of daily operation.

The second industrial revolution would not have been possible without the assembly line and Henry Ford's "$5 a day". The myth that Henry Ford was a budding Keynesian because he decided to double the wages of his workers is somewhat undermined by the harsh historical reality. At the time, this increase was the only solution to fight against the vagrancy of workers who saw line operators change employers for a few cents more. Henry Ford understood that his production line would not achieve the expected productivity gains if the workers on the line did not complete the lasting apprenticeships necessary for its operation.

Automation has its limits and needs people. More recently, in the early 1980s, Volkswagen experienced this with its project to fully automate the final assembly of the Golf in Hall 54 in Wolfsburg[28].

This project failed because it ignored the multiple actions of regulation and adjustment of the chain that are carried out by the operators and often go under the radar.

Of course, one could argue that artificial intelligence reduces or even cancels the importance of these learning effects. Can't machines learn by themselves?

But this would be forgetting that artificial intelligence is often just a gigantic means of capitalizing on learning done by humans. And updating this learning, the new learning necessary for any continuous improvement process, requires a dose of contextual and situational intelligence where humans are still far ahead of machines.

In order to create the necessary learning for the deployment and operation of Industry 4.0, the stakeholders quickly understood that the most effective way was to experiment collectively. In this respect, the strategy of the German metalworking union IG Metall is very instructive.

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28 Martina Heßler: „Die Halle 54 bei Volkswagen und die Grenzen der Automatisierung. Überlegungen zum Mensch-Maschine-Verhältnis in der industriellen Produktion der 1980er-Jahre", *Zeithistorische Forschungen/Studies in Contemporary History* 11, 2014, pp. 56-76.

A Pragmatic Position of IG Metall: "Vigilant Benevolence"

"IG Metall's strategy in relation to Industry 4.0 marks a turning point. The old strategy was very defensive in relation to new technologies, for example against CIM (Computer Integrated Manufacturing). This time, there is no room for a blocking strategy. What we liked is that production is once again seen as a relevant field. We are involved in the development of new knowledge and are openly discussing the opportunities and risks," emphasized Constanze Kurz, a member of the IG Metall Board of Directors, in an interview in March 2015 with Kohler C&C[29].

In the context of the works councils (*Betriebsrat*), the union is mobilized to monitor the various projects related to Industry 4.0 and accompany them in the context of co-determination (*Mitbestimmung*). For example, IG Metall is involved via its works councils in the projects of Bosch Rexroth in Homburg or Siemens in Amberg. In a company of the Premium *Mittelstand* such as Wittenstein, where IG Metall is not represented, there are personal contacts with the company director. The gray area is the small *Mittelstand* companies with 50 to 60 employees where the organizations have no or few representatives.

The union accompanies changes with vigilance, remaining attentive to the limits that must not be crossed. It evaluates innovations in the workplace and supports projects that it believes will bring about real improvements in working conditions. IG Metall has distinguished itself by proposing a dual approach that identifies the opportunities and threats associated with Industry 4.0[30].

Fig. 11: The Impact of Digitalization on Work According to IG Metall

Negative view
• Work becomes passive and subject to technology • Lack of cross-functional skills (specialist-centric system) • High stress potential • Increased flexibility of work • Discrimination between the "trained" and the " less trained ". • Reduced opportunities for progression for those with low qualifications • Staff reduction • Increase in temporary work/social dumping strategies • Bypass on co-determination • Blurring of boundaries between professional and private life
Positive view
• Positions with new margins of maneuver with the end of central, hierarchical control • Richer, more interesting work content, calling for more responsibility and the ability to solve problems • Work better adapted to seniors • More extensive participation within the company • More open communication and management • More robust skills and career development • Long-term job retention through the development of new technologies

Source: Dr. Constanze Kurz, « Industrie 4.0 – Veränderungen der Arbeitswelt: Mensch, Maschine und die neue Rolle der Beschäftigten », presentation at seminar of the Saarland Chamber of Trade, 2014. Translated by Kohler C&C. Table drawn from Dorothée Kohler, Jean-Daniel Weisz, *Industrie 4.0. Les défis de la transformation numérique du modèle industriel allemand*, La Documentation française, 2016, p. 69.

29 Interview between KOHLER C&C and Dr. Constance Kurz quoted in Dorothée Kohler, Jean-Daniel Weisz, *op. cit.*, p. 69.

30 Dorothée Kohler, Jean-Daniel Weisz, *ibid.*, p. 70.

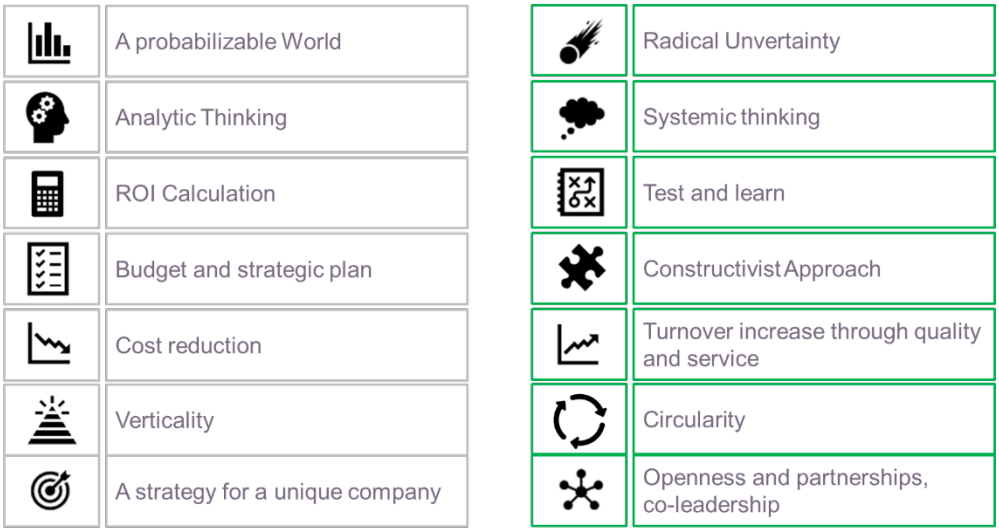
IG Metall has adopted an open strategy of accompaniment of cases of application such as the implementation of cobots or digital tools to organize production teams. The union considers that it has more power by accompanying the experiments and by influencing them if necessary than by opposing them head-on[31]. Other players, such as the DGB, various political foundations and social science institutes, have also worked on concrete cases of implementation of Industry 4.0 solutions, with projects focusing on the development of skills and the creation of a range of initial and continuing training courses. The work carried out under the aegis of the Federal Ministry of Economics and Energy resulted, in August 2018, in the modernization of a whole range of training courses (industrial mechanic, electronics technician for equipment and systems, plant mechanic...) by integrating new content such as cybersecurity, the cloud, process management[32]...

> The union considers that it has more power by accompanying the experiments and by influencing them if necessary than by opposing them head-on.

From Radical Uncertainty to Transformation in Complexity

This is probably one of the most structuring lessons of our observation of the 4.0 phenomenon in Germany: cultural transformation materializes the shift from an analytical and disjunctive approach to a systemic worldview and to constructivist approaches[33].

Fig. 12: A Change in Worldview



Source: Dorothée Kohler, Jean-Daniel Weisz, « Industrie 4.0, une révolution industrielle et sociétale », Futuribles n° 424, May-June 2018, p.67.

31 Dorothée Kohler, Jean-Daniel Weisz, *op cit.*, p.68.

32 BMWi, « Ausbildung und Industrie 4.0: Zupacken statt zu warten in der Metall- und Elektroindustrie », available at <https://www.bmwi.de/Redaktion/DE/Presse-mitteilungen/2018/20180608-ausbildung-industrie-4-0-zupacken-statt-zuwarten-in-der-metall-und-elektroindustrie.html>.

33 Dorothée Kohler, Jean-Daniel Weisz, « Industrie 4.0, une révolution industrielle et sociale », *Futuribles*, May-June 2018 – No. 424, p. 67

“I don’t really know what Industry 4.0 is or where it’s going, but I do know that we have to get there... and fast! “We heard this injunction often during our trip to Germany on the trail of Industry 4.0. A strange fourth industrial revolution that assumes this context of radical uncertainty and complexity where “the purpose is in the journey”.

This world accepts radical uncertainty. The strategies of stakeholders observed in the field reveal iterative, experimentation, test and learn (learning based on a logic of trial and error) approaches. Strategy is built along the way by seizing opportunities, capitalizing on successes and learning from failures[34].

There is no royal road to 4.0. Each transformation is unique and only becomes sustainable if it is co-constructed and tailored within each organization, by mobilizing collective intelligence. New methodologies are appearing in companies, such as design thinking, to rethink product and service offerings, identify customer uses and needs, and mobilize multidisciplinary approaches to provide innovative solutions[35].

Within industrial family businesses that are facing the challenge of renewing a generation of founder-managers, this cultural mutation is a major challenge. It is also a major challenge for social sciences, which must now grasp this vast transformation movement and accompany it in real time by thinking in complexity[36].

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34 Dorothée Kohler, Jean-Daniel Weisz, « Industrie 4.0, une révolution sociétale ? », *Allemagne d’aujourd’hui*, n° 222, October-December 2017.

35 Dorothée Kohler, Jean-Daniel Weisz, « Industrie 4.0, une révolution industrielle et sociale », *Futuribles*, May-June 2018 – No. 424, p. 68.

36 Robert Delorme, *Deep Complexity and the Social Sciences: Experience, Modelling and Operationality*, Cheltenham/Northampton, Edward Elgar, 2010, pp. 180-191.

Conclusion

Industry 3.0 was a world where we always did a little more of the same: more automation, more robotization, more cost reduction, more planning... In Industry 4.0, it's about consuming differently and producing and working differently. Questioning the business model and the product and service offering in relation to the changing needs of different customer profiles is an essential first step. This questioning also requires the identification of the learning that needs to take place in order to evolve the company's organization and to develop cooperation outside the company. The adaptation of the industrial plan and the organization of work in relation to the evolution of professions and skills are the other pivots of this digital transformation. This is a multi-dimensional transformation that can prove to be distressing for the teams of industrial companies, as it requires them to work on all dimensions at the same time, abandoning a sequential and structured approach based on fixed processes.

However, our experience in the field in Europe and abroad teaches us every day that the new spaces of freedom and creativity generated by this 4.0 revolution are also a tremendous opportunity to be seized in order to build a collective approach to experimentation, to create links and to make society. Far from fatalities, this new industrial world remains to be built and it will be nothing other than what we make of it.

Industry 4.0: the 4th Industrial Revolution
Volume 2 – Organizational and Societal Challenges
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Capitalisé à hauteur de 60 millions d'euros, W.IN.G by Digital Wallonia investit dans les start-up aux différents stades de leur évolution : de la phase de « pré-amorçage » (finançable dès 50 000 euros) à la « Série A » (finançable jusqu'à 2,5 millions d'euros).

▶ NOTRE APPROCHE

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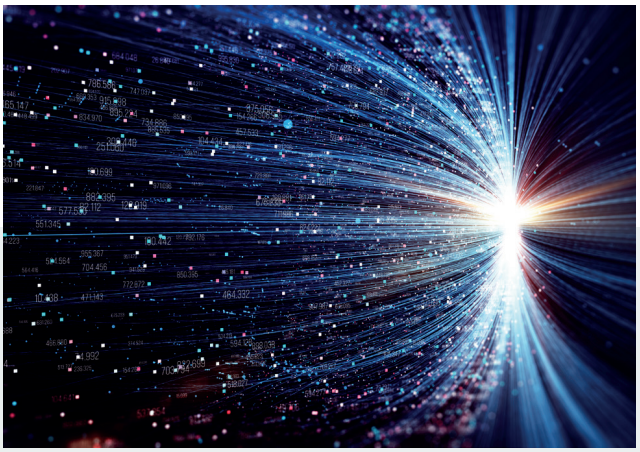

▶ NOTRE ÉQUIPE

L'équipe derrière W.IN.G, ce sont 4 Investment Managers aux profils complémentaires et aux compétences variées ; mais aussi une Operating Team qui offre aux start-up une première intervention gratuite dans les domaines les plus pertinents (growth marketing, RH, vente, stratégie, finance).

▶ NOTRE RÉSEAU

Par le biais de la Société Régionale d'Investissement de Wallonie (SRIW), W.IN.G bénéficie d'un accès à un réseau étendu de partenaires, d'entreprises et de fonds spécialisés.

▶ NOS RÉFÉRENCES

En quatre ans à peine, le fonds d'investissement W.IN.G by Digital Wallonia a déjà contribué à l'émergence de nombreuses startups reconnues au niveau national comme à l'international : **E-Peas**, **OnComfort**, **Mozzeno**, **ListMinut**, **WooClap**, **Neveo**, **Verbolia**, **etc.**

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