

The Digital Transformation of the Industry: A Franco-German Issue

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Abstract

The issue of the digital transformation of the industry provoked in France as in Germany the return of the state and the introduction of a subsidiary industrial policy. Feeling threatened in its industrial leadership, Germany mobilized its resources through industry 4.0 by building a vision around the concept of “cyber-physical system” before developing in each Land an accompanying offer. France has forged the concept of the industry of the future by following a logic of modernization of the production tool, reinforcing particularly the automation and building on the integration of new technological bricks. Both countries now have an accompanying infrastructure in their respective territories. The stakes of the 4.0 industry for production systems, work organization, trades, skills, and employment are anticipated through dialogue and consultation processes.

But beyond the limits of each plant, the digitalization of industry will radically change the distribution of power within the branches and streams between suppliers, subcontractors and ICT providers. This issue culminates in the rise of industrial service platforms that will become an essential infrastructure for the economy. However, the scale effects of these platforms are largely captured by the infrastructure providers dominated by the GAFAM (Google, Apple, Facebook, Amazon, and Microsoft).

Facing these challenges, the Franco-German cooperation can intensify around three key axes: the regulation of platform players to build a competitive market, the development of the levers of relational competitiveness and common thinking and action on the future of work.

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Introduction

The Industry of the Future in France and Industry 4.0 in Germany are the two national programs aimed at promoting digitalization in industry. They have gradually developed from 2011-2012 and reflect the influence of industry in both our countries, the place and role of the State in the economy, and the structure of the business sector. However, they also show the cultural differences in tackling the issue of digitalization of industry in order to organize joint action.

At a time when Germany is examining the sustainability of the link between economic and social policy, the mainstay of its post-war model¹ in the face of rising populism, and when increasing digitalization of the economy is raising further questions about the organization and future of work, the common issue of transformation is clearly a priority for the political and economic agenda.

How can the differences in approach to the digitalization of industry in France and Germany be explained? What can we learn from each other about these subjects? What are the issues requiring concerted or even joint responses? To what extent can the issue of digitalization reinvigorate Franco-German cooperation which has been declining for several years?

1. C. Boutelet, "En Allemagne, le fossé se creuse entre politique et économie", *Le Monde*, 13 October 2018, available at: www.lemonde.fr.

Industry 4.0: is it a matter of State?

In Germany as in France, the emergence of digitalization and its challenges in the industrial world has seen a revival of the State as a player in industrial policy. While the modalities of action are similar in both countries, they actually cover different ways of organizing joint action.

The return of the French State to industrial policy

After several decades of rhetoric in France about the post-industrial world culminating in the destructive ideology of *fables* – a world of services and design where manufacturing is carried out in low-cost countries – Arnaud Montebourg, then François Hollande’s Minister of Economics, was credited in 2013 with having realigned industry and more generally the “Made in France” brand as a major concern. Along with industry plans or targeting an innovative product, the 34th and last plan of the New Industrial France initiative was about the factory of the future. It was led by two French champions, the engineering company Fives and Dassault Systèmes, a world leader in computer-aided design software. This plan’s ambition was twofold: to promote the modernization of production tools and “to develop a French solution of technology and change management” by “coordinating existing technological building blocks” and by developing “those still missing in our ecosystem.” The theme of catching up is even more pronounced as the French deficit in terms of robots is considered disadvantageous (see Table 1).

So, several kinds of methods were implemented: state-funded research and development (R&D) projects, setting up showcases demonstrating pilot production lines and conducting several thousand Factory of the Future diagnostics in small and medium enterprises (SMEs).²

2. Ministry of Economics , *Présentation des feuilles de route des 34 plans de la nouvelle France industrielle*, 2013, available at: www.economie.gouv.fr.

Table 1: French deficit in multi-tasking industrial robots

	Supply of robots installed per 10,000 employees in 2016	Flow of new robots installed in 2017
France	132	4897
Germany	309	21404

Source: International Federation of Robotics, annual reports 2017 and 2018.

In 2015, the 34 plans were grouped into nine solutions with a cross-functional base called Industry of the future. In July of the same year, an Alliance for Industry of the Future (AIF) was established, bringing together professional industry and digital organizations, as well as academic, technical and corporate finance partners.

This alliance managed six working groups.³ It was responsible for identifying projects and endorsing the showcases (41 in total at the end of 2017) in the country. Nevertheless, the diagnostics were entrusted to the regions which issued calls for tender with private service providers.

Finally, in September 2018, the government decided on the recommendation of a report by the Montaigne Institute,⁴ to create Industry of the future acceleration centers, a sort of one-stop shop bringing all the players together under the auspices of a large group.

With hindsight, we can only be struck by the very subsidiary role of the French State, leaving the responsibility of developing support to the regions. This decentralization of industrial policy is interpreted as a positive sign by leaders of SMEs and mid-market companies, as the regions have detailed knowledge of their industrial network. However, although the French government has managed to establish an approach, Industry of the Future still lacks a clear 10-year vision and a purpose that goes beyond the generic terms of ‘catching-up’ and modernizing industrial facilities.

This risk of focusing on methods was highlighted by Bernard Charlès, CEO of Dassault Systèmes, who thinks that the French approach is limited to “digitalizing 20th-century industry” whereas it should now “be inventing

3. These working groups are: GT 1 – Technological development of the Future, GT 2 – Regional implementation with companies, GT 3 – Humans and Industry of the future, GT 4 – International standardization, GT 5 – Promoting existing technology, GT 6 – Industry of the Future Showcases.

4. Institut Montaigne, *Industrie du futur, prêts, partez!*, September 2018, available at: www.institutmontaigne.org.

21st-century industry”.⁵ According to him, France has not really got the measure of the digital revolution which goes beyond modernization and moves well beyond the realm of production.⁶

In Germany, a major stimulus from the federal government

Faced with the challenges of digitalization of industry, France and Germany have looked at how to solve the problem differently. While France has been raising the issue of modernization and the development of a national solution since 2013, Germany would mobilize much more emotional levers and play on both risk and fear. The fear of losing its industrial leadership *vis-à-vis* its Chinese and US competitors, if its industry failed to digitally upgrade by combining the mechanical and information and communications technology industries.

German manufacturers questioned the impact of the GAFAM’s breakthrough in the industrial world on the distribution of economic power along the production chain. Like disruptions in the catering or publishing industry, the intermediary between the manufacturer and their client has a decisive power over players in the sector. They are the ‘recipient’ of the end-user’s usage data which enables them to both develop appropriate services, collect an increasing share of the value and profits, but also move as close as possible to trade secrets.

For example, in 2010 Google became the bogeyman of Industry 4.0 conferences in Germany, by seeking to foist its Android software on car navigation systems. It was not unusual to see manufacturers very far upstream in the mechanical sector questioning the consequences of data captured by the Internet giants. As for the German car manufacturers, they joined together to buy a competitor’s mapping application.

In light of this, the German federal government had a leading role, through the Federal Ministry of Education and Research, in the launch of the high-tech strategy in 2006 which would result in the “project of the future, Industry 4.0.” From 2006 to 2011, the Germans took time to think about developing procedures for joint action for the digitalization of

5. B. Charlès, “La France doit d’urgence changer d’approche en matière de numérique”, Interview by E. Grasland and D. Barroux, *Les Échos*, 27, March 2018, available at : www.lesechos.fr.

6. D. Kohler and J.-D. Weisz, *Industrie 4.0. La transformation numérique du modèle industriel allemand*, Paris: La Documentation française, 2016.

industry in an ongoing dialogue between the worlds of research and industry and between large companies and the *Mittelstand*.⁷

If this topic is of significant importance in Germany, it is because the industry makes up nearly 22% of GDP, as opposed to slightly less than 12% in France. However, it is also because, besides car manufacturing and chemistry which are two very concentrated major cornerstones of German industry, the third cornerstone is made up of mechanical and electrical engineering. These companies manufacture and install the machines that equip German factories. Yet, unlike the first two industries, the last one is the realm of the smallest companies in the *Mittelstand*.⁸ This *Mittelstand* is the champion of incremental innovation, the “perfection of the mundane” in close cooperation with its clients⁹. However, is this *Mittelstand* equipped in the face of radical innovation driven by digital technology?

It was therefore no accident that the first Industry 4.0 platform, which was initiated in 2013, was governed by three professional bodies from mechanical engineering (VDMA), electrical engineering (ZVEI) and information and communication technology (Bitkom).

Some years later, in 2015, Reinhard Clemens, the CEO of T-Systems (a subsidiary of Deutsche Telekom) forcefully stated that Germany had lost the first half of the industrial digitalization game. The Industry 4.0 platform produced many reports and recommendations, while at the same time the Americans pragmatically increased applications. It was time to wake up!

Sigmar Gabriel (SPD), the Federal Minister for Economic Affairs, on realizing the relative failure of the Industry 4.0 platform entrusted to three professional bodies that had difficulty working together, took control by creating a more open platform and assigning it three priorities in April 2015: to spread Industry 4.0 in the *Mittelstand*, to develop thinking about the future of work and a more aggressive roadmap on cybersecurity.

7. Forschungsunion, Acatech, *Umsetzungsempfehlungen für das Zukunftsprojekt Industrie 4.0*, Abschlussbericht des Arbeitskreises Industrie 4.0 [Implementation Recommendations for the Future Project: Industry 4.0, Working Group's Final Report], April 2013.

8. The *Mittelstand* brings together medium-sized independent family businesses in Germany. The Institute for Mittelstand Research (IfM) which previously maintained turnover limits (less than € 50 M) no longer provides thresholds under the *Mittelstand* category. Mid-market companies, but also large companies can therefore come under this category which is not to be confused with that of SMEs.

9. D. Kohler and J.-D. Weisz, *Pour un nouveau regard sur le Mittelstand*, Rapport au Fonds stratégique d'investissement (FSI), Paris: La Documentation française, 2012.

From 2016 onwards and while initiatives were being rolled out in the *Länder* (regions) – for example the Industry 4.0 Alliance in Baden-Württemberg – the German government accredited Industry 4.0 competence centers throughout the country that were led by regional players, technical centers or Fraunhofer Institutes. There are now around 23 of them associated with four themed agencies (*cloud*, business, process and communication) whose role is to support the *Mittelstand* and the small business sector in their digital transformation.

Both France and Germany, now have an infrastructure in place geared towards supporting industry in its transformation. Nevertheless, are the industry organizations and regions sufficiently equipped to act in a world where the basic principles of industrial capitalism and business models are being challenged? Each institution and each intermediate body are struggling to define a solution in keeping with industry requirements. Therefore, it was hardly surprising to discover manufacturers assuming the role of consultants at the 2018 Hanover Fair. As a new way of consuming, manufacturing and working, Industry 4.0 involves the State and its regions in inventing new forms of engagement and regulation.

Industry 4.0: a change in the industrial paradigm?

Behind the terms smart or connected factory, beyond the commonly cited technological building blocks (augmented reality, advanced robotics, predictive maintenance, etc.), Industry 4.0 is a break with the Fordist paradigm born in the early 20th century.

A fourth industrial revolution?

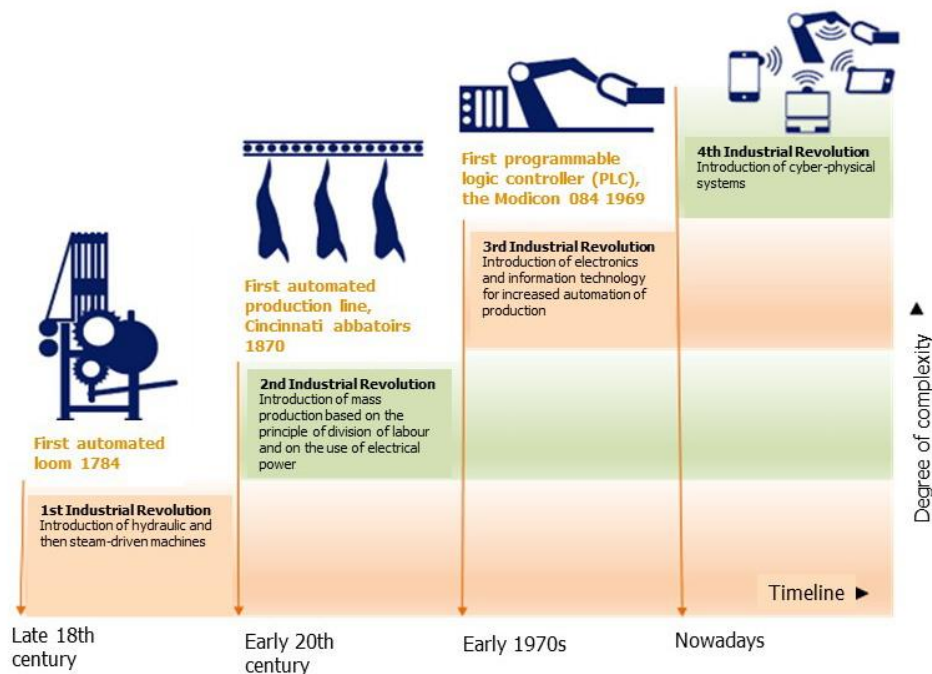
Germany is the country in Europe which has forged the most radical vision of the digital revolution in the industry by calling it Industry 4.0. This expression which is similar to a slogan, implies that we are experiencing a fourth industrial revolution originating from the software world (point zero: ‘.0’).

The first industrial revolution saw hydraulic power and then steam supplant human strength in industrial work (see Table 2). Henry Ford and Frederick Taylor’s second industrial revolution was driven by the advent of electricity, assembly lines and the scientific organization of work. The third industrial revolution was characterized by ever increasing automation that enabled the development of mass production. Information and production management systems emerged to increase control over productivity and the flows between order and delivery.

In the German vision, the revolution described below is Industry 4.0: “Industry 4.0 is much less about automation and more about intelligence!”¹⁰ In addition to automation and the increase in robots and machines, Industry 4.0 is a revolution in how to make plant equipment interact with each other and with humans. The technology at work in this interaction revolution is the Internet of Things. The production and information systems are merged to form a “cyber-physical production system” which enables overall co-ordination. Like an airplane on autopilot that constantly adjusts its flight parameters, Factory 4.0 is able to self-regulate in real time.

10. Interview with I. Ruhmann, Federal Minister of Education and Research in D. Kohler and J.-D. Weisz, *Industrie 4.0, op. cit.*, p. 26.

Table 2: The four stages of the industrial revolutions



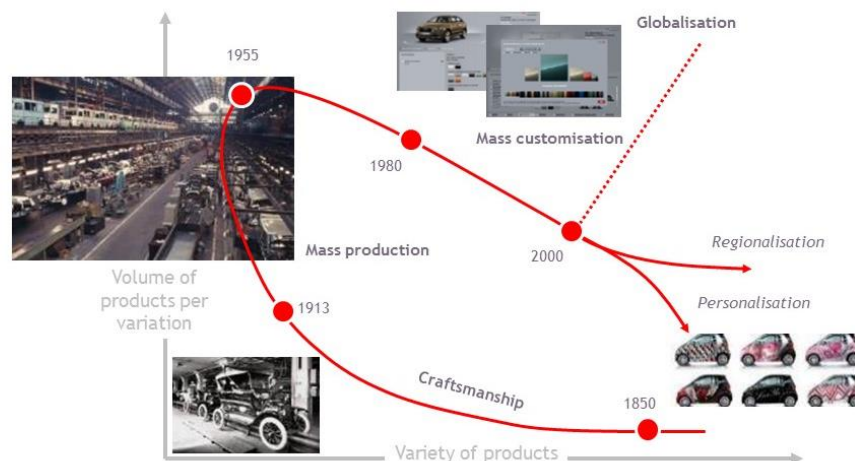
Source: D. Kohler and J.-D. Weisz, *Industrie 4.0. La transformation numérique du modèle industriel allemand*, Paris: La Documentation française, 2016, p. 25. As per DFKI, 2011 from Acatech, Forschungsunion (2013), *Umsetzungsempfehlungen für das Zukunftsprojekt Industrie 4.0: Abschlussbericht des Arbeitskreises Industrie 4.0* [Implementation Recommendations for the Future Project: Industry 4.0 Working Group's Final Report], April 2013, p. 17.

So, the Germans have pushed a cybernetic vision of the economic world to the limit that does not stop at the factory walls, but encompasses the entire environment of energy, material, component, product flows, etc.

This transformation of the production method is accompanied by a shift in the very purpose of the industrial paradigm. The driving force of the second industrial revolution was based on the productivity gains achieved by an ever increasingly efficient organization of production. From the scientific organization of work by Frederick Taylor to *lean manufacturing* methods, the goal remained the same: mass production, increased productivity and quality, cutting waste and reducing costs.

The slogan for Industry 4.0 is “batch size 1” (*Losgröße 1*) with the challenge of manufacturing one-off products at the same costs as mass-produced ones. It is part of a movement started in the 1960s with a return to personalization and differentiation from consumer goods (see Diagram 1).

Diagram 1: Is "Batch size 1" production a convergence between craftsmanship and industry?



Source: D. Kohler and J.-D. Weisz, "Industrie 4.0, une révolution industrielle et sociétale", *Futuribles*, No. 424, May-June 2018. See Y. Koren, *The Global Manufacturing Revolution, Product-Process-Business Integration and Reconfigurable Systems*, Ann Arbor (MI), University of Michigan, 2010.

Industry 4.0: moving towards the end of mass production

Although the narratives differ in France and Germany about the vision of the future industrial world, we can however see a convergence in the implementation of Industry of the Future and Industry 4.0 in both countries.

Nothing better symbolizes this fourth industrial revolution than the reconfiguration of automotive plants. Far from linear production lines, in the automotive plant of the future, the car body is transported by an AGV (*Automated Guided Vehicle*) in an area with nearly 200 production islands. The car is assembled according to a self-regulating process in real time based on availability in each island. The production system is subject to digital continuity all along the value chain from the client's order to delivery.

France has not been left behind in this race to personalize every variety of product and also has champions. The engineering company, Fives, developed a fully automated plant for the Schmidt Group. It

manufactures bespoke kitchen units to fit the dimensions of the end-user's room to the nearest millimeter. Production is started to fit in with the delivery trucks' rounds.

The manufacturers, together with the end client, fully benefit from the competitive advantages provided by the client experience. Adidas' *Speedfactory* also provides a breakthrough design-manufacturing scheme. Formerly produced manually and imported by sea from Asia, trainers can now be manufactured in Europe near large cities using mini-factories with automated critical operations. The Speedfactory is a miniaturized factory that has become a design-marketing-manufacturing tool that produces a brand of shoes AM4PAR (Adidas Made for Paris) in Paris and a brand of shoes AM4LDN in London. In the future, the 3D-printed sole will be personalized and adapted to each jogger's morphology and waiting for the connected sole will allow the jogger to optimize their stride.

This transformation of plants to produce personalized goods also extends to the world of capital goods. Trumpf is a world leader in manufacturing laser-cutting machines for sheet metal. At its Ditzingen plant, Trumpf produces punches for sheet metal forming tools that are specific to each industrial client. Manufacturing and delivery times are a major issue, as a damaged punch can stop a production line. Faced with the extreme variety of shapes required, the manufacturing process has evolved to deal with more than 31 million configurations in automated mode and to deliver parts in 24 hours.¹¹

The *storytelling* of Industry 4.0 is built as a break with the Fordist vision of industry around agile and modular production units that can be reconfigured in real time to mass produce one-off goods. In this vision, it is less about reducing costs than increasing turnover due to the competitive advantage provided by the new industrial facilities.

The focus on the cyber-physical production system has shaped a narrative about Industry 4.0 in Germany that has been adopted by all players: industry, government, research and social partners. As a technological meta-building block, the cyber-physical system avoids focusing on one or other of the existing solutions and emphasizes the systemic vision of Industry 4.0: value is created in linking system components rather than in the system components themselves. It is the reason why Germany addresses Industry 4.0 from the perspective of a revolution in the production system and its integration into the

11. G. Deboutte, "Trumpf à la pointe de l'Industrie 4.0", *L'Usine Nouvelle*, Business Case, Cahier No. 2, October 2018, available at: www.usinenouvelle.com.

environment, while in France, the discourse tends to focus on the concept of technological building blocks and the development of solution providers.

What is the future of work in the 4.0 world?

Industry 4.0 has been criticized for forgetting the human element in a vision too focused on technology. Indeed, what is the place of mankind in this cybernetic world, which seems to be automatically controlled? What is the future of work and manufacturing jobs?

This question of the future of work is extremely complex and uncertain. It is not only anticipating the changes in skills and trades by taking a large number of parameters into account: changing business models and industry location factors, technology diffusion speed, changing production methods, changes in the organization of work and working time, the transformation of learning methods, demographic changes, etc.

In light of this, two approaches are possible. The first is to try to assess the impact of an uncertain future. A study published in 2013 by Frey and Osborne¹² measured the impact of digitalization on the labor market in the United States. Firstly, it concluded that 47% of US jobs were likely to be impacted by digitalization. It also showed that the most affected activities were less in the realm of manufacturing than in administrative services and sales roles. Other studies have used their own methodologies to calculate a net effect of digitalization on employment¹³ with very variable results.

The second approach in the face of digitalization seeks less to predict the future than to anticipate it in order to prepare for it. In Germany, the topic of the future of work was approached pragmatically very early on. IG Metall has distinguished itself by proposing a dual approach (see Table 3) identifying opportunities and threats related to Industry 4.0.

12. D. Kohler and J.-D. Weisz, *Industrie 4.0*, op. cit. p. 66; C. B. Frey and M. A. Osborne, "The Future of Employment: How Susceptible are Jobs to Computerization?", University of Oxford, 17 September 2013, available at: www.oxfordmartin.ox.ac.uk.

13. IAB, "Industrie 4.0 und die Folgen für Arbeitsmarkt und Wirtschaft, IAB Forschungsbericht" [Industry 4.0 and the Consequences for the Labour Market and the Economy, IAB Research report], August 2015.

**Table 3: The impact of digitalization on work
as per IG Metall**

Negative vision	
<ul style="list-style-type: none"> • Work becomes passive and subject to technology • A lack of cross-functional skills (specialist-focused system) • High stress potential • Greater flexibility of work • Discrimination between “trained” and “untrained” • Lesser opportunities for progression for those with low skills • Workforce reduction • Increase in temporary work/social dumping strategies • Circumventing co-determination • A blurring of the boundary between working and private lives 	
Positive vision	
<ul style="list-style-type: none"> • A job with new margins for maneuver with the end of central and hierarchical management • More diverse and interesting work content with more responsibility and problem-solving ability • Work better suited to seniors • Broader involvement in the company • More open communication and management • More reliable development of skills and careers • Long-term job retention due to the development of new technologies 	

Source: C. Kurz, "Industrie 4.0 – Veränderungen der Arbeitswelt: Mensch, Maschine und die neue Rolle der Beschäftigten", [Industry 4.0 - Changes in the World of Work: Humans, Machines and Employees' New Role], presentation at the Saarland Chamber of Trade seminar, 2014. Translation KOHLER C&C.

So, IG Metall has adopted an open strategy of supporting applications like the introduction of robots or digital tools to organize production teams. In fact, the union considers that it has more power by supporting the experiments and influencing them if required than opposing them head-on.¹⁴ Other players, such as the DGB (German Trade Union Confederation) or social science institutes have also worked on specific cases of implementing Industry 4.0 solutions.

Sites also focused on the development of skills and the courses required in terms of initial and continuing training. In August 2018, studies conducted under the auspices of the Federal Ministry for Economic

14. D. Kohler and J.-D. Weisz, *Industrie 4.0*, op. cit., pp. 65-84.

Affairs and Energy led to the modernization of a whole series of training courses (industrial mechanic, electronics technician for equipment and systems, facilities mechanic, etc.) by incorporating new content like cybersecurity, the *cloud*, process management,¹⁵ etc.

As we can see, France and Germany have reacted differently in the face of the challenge of a fourth industrial revolution. The engagement of the different players seems more pronounced in Germany in the face of a shared narrative offering a vision of a reversal of the Fordist paradigm. It borders on a science fiction tale, whereas France remains more soundly technical and offers, with the Industry of the Future, an extraordinary journey in the footsteps of Jules Verne.

15. BMWi, "Ausbildung und Industrie 4.0: Zupacken statt zu warten in der Metall- und Elektroindustrie", ["Training and Industry 4.0: Getting down to it in the metal and electrical industry instead of waiting"] available at: www.bmw.de.

The geopolitical challenge of the digitalization of industry

Whether they are machines or products intended for the public, the examples listed show that the introduction of new materials, electronics and code in products and machines has resulted in the development of the company's business model. Manufacturers closely follow the use that clients make of the products sold. This in turn allows them to constantly improve the product and to develop new services in relation to changing uses.

Industry 4.0 is not restricted to automating a plant or introducing some technological building blocks. One of the major changes lies in the client's position at the heart of the value chain. It has been central to redefining the company's strategy in order to develop personalized solutions in real time. And this is why some powerful players are rushing into this field.

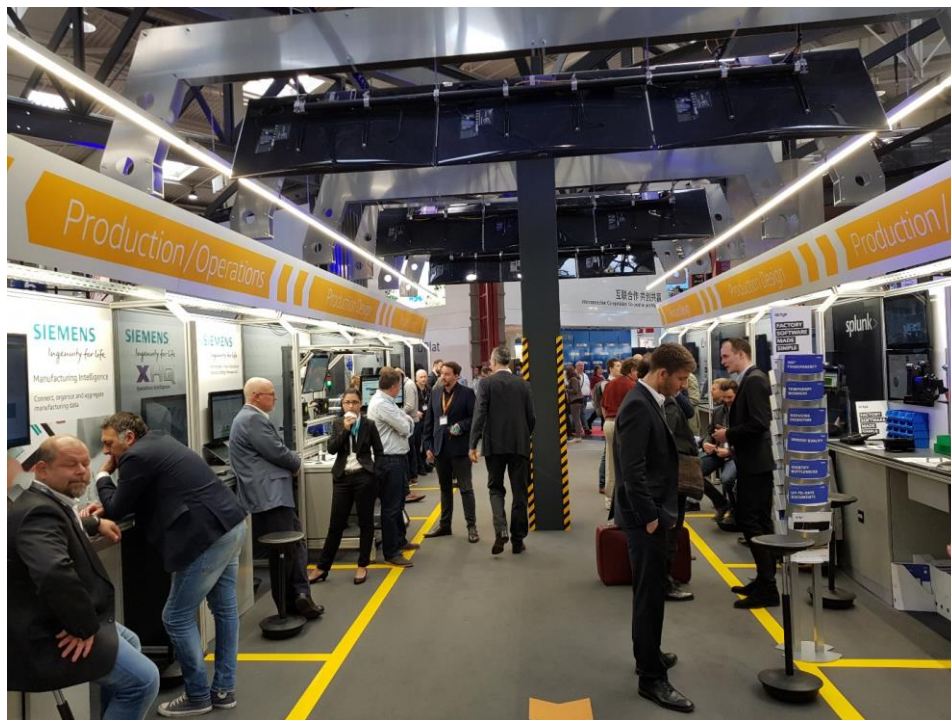
Back from Hanover 2018: China and the USA were the headliners

In April 2018, we observed fewer machines in Hanover and more tablets and the recurring demonstration of the ability to operate networked equipment. At the Kuka stand, the large robot which previously acted as a carousel had disappeared. Lots of cobots were exhibited there, much smaller-sized robots and in particular the latest, Iisy, which weighs 7 kilograms and should cost three to four times less than its predecessor, Iiwa. Tablets were ubiquitous and woe betide those who did not provide a broadband connection to power their stand!

The French pavilion, led by Bpifrance and Business France under the banners *Creative France* and French Fab was also very noticeable. The major French standard-bearers like Schneider Electric or Dassault Systèmes are regulars at the Hanover fair. The presence of French start-ups, SMEs and mid-market companies was a real novelty with a spirit of team-building which is an inevitable step of "hunting in packs".

In the background, the extent of the Chinese pavilion was surprising. Admittedly, the products presented did not seem groundbreaking and the visitors were not crowding around the electric motors, mechanical assemblies and foundry parts. However, this presentation of “China’s diversity” and the demonstration of its know-how were not trivial. The astute German observer who we shared our astonishment with, quickly answered: “But what is the alternative? Can an exporting company like Germany close in on itself and prevent it?” The transfer of Kuka to Chinese ownership has had no apparent consequences for the time being and it is expected that the head office will remain in Bavaria until 2022. But, the epicenter of the robotics market has moved to China.

The Amazon Web Services stand at the Hanover Fair 2018



Source: Photo © Kohler C&C.

However, this increased Chinese presence has become almost anecdotal in the face of the other major development: the square meters occupied by the US ICT giants. The Microsoft stand could soon rival the Siemens’ one in size. Amazon Web Services rebuilt an industrial building in brick in the middle of Hall 8 where it presented its partnerships with solution providers from design to manufacturing. Industrial service platforms already had a strong presence in 2017, particularly with General Electric’s Predix and Siemens’ Mindsphere, and are at the heart of the trade fair.

The advent of industrial service platforms

The digital transformation enables the emergence of platforms, new infrastructures for the economy.¹⁶ A digital platform is an interface that connects many players and facilitates their interactions. Less well-known than ecommerce platforms, industrial platforms have become a critical issue for economic players.

In Industry 4.0, industrial equipment is designed to be managed in real time by applications and algorithms. At a first level are application libraries, comparable to those available on our mobile phones. Manufacturers can select the most useful, for example, an application for computer-aided maintenance management. They can also develop these applications for their own needs and then offer them for sale on these platforms. The applications are adapted to the specific nature of each manufacturing activity.

At a second level is the infrastructure which enables these applications to run. Yet, unlike our smartphones, these applications are not downloaded to work with a local microprocessor. They are in the *cloud*, that is to say, in a storage space and with outsourced computing power. The expertise of giants, such as Amazon Web Services or Microsoft Azure is to provide computing power capable of monitoring the rapid development of the order. This is called 'scalability', the real-time scaling of the system based on the volume of demand. Although the second or third industrial revolution benefited from the scale effects of assembly-line production and automation, the scale effects of the fourth industrial revolution derive from the scalability of this infrastructure. And these scale effects are mainly absorbed by the owners of the platform infrastructure.

In this area, the Americans are enjoying their victory. On the Siemens-Mindsphere stand at the Hanover Fair in April 2018, SAP had vanished from the key partners, giving way to Amazon Web Services. Amazon, known for its parcels and warehouses, makes more than € 20 billion in turnover from a completely different activity: IT infrastructure. Amazon sells data storage and computing power. The platform infrastructure battle has been won by the Americans. The German (SAP and Telekom) and even European players, do not yet have the capacity to offer services of the same quality in terms of scalability. Perhaps, we will one day see a Chinese competitor to Amazon and Microsoft emerge. The German stakeholders no longer seem to believe in Europe's ability to create a *cloud* giant.

16. N. Colin and H. Verdier, *L'âge de la multitude : Entreprendre et gouverner après la révolution numérique*, Paris: Armand Colin, 2012.

An inevitable switch-over to the *cloud*

Consequently, it is not surprising to see the German machine and tool federation hammer into its members that they must soon be concerned about the issue of platforms.

The *cloud* and platform revolution are significantly under-estimated in German and French industry. It is still seen as a fad and raises fears about data ownership and the independence of the company in relation to its IT systems.

However, three arguments advocate for an overwhelming and urgent consideration of these subjects.

Firstly, the chances are that we are close to a massive switch-over as there are many *cloud*-related benefits: quick operation of heavy-duty applications like CAD software, lower operating costs, the transition from Capex to Opex expenditure,¹⁷ etc. The first industrial converts will gain a competitive advantage in terms of speed and cost.

Secondly, all manufacturers are threatened by disruptive players, like start-ups, who may for example pre-empt the relationship between the machine manufacturer and their clients. When the manufacturers make at best 5 or 6% margins on the sale of their equipment, what will happen if the spare parts and services market, where margins approach 20% are disrupted by more agile players? We can interpret the willingness of manufacturers, like Trumpf or DMG-Mori, who have launched their own platforms, as an attempt to quickly gain ground.

Finally, there is the question of the new distribution of economic power throughout the value creation chain. To a fairly large extent, the digital giants already control the end user's data and monitor its uses. They are in the process of asserting themselves throughout sectors and value creation chains, as providers of computing power which industry will need in the future to manufacture. Finally, they are also extending their power all along the supply chains. In the future, the physical and data flows could mostly pass through the GAFAMs.

17. Capex refers to capital expenditure and Opex to operating expenditure. Hired equipment falls under Opex (regular rents) rather than under Capex.

Three major Franco-German challenges

Nowadays, there is an urgent need for further Franco-German cooperation in the field of digitalization in industry. For the time being, the greatest fears have come from the German side, given the potential impact on their capital goods industry. However, France has just as much to fear from the advent of a new balance of power in the industrial world.

Regulating the GAFAMs: the future masters of flows

Manufacturers and the players in their ecosystem maintain control of the distinctive expertise and the GAFAMs do not aspire to manufacture in their place. But, what about a possible reversal of the relationship between the client and its provider, that is to say between the manufacturers and their IT infrastructure suppliers.

Let us imagine connected manufacturing that runs and self-optimizes in real time by means of applications in the *cloud*. The machines operate on “pay per use”, the manufacturer did not buy them and only pays for their operating hours. Does its client not have an interest in turning to the platform directly in the future to identify the most advantageous production capacities available among the listed manufacturers? The manufacturer would then become a platform service provider. And where is its added value in the future, when its expertise is mainly digitalized and its machines rented?

For their part, will these platforms, which are now service providers, be satisfied with supplying infrastructure? Will the GAFAMs not be tempted, when these platforms are mature, to absorb the existing relationship between their industrial client and its own clients, to take advantage of their almost monopolistic position, like nowadays Apple, Google or Amazon does?

The power of the GAFAMs is already excessive and their market capitalization is eight to ten times greater than that of the largest European manufacturers. And their power over the economy only continues to grow. They have control over the distribution of profits from network effects and

economies of scale, and potentially also in the future, over the distribution of production within sectors and the economic infrastructure.

We can imagine an industrial economy, where, once the end user's need has been reflected, the design, manufacturing and logistics functions will to a very large extent be left to the power of algorithms distributing the operations within the production system. A question remains that deserves consideration: in this world constantly rescheduled in real time what becomes of the concept of competition concerns? Perhaps, in France, it is time to focus less on the transformation of 20th-century monopolies to look at those emerging before our eyes, and in Germany to raise the question of "Ordoliberalism 4.0".

Strengthening Franco-German relational competitiveness

Besides the creation of particularly powerful oligopolistic players, new methods of interaction are also developing between economic players. The great surprise of our field analysis of Industry 4.0 in Germany, was not the discovery of remarkable technologies, but the players interacting with each other in a new way. These modes of interaction, which were promoted from the outset by the federal government and spread by the Länder, are the basis of a new form of competitiveness, relational competitiveness.¹⁸ It is a set of competitive advantages arising from the ability to join forces with other players to develop shared leadership. So, MSF Vathauer Antriebstechnik, an SME in Westphalia will seek solutions from a mid-market company, Weidmüller, a specialist in industrial connectivity, enabling it to digitalize its range of drive systems. In France, as in Germany, the big companies will in turn select designs from start-ups that can be implemented in their plants in the form of *proof of concept* (POC). Alliances between large companies are also in fashion, like that of Fives and Michelin in 3D printing with their joint venture Add-up.

This role of increasing interaction was demonstrated in Germany by a study by the Federal Ministry of Economic Affairs and Energy in 2015: at 5-10 years, German companies with fewer than 500 employees expect to have to work with an average of 74 new partners to deal with the challenges of Industry 4.0.¹⁹

18. D. Kohler and J.-D. Weisz, *Industrie 4.0, op. cit.*, p. 141; D. Kohler, "La compétitivité relationnelle, enjeu de la révolution numérique", *Les Échos*, 5 April 2016.

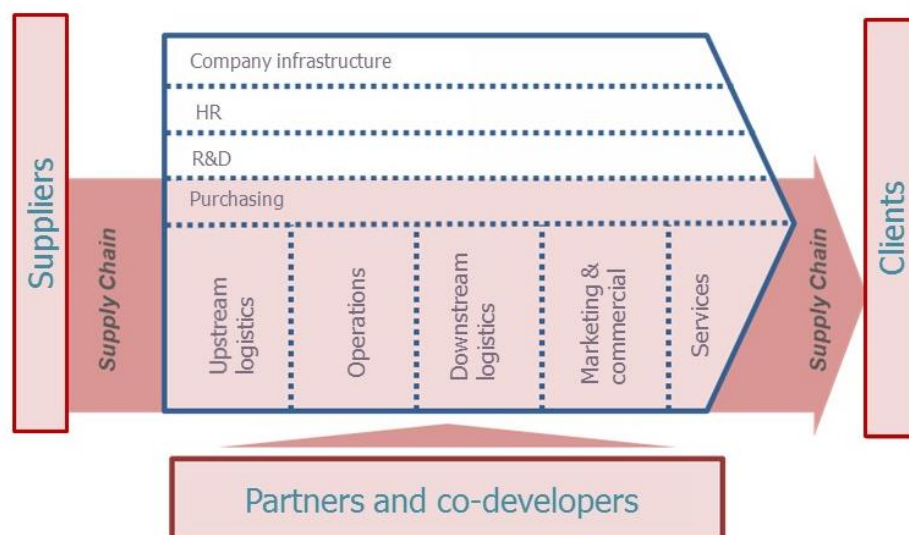
19. BMWi, "Industrie 4.0 - Volks- und betriebswirtschaftliche Faktoren für den Standort Deutschland, Eine Studie im Rahmen der Begleitforschung zum Technologieprogramm AUTONOMIK für Industrie 4.0", [Industry 4.0 - Economic and Business Factors for Germany as a

This rise in relational competitiveness is influenced by various constraints.

The first is related to the availability of resources. Digital skills are scarce and expensive, so players are encouraged to look for partners. Often, far removed from the original professions, these skills furthermore are slow to be internalized within companies. Yet, digital time requires high responsiveness.

However, this relational competitiveness is mainly bolstered by the same transformation of industrial organizations. The classic representation of the value chain showed silos between the different company activities and functions (see Table 4).

Table 4: Yesterday's value chain



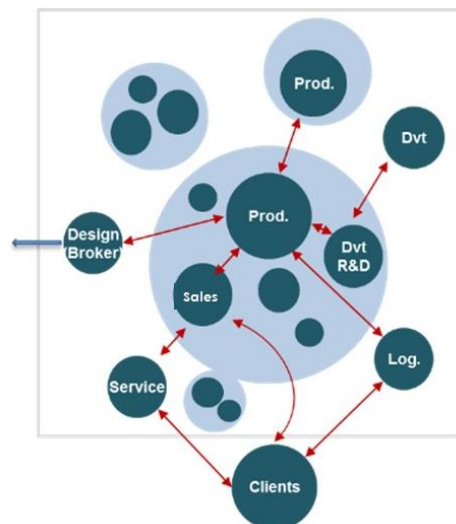
Source: D. Kohler, J.-D. Weisz, *Industrie 4.0*, op. cit., p. 42.

In the representation given by Henning Kagermann, one of the pioneers of Industry 4.0, this organization is broken apart and its functions and activities are decoupled to form more independent entities, regulated by greater interaction (see Table 5).

In a vision taken one step further, we imagine a production system where interactions have increased with the emergence of new client-focused players (platforms and start-ups).

On the one hand, the responsiveness required for real-time coordination of interactions requires fast decision-making processes. On the other hand, Industry 4.0 results in a decentralization of control and decision-making with autonomous systems and operator-technician-engineers able to make decisions instead of traditional hierarchies. As the company expands, the company hierarchy tends to flatten (see Diagram 2).

Diagram 2: What is the future for the value chain?



Source: Henning Kagermann, Impuls – Zukunftsbild Industrie 4.0, Bitkom Kick-Off „Industrie 4.0“, [Impetus - Industry 4.0 Radical Vision, Bitkom Kick-off Meeting] Berlin, 9 January 2013.

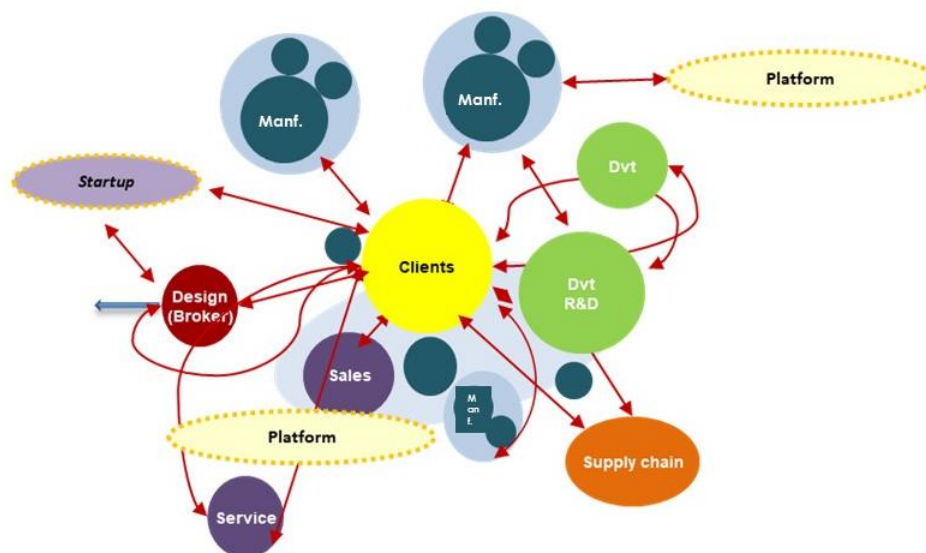
This development obviously raises the question of the position of intermediate management, whose technical legitimacy can be overcome by the digital affinity of lower levels. But also, that of leaders whose decision-making capacity is undermined. Some company leaders, who have started this transformation, have also fully understood the issues; they are coming to question their own added value and are thinking about ways to rebuild their legitimacy and establish their authority.

This representation of the impact of Industry 4.0 on the organization puts the cultural issue at the center of the transformation process. The break with the old post-Fordist paradigm is clear and definite (see Table 5).

The world of 3.0 is partly predictable and probabilistic. It is the world of budgets, scenarios and the return on investment calculations. The transformation is understood as a transition from point A to point B materialized by a roadmap, project agendas and markers.

The world of 4.0 is first and foremost made up of connections. Beyond silos, it is at the gaps between functions, between the scopes of application, between sectors that new value is created. We are seeing an increase in hybridization phenomena, particularly between manufacturing, design and logistics and between industrial sectors.

Diagram 3: The new constellation of the value chain















Source: D. Kohler and J.-D. Weisz, "Industrie 4.0 comment caractériser cette 4^e révolution industrielle et ses enjeux", *Réalités industrielles, Annales des Mines*, November 2016, p. 56.

This world accepts radical uncertainty. Players' strategies observed in the field are based on iterative approaches, experimentation and *test and learn*. The strategy is built along the way by seizing opportunities, capitalizing on success and learning from failures.²⁰

Therefore, it is a world abounding with opportunities provided that the economic players have achieved what many French and German leaders have described as a "cultural revolution."

20. D. Kohler and J.-D. Weisz, "Industrie 4.0, une révolution sociétale ?", *Allemagne d'aujourd'hui*, No. 222, October-December 2017.

Table 5: A change of world view

In the 3.0 universe		In the 4.0 universe	
	The world is probabilistic		Radical uncertainty
	Disjunctive, sequential, analytic thinking		Systemic thinking
	ROI calculation		Test and learn
	Budget and strategic plan		Constructivist approach
	Cost reduction		Increased turnover through quality and service
	A strategy in a single company		Openness and partnerships, co-leadership

Source: D. Kohler and J.-D. Weisz, "Industrie 4.0, une révolution industrielle et sociétale", op. cit., p. 67.

Pre-empting the issue of the future of work together

This anticipated effect on organizations, trades and skills makes the changes to come even more daunting. Hence, the need to combine our strengths and to confront our visions of the world in order to work hard on this project.

Indeed, the Germans have already produced important work: the vision of a fourth industrial revolution embodied by Industry 4.0 did not remain confined solely to the perimeters of manufacturing for long.

Since the beginning of the 2010s, the government, trade unions, companies, and researchers have taken a particular interest in the impact of Industry 4.0 on work, a major focus for discussion entitled "The Future of Work" (*Zukunft der Arbeit*). It is translated into reality by a dialogue exercise launched on 22 April 2015 at the initiative of the Federal Ministry of Labor and Social Affairs (BMAS). This initial exercise was then materialized by the publication of a green paper (*Grünbuch*). This paper examines the representations of work 4.0 in relation to changing lifestyles, individual and shared aspirations and the future roles of social partners and the state. It kick-started sessions with experts dedicated to specific topics, dialogue sessions with civil society and the creation of a group of experts for one year, all led by the Federal Ministry of Labor and Social

Affairs (BMAS). A study specifically identified the seven configurations of the world of work that the Germans want to experience.²¹

On 28 November 2016, the Social Democrat Minister, Andrea Nahles, presented the White Paper (*Weißbuch*) which summarized all the solutions negotiated between the social partners. “Good work in the digital transformation” (*die gute Arbeit im digitalen Wandel*) is characterized by two keywords: security and flexibility. The experts particularly recommend setting up “long-term working-time accounts in companies” (*betriebliche Langzeitkonten*). Setting up a training account that can be used throughout working life and mainly supported by the state is also considered. Safeguarding work for the self-employed is also one of the focuses promoted in this White Paper. This method of dialogue is a basis for reflection on the common good to be developed and what the citizens wish to obtain and prepare for the next more operational step.²²

The “Work 4.0” White Paper

The “Work 4.0” White Paper identifies six impacts of digitalization on the world of work:

1. Digitalization has a direct impact on employment and particularly on administrative tasks, but it also consists of important transfers of jobs between industries and businesses. A prospective study by BMAS forecasts a reduction of 750,000 jobs in sectors like commerce, printing and administration, but also an increase of a million jobs in machine-tools, information technology, research and development...or a positive balance of 250,000 jobs. This development raises the question of training and the implementation of flexi-security.
2. The increase in platforms that no longer appear as employers, but as intermediaries, leads to regulating working conditions and identifying a framework of suitable employment law.
3. The use of *big data* examines the need to protect personal data just like privacy.
4. The human-machine interaction in Industry 4.0 involves job enrichment, a development in skills, but also raises many

21. Bundesministerium für Arbeit und Soziales, Nextpractice, Wertewelten Arbeiten 4.0 [Reimagining Work 4.0], March 2016, available at: www.arbeitenviernull.de.

22. D. Kohler and J.-D. Weisz, “Industrie 4.0, une révolution industrielle et sociétale”, *Futuribles*, No. 424, May-June 2018.

questions, as the collected data also allows greater control of individual productivity. Similarly, what happens when the machine becomes the team leader and orders the operator?

5. The end of the culture of attendance and the emergence of flexible ways of working over time and space questions the future ability of company employees to be involved in defining their working time without it being imposed on them.
6. The transformation of the business organization where hierarchical structure disappears in favor of a networked organization destabilizes the institution of co-determination. How is the social dialogue reorganized in this model?

Source: D. Kohler and J.-D. Weisz, "Industrie 4.0, une révolution industrielle et sociétale", op. cit., p. 64.

From the French point of view, since its establishment the Alliance for Industry of the Future has also emphasized the place of humans in the factory of the future. A working group was set up within the organization with the stated objective of developing a range of initial and continuing training for employees which is tailored to new skills and at the same time the launch of multi-disciplinary research programs and chairs. This vision of humans in the Industry of the Future was specified by the publication of a White Paper at the end of 2017.²³ Written with contributions coming from very different perspectives (students, professional bodies, experts, etc.) it particularly emphasizes the importance of breaking down barriers between economic and social players.

Finally, France and Germany face three challenges, the outcome of which will very much determine how we work and live in the future. Although the language barrier partly explains the difficulty, we have in approaching them together, the question now arises whether remaining locked in our national approaches still makes sense.

23. Agora Industrie, "Révolution humaine ? Un nouveau rôle pour les hommes et les femmes de l'industrie du futur", March 2018.

Conclusions and prospects

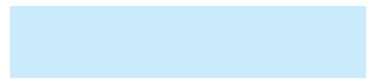
Germany and France are privileged economic partners nowadays facing the same challenges. Although the impacts are different given the structure of our national economies, the approaches can only be complementary, since our cultural differences are based on distinct competitive advantages.

A true common value can be created by connecting the economic structures more deeply. Apart from the large groups, whose future is global, the SME-mid-market companies on the one hand, and the *Mittelstand* on the other, can become players in the increasing relational competitiveness beyond the Rhine. This forging of links must overcome the obstacle of language and the *a priori* to systematically priorities an approach close to the field and constantly paying attention to industry's needs.

The challenge of digitalization of industry is a great opportunity to forge more substantial links between its economic structures on both sides of the Rhine and so contribute to strengthening our economies in the face of other current challenges, like the consolidation of sectors, the hand-over between generations, the defense of European gems in the face of the appetite of certain powers, not to mention the economic integration of large migrant populations. The ability to fully benefit from this challenge will depend on our willingness to go beyond our own understanding and to recognize the challenge of creating a Franco-German *Mittelstand*.

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