Chapter 2
Inside looking out: Digital transformation in the German automobile sector and its effects on the value chain

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The term Industry 4.0 has been in our discourse for some time now although there is still some confusion about what it means. It is, however, consensus that digital technology, together with other factors, is unleashing a transformation of how things will be produced and new possibilities of what can be produced. One aspect involves a broad array of IT and digital applications aimed at making industrial production more productive or efficient, more networked, increasingly monitored and more automated. Other elements entail potential new product and service innovations, higher quality in production, the generation of more information and analytics, and greater synergy between customers and producers.

Germany, in particular, has placed a high emphasis, backed up by large investments, in Industry 4.0 applications. The hope is to lay a foundation for ongoing competitiveness given the country’s still-strong industrial base (compared to other western industrialised economies), especially in the light of the changing production landscape and pressure from emerging economies. Industry 4.0 has become a kind of catch-all phrase, but it does have some characteristic elements: new opportunities are seen in the linking of services and production; there is a stronger connection between pre- and post-production processes; and the roles of the various actors (customers, for example) are being increasingly integrated into the production process (Kagermann et al. 2013).

1. A world of global value chains

Another trend characterising the last couple of decades of production in industrial goods, and increasingly also services, is the distribution of activities across global value chains. Initially, low-level tasks and production activities were targeted for outsourcing to lower cost sites (Porter 1985). As time progressed, more and more activities and functions, aided by developments in digital technology, have been outsourced which has created complex networks of production and services (Henderson et al. 2002). The motives for externalising activities has varied: costs; access to markets; access to resources; access to labour; pressure from shareholders; pressure to reduce wages at home and push for concessions from local labour forces; and so on (Meil 2019). As a result of developments in global value chains, intermediate production activities have grown extensively (Cattaneo et al. 2010), with pieces of the stages of production criss-crossing the globe and making it increasingly difficult to trace the origins of value added creation for a particular product (Linden et al. 2011).
Research on global value chains (GVCs) has demonstrated that their growth is dynamic (Gereffi et al. 2005, Gereffi and Kaplinsky 2001). The simple outsourcing of a product or process from location A to location B, mainly for reasons of cost reductions, often changes over time as interconnectedness and interdependence grows between the sites. Thus, the simple outsourcing of low-skill tasks for the purposes of cost reduction has long since stopped being an accurate characterisation of global value chains, particularly for industries producing complex products or services such as automobiles. Over time, actors in value chains shift, suppliers change and chains lengthen, altogether creating a complex production network in which supply chains are integrated and interdependently linked (Humphrey and Schmitz 2002).

In this study, the auto industry and its suppliers are a central focus of interest. Complex value chains, developed over a long period of time between dispersed production sites and across supplier networks, play an important role in the automobile sector. At the same time, this sector is one of the main ones in which Industry 4.0 technology applications are being developed, implemented and deployed. The increased potential of automation; the development of ‘smart factories’ in which logistical systems are digitised, connected and streamlined; the use of sensors in assembly lines; sophisticated person-machine (robot) interactions; artificial intelligence and ‘learning’ machines; and links between external and internal systems of operation: these are all technologies linked to the term Industry 4.0 and which all have fields of application in the auto industry (Lichtblau et al. 2015).

The other contributions in this collection examine developments in new digital transformations in the auto industries of the emerging economies of eastern Europe as well as in Spain and Italy. The former has strong links to western Europe automobile OEMs, and many are outsourced production sites or subsidiaries. There are also subsidiaries of auto manufacturers from other European countries, such as Germany, in Italy and Spain although Italy in particular also continues to ha its own long-standing indigenous auto production and engineering plants.

A central question addressed by these studies is: what effect does, or will, new digital transformations, often subsumed under the rubric Industry 4.0, have on their local or regional sites? As part of OEM value chains, will production and engineering sites be upgraded or downgraded? Will the effects be marginal or lead to noticeable shifts in how and what is produced? And what will be the impact of Industry 4.0 on workforces? Will there be shifts in the division of labour across value chains? Will employees in emerging economies be replaced by automation and their workplaces degraded? Or will the opposite occur: a shift towards more high-skilled tasks and more diverse activities?

Decisions on the future of sites along the value chain ultimately come from OEM headquarters, where strategic decisions are made concerning future investments, site use and capacity as well as the division of labour between sites. This chapter addresses precisely this side of the issue by asking the following question: what strategic orientations do OEMs pursue regarding the implementation and planning of new digital technologies and Industry 4.0 applications at their outsourced sites and subsidiaries?
Many OEMs and their tier one suppliers in the auto industry are located in Germany and this is the case described and analysed here.

2. A note on method

Methodologically, the original approach was to identify companies who were part of the empirical analysis of the other case studies presented in this book. Of those with German owners or headquarters, the design plan was to conduct analyses of matched samples linking expressed central company strategy to conditions at production sites in the countries represented in this collection. This proved impossible to implement due to difficulty of access, in part because of the saturation of Industry 4.0 studies in Germany and the consequential refusal of new requests, and ultimately due to impasses on account of the corona crisis.

In the end, four companies participated in the study: two automobile producers; one high-end automobile supplier which carries out production and facility planning for a broad range of customers; and one highly innovative producer of automation systems. All of the companies have production or engineering development sites dealing with the auto industry in one or more of the countries in southern or eastern Europe represented in this book. Eleven interviews, based on an open-ended questionnaire, were carried out. This information was supplemented with desk research on the companies and issues related to Industry 4.0 and value chains.

3. The cases

3.1 Case 1: EDAG

An engineering service provider to the auto industry with three divisions: one specialising in vehicle engineering; one in the development of production solutions (factory and assembly line planning); and one devoted to electronics development and in-car IT systems. The company has over 8,000 employees and more than twenty sites worldwide, usually connected to the sites of auto manufacturing facilities among others in Italy, Spain, the Czech Republic, Poland and Hungary.

The respondents from production solutions offer a range of services to their auto manufacturing customers that deal with topics surrounding Industry 4.0 applications such as the development toward ‘smart factories’, in which digitalisation and networking for facility, production and logistical planning is conceived and implemented, as well as the potential development of ‘smart assistants’ (for example, sensors and the use of augmented and virtual reality).
3.2 Case 2: Volkswagen

Volkswagen Group is the holding company for twelve auto manufacturers in seven European countries which have about 120 production sites in over thirty countries around the world. The company has some 670,000 employees working in production, services or sales. Production sites can be found in Spain, Italy, Poland, Hungary, Slovakia and Slovenia, most of which began as car brands from those countries and later became part of the VW group. This is important because a certain amount of differentiation and some autonomy exists based on brand identity and history. This is true within Germany as well as outside it.

The respondents for this study came mainly from a newly-established unit within the group: VW Group Components, which emerged out of a long process of converging individual product groups and brands. This unit is the supplier for all of VW’s car brands and can also sell to customers outside the group although currently about 95% of its business is within VW. VW Group Components employs 80,000 workers in 61 production sites across 47 countries. It encompasses a broad range of products including seats, undercarriage, gearbox and drivetrain, engines, foundry and e-mobility (batteries for new electric cars, for example).

Auto components production is particularly interesting to study with regard to digitalisation because, while it includes the most labour-intensive parts of manufacturing and assembly, it also contains some of the most automated parts of the production process. Some of the more highly traditional parts of automobile production, and the oldest machines, are found in component production, at the same time increasingly alongside some of the newest and most automated due to the production of electric cars. Electric engines and battery production all fall within the purview of Group Components.

Generally, the idea behind the concentration of components into a centrally-steered group was to bundle the production of certain components at particular sites and to distribute capacity utilisation more efficiently. Obviously, the process of closing down, shifting and concentrating activities was a contentious one. Some respondents portrayed the shift to more modern and digital forms of production as a step-by-step process, particularly because there are production lines and machines that are quite old, but still in operation, and many of these are in Germany. In fact, some of the ‘most state-of-the art sites for component production are in eastern Europe simply because they were built more recently.’ (VW-5)

3.3 Case 3: BMW

BMW is a premium car brand with about 125,000 employees in auto-related activities worldwide, including the other brands in the group – MINI and Rolls-Royce. There are thirty production plants in 14 countries. Compared to other carmakers, BMW is relatively small and its activities are confined to a relatively low number of countries for actual auto manufacture. Even fewer are involved in higher range activities such
as development and engineering. BMW is currently building a new assembly plant in Hungary but, otherwise, auto production is confined to its sites in Germany, China, the US, Britain (due to the takeover of MINI and Rolls-Royce) and Mexico. Unlike VW, BMW outsources considerably to external suppliers for parts and services. It also enters into general contracting agreements with large engineering and design companies to take over pre-production processes for certain projects.

The interviewees from BMW work in prototype development for auto assembly, with expertise in digital transformation processes in pre-series production.

3.4 Case 4: Festo

Festo is well-known in Germany as a highly innovative company specialising in automation technology, including interactive robots and VR and AR applications. An interesting aspect of Festo is that it also has a large business unit specialising in training and consulting and the development of e-learning systems, including an entire set of training modules for Industry 4.0 technologies. The company has over 20,000 employees worldwide and an eighty per cent share of turnover is targeted for research and development activities. Production sites exist in several countries (China and the US have major sites) but in Europe, outside of Germany, only in Hungary, Poland and Belgium. There are also smaller sites for research and development in Hungary and Bulgaria. The export share of what is produced is particularly high: sixty per cent. Most employment is in research and development and in sales (about seventy per cent), with only thirty per cent in production, logistics tasks, assembly and manufacturing.

The interview partner is from the department of solutions technology transfer.

4. Areas investigated in the interviews

The questionnaire used in the study contains three main areas of investigation:

1. Background information on company structure and global presence. The estimated level of Industry 4.0-type applications in the company or the area of the company which the interviewee represents (necessary to limit the focus for very large companies). The estimated growth in importance for specific areas and technological applications of Industry 4.0 for the company or unit, including in a five-year forward-looking timeframe.

2. Company strategy regarding site use and the role of various factors in decisions to outsource or invest in sites. Company strategy for investing in Industry 4.0 applications across the value chain. Determinants or reasons for deciding investments and choosing particular applications. Differences in Industry 4.0 implementation and use between HQ (or home) production sites and remote sites. Opinions on the occurrence of reshoring as a result of Industry 4.0. Opinions on applications that should remain at HQ or the home country and not be outsourced.
3. Effects of Industry 4.0 on workers and working conditions:

a. increases or decreases in employment

b. new divisions of labour (also across the value chain)
   — the influence of Industry 4.0 on the use of sites across the value chain and whether this differs by region

c. effects on worker profiles and qualifications:
   — have new workplaces or tasks been created? Has deskilling or upskilling occurred?
   — the impact of Industry 4.0 on work and tasks: will they become more standardised and simpler, or more complex and demanding? Which kinds of tasks are most affected?
   — training or programmes that are offered for Industry 4.0 applications – by unit and, if applicable, by region

It is obvious that the range of products, processes and services deployed in the company or headquarters unit has an impact on the implementation of Industry 4.0 and its deployment across their value chains. If they are not very far along at home, they are not going to be very far ahead abroad. It is expected that the companies will be at different levels of implementation in different departments and applications. Given this diversity, the goal here is not to convey a definitive portrayal of strategies for future Industry 4.0 developments in a particular company or sector. Rather, it provides a snapshot, based on the estimates of interviewees, of the current conditions and possible business models that German auto producers and tier one suppliers are pursuing for their various sites across the value chain, at home and abroad.

5. The impact of global value chains

Putting developments in the auto industry in context, McKinsey estimates that what it calls ‘global innovations’ sectors – industries that include automobiles, computers and electronics, and machine-building – have given rise to the most valuable, highly traded and knowledge-intensive of all the value chains involved in the production of goods (MGI 2019). Spending on R&D and intangible assets averages thirty per cent of revenues in ‘global innovation’ industries, 2-3 times the figure in other value chains (MGI 2019: 2). As Sturgeon (and his colleagues) has shown, a lot of trade in auto manufacturing takes place as intermediate goods (Sturgeon and Memevodic 2011; Sturgeon and van Briesebroek 2011).

Regionalisation, meaning a concentration of value chains in local and regional networks, has been increasing. McKinsey sees this trend as most evident for global innovation value chains, which include the auto industry ‘given their need to closely integrate many suppliers for just-in-time sequencing’ (MGI 2019: 9). However, a noticeable exception to this trend is central and eastern Europe, which continues to integrate with western Europe as Figure 1 below demonstrates.
It appears that industries in the emerging economies of eastern and central Europe are, in fact, integrating more deeply into the supply chains of OEMs in western Europe. Many countries have joined the production networks of the large western European carmakers (especially Germany).

Figure 1  China and emerging Asia are building domestic supply chains, while central and eastern Europe continues to integrate with western Europe (reprinted from MGI 2019)

Source: World Input-Output Database; McKinsey Global Institute analysis

6. Findings

Respondents were asked how they understood Industry 4.0 and to assess the relevance for their companies of various applications. Almost all were especially careful in their assessment of the level that their companies had achieved in terms of the implementation of Industry 4.0. Between a choice of beginner, ‘on the way’ and advanced, most chose ‘on the way’ to describe where their company stood in the introduction and use of Industry 4.0 technologies. This, in fact, reflects the overall picture that surveys have portrayed on the progress of Industry 4.0 in Germany (see Figure 2) (Kinkel et al. 2016; Heidling et al. 2019).
Explanations for the assessment of ‘on the way’ revolved around the feeling that only some areas and research topics involving Industry 4.0 were at an advanced stage. In general, however, respondents’ perceptions of Industry 4.0 involved highly complex networking and examples of artificial intelligence and algorithm development, albeit that these were still in the early phases of pilot projects at their various sites. Their assessments should therefore be understood as keeping the bar rather high for determining how far along were Industry 4.0 applications in their respective companies. They did not understand the term to mean general uses of digital tools or ongoing shifts towards more automated production.

The implementation of Industry 4.0-type applications was often made initially in the form of pilot projects. This was done either by identifying areas or processes at different sites – also outside Germany – where a particular new tool or application would be especially relevant and then trying to deduce lessons which, eventually, would lead to implementation at other sites. Both BMW and VW had highly similar approaches in this type of initial implementation strategy. One respondent from a supplier who has an overview of several OEMs pointed out that one problem is an abundance of strong pilot projects, ‘super islands in some factory, in which Industry 4.0 is practised and demonstrated’ (EDAG 1) but that it never really progresses beyond the pilot stage: ‘The projects never seem to seep into the regular processes but remain little islands of innovation.’ For VW Group Components, in particular, investments to replace older equipment were planned to be carried out incrementally. Although there did seem to be a slight preference for launching innovative pilot projects at German sites – perhaps also because this is where development engineers tend to be situated – the introduction of pilots at other sites was not out of the question. Several times VW’s engine plant in Poland was mentioned as being more modern technologically than some plants in Germany and, therefore, a prime location for pilot projects or new investments in technology.
Without actual investment numbers for these specific types of technologies, it is difficult to know precisely how accurate this picture is. Festo conducts most of its state-of-the-art R&D in Germany, but it is a high-end supplier geared to exports. BMW seems to have a number of its pilot programmes in the German headquarters, although some high-end projects specifically related to quality control are being carried out at foreign plants. Meanwhile, VW Group Components has been investing heavily in plants in Chemnitz and Salzgitter; battery research and production, an important future topic for e-mobility, appeared to be prioritised for its German sites. One respondent from VW did raise the possibility – hypothetically – that the production of gas and diesel cars could theoretically be concentrated mainly at older production sites or ones outside Germany, whereas the production of electric cars could be concentrated at newer sites in Germany, at least for European markets. Nonetheless, there was no clearly explicit strategy at any of the companies to invest only in Industry 4.0 technologies at the home country site.

All in all, it seems that future strategies for implementing Industry 4.0 technologies in the cases examined here are still in flux, independent of place. It seems quite evident from the discussions, however, that there is not a clearly articulated strategy to keep external sites at a low technological level either by not investing in their production facilities or by slowly fading them out of the value chain.

Respondents were questioned regarding a list of specific technologies associated with Industry 4.0 and on their view of their relevance for their companies now or in the near future.

— automation
— cyber-physical systems
— business process automation
— digital knowledge transfer
— intelligent solutions (predictive maintenance, workforce analytics)
— artificial intelligence and learning algorithms
— digital networking with external and internal systems.

Looking in detail at these specific applications that are often linked to Industry 4.0 gives a more concrete picture of the use, or intended use, of Industry 4.0 in the overall company strategy, even if companies are still not currently at a very advanced stage of implementation.

All of the respondents indicated that automation would increase and would play a large role in the future of production. It was not always clear, however, if they shared the same exact definition of automation: whether production IT, greater use of robots, etc.

With cyber-physical systems (interactions between worker and robot; and the use of sensors for production monitoring and analytics), the reaction was more mixed. Several interviewees were not familiar with the term or technology while others characterised it as ‘buzzword’. Others did see the potential in cyber-physical systems, depending on what customers (in this case, the OEMs) wanted. Nonetheless, a certain amount of caution...
or holding back was evident. As one respondent put it, ‘I was contacted nearly every week about a great sensor that delivers super measurement data or links to clouds. Like mushrooms popping up after rain. But it must be recognised that such things only work when there is connection to what is actually being produced.’ (EDAG 1)

Business process automation and intelligent solutions were also seen as extremely important topics that companies were currently addressing. For several, it also involved efficiency effects in administration and services, not only in production. And for most, the topics dealt with streamlining or even standardising processes. To achieve this, it was necessary to understand the processes, extending right across the value chain, in great detail and this was considered a ‘central’ challenge for the future. ‘If you have an – excuse me – ‘shitty’ process, and it is digitised, then you have a digitised ‘shitty’ process.’ (VW-4) ‘If you can’t play the piano, and you buy a really expensive piano, you still can’t play the piano.’ (EDAG 1) Thus, process optimisation was considered highly relevant, as long as it was understood what processes were being optimised. Predictive maintenance, as a sub-category of intelligent solutions, was already being implemented at many sites. Projects for quality detection using new Industry 4.0 applications and algorithms for machine learning were underway at all of the companies. It is clear as regards these two specific technologies that applications that were easily definable and tightly linked to production were the ones most likely to be deployed.

Knowledge sharing through digital media (Web 2.0, for instance) was not widely practised.

All the companies were, however, interested in using artificial intelligence and algorithms, but they were mainly seen as topics for the future. Moreover, they were all quite careful in utilising the term AI, because it covers a broad range of possibilities and depends on the available data. The auto companies seemed to be targeting AI for the identification or evaluation of mistakes or quality problems in production. Ideas and pilot projects on the subject were in discussion or actually being implemented in both OEMs in this area. One respondent cautioned that, although everyone was talking about AI because it was ‘modern’, what was being carried out reflected ‘minimal’ applications. Nonetheless, even this respondent felt that AI would gain importance over time.

With regard to the issue of digital networking both within and outside the organisation, the view was that these types of digital links and networking have existed for a long time, particularly between top suppliers and OEMs. A number of new areas or unsolved issues remain as future challenges to be addressed – among them intellectual property and privacy concerns and also the need for, but difficulties with, the standardisation of systems. For VW Group Components, part of VW Group but nonetheless also a supplier, the goal is a unified system for its internal customer: VW Production. Of course, this includes all sites, even outside Germany, falling within VW Group. The issue seems to be mainly one of achieving transparency, improving logistics and reaching a better just-in-time availability of components. Consequently, new digital tools will be developed and implemented, but whether or not this can be categorised as Industry 4.0 is questionable. Digital networking in Industry 4.0 is further-reaching and involves the links between services and production activities as well as connections with customers.
These types of application seemed less of a concern to respondents than more traditional IT infrastructures and company internal shared databases.

Another of the central issues surrounding digital transformation discussions is the explosion in the data and information being generated. What should be done with this and how should it be used? Where is information collected and analysed, and what are the systems for reporting? For sites down the value chain, and for the empowerment or development of workforces, this becomes a central issue in terms of monitoring, control and autonomy.

The picture that emerges from the interviews is that both local sites and central headquarters are involved in data analysis based on digital data reporting. ‘One has to look which data is needed where’ (VW-4). At the moment, if plants have their own programme planning or manufacturing control systems, then only local sites need the data. Having said that, there is nonetheless an evident trend that data on the optimisation of production lines will be collected more centrally and then shared. In a positive scenario, in fact expressed by respondents here, the data would be used to improve performance at all the plants. Naturally, the negative scenario is that the data could be used for benchmarking and performance comparison and, theoretically, to substantiate reductions or even closures (Meil et al. 2003).

In the strategy department of VW Group Components, for instance, there is a definite plan to move from a decentralised reporting structure delivering reports to headquarters towards a more centralised and standardised structure. Here, the notion is to optimise capacity utilisation at the level of the entire group across all of its sites, and to bundle products and processes ever more efficiently. Consequently, there has been some shift away from local autonomy once held at decentralised units to a more centralised decision-making structure. This development applies to all the units in the value chain, including the German ones. However, in order to achieve a ‘real time’ reporting flow from the plants to the centre, investments in new types of competencies and technologies are necessary in Germany and beyond. A modern engine plant in Poland is currently seen as the ‘gold standard’ in which remote reporting via iPads located on the shop floor is available to central monitoring units. On the one hand, this allows increased potential for control and monitoring; on the other, it could have the effect of raising the competency levels of the local workforce.

### 7. Effects on work and workers

This bring us to the issue of what effect developments in Industry 4.0 have on the organisation of work and working conditions, which is a central focus of the research presented here. Will digital transformation result in a decrease in employment? Will the division of labour shift, leading to a downgrading or upgrading of sites? Will more skilled tasks move to the headquarters or home sites of companies, resulting in remote sites down the value chain becoming external low-skill workbenches?
Given the backgrounds of the interviewees – who come from central headquarters and from departments for strategy, change management and project development, and who do not have detailed knowledge of the organisation of work or the conditions of work at shop floor level – their view is somewhat aggregated and quite abstract. Even in the cases at the level of production described in the other contributions, interviews did not take place with workers themselves. Therefore, we can only portray here a broad picture of possible developments regarding divisions of labour, skills levels and development, general employment trends, etc.

Most respondents expect a decrease in employment in production as a result of increased automation leading to ‘efficiencies’ in the long run. However, they also predict opportunities in other areas – monitoring, programming, data analysis – to increase. Moreover, most respondents expect a shift in occupational profile, which will affect most areas including production. There are a number of studies on Industry 4.0 which also document such shifts (Hirsch-Kreinsen 2014; Pfeiffer et al. 2016; Heidling et al. 2019).

Currently, the view is that most of the decreases can be achieved through attrition (retirement, etc.) but this is, of course, mainly with regard to Germany. VW is partially owned by the state of Lower Saxony and there is a ten-year guarantee regarding employment security, particularly regarding the introduction of new digital technologies.

A main issue accompanying digital transformation is that task areas and jobs will be changing, sometimes drastically. This is partly due to digital transformation in the auto sector, but also because of the move to e-mobility which is a major new focus for the carmakers. If this trend continues, many assembly-related jobs will become obsolete.

Previous research has already shown that Industry 4.0 technologies, as well as other changes to the organisation of work, induce a shift in qualification profiles even for skilled workers in production areas (Pfeffer et al. 2018; Heidling et al. 2019; Meil and Heidling 2010). IT and electronics knowledge are replacing traditional qualification profiles, such as metalworking, machine-building or other specialities in auto-related occupations that were designed for the production of cars based on combustion engines or diesel. With electric motors, subjects which were never considered a part of automobile production, such as chemical engineering, have even become relevant for auto production (VW – 5). The change is, therefore, not only about low or high skills, but also a massive shift in the competence mix of the workforce. This affects all sites, although perhaps at different speeds and with different emphases.

Interestingly, there seems to be an inclination at the central divisions and strategy levels to think very much in terms of processes rather than people. Consequently, the overwhelming focus is on getting the technology, and especially the process, right. The other things – work organisation or the composition of the workforce – are expected to adapt or be adapted to meet the new demands. Given that the line of communication at these levels is mainly with management or engineers, this view is not so surprising. Certainly, getting processes right across a complex value chain are crucial. Nonetheless, this fairly typical planning orientation – first the technology, followed by competencies
and the organisation of work – has been the modus operandi in most development waves and this almost always leads to problems in implementation (Böhle 1998; Böhle et al. 2002).

The general tenor of the interviews is that some jobs will be lost as a result of Industry 4.0 but others will be gained. There has been some thought about how to enact the shift, particularly in light of employment protection regulations in Germany and given that trade unions are a strong factor in this particular industry. The general concept seems to be of a long-term ‘re-training’ by having younger workforces – those with a long-term perspective at the plants – rotate through various workstations for stints of several months. It is unclear if similar arrangements are being offered across all sites and countries, although it is quite clear that such programmes are not targeted for older workforces.

It is evident that, other than recruitment and job rotation strategies, there appeared to be little training taking place specifically for Industry 4.0 applications at any of the sites in any of the cases.

What will happen to work as a result of the introduction of Industry 4.0? With regard to effects on work tasks and content, we asked what future developments could be expected. These findings would then give us additional information on whether work might be deskillled, and thus easier to automate, or what kinds of reskilling could be expected and what types of workers would be sought. In line with questionnaires from the other case studies presented in this book, we asked if activities would become increasingly standardised simpler, or more demanding and complex.

Interestingly, most respondents understood standardisation as compatibility and not as a characteristic of a task or activity. Thus, they predicted an increase in standardisation, but mainly regarding product platforms or systems integration rather than of the tasks or activities being carried out by workers. Some, however, suggested that tasks would become simpler in terms of being based on systems and architectures that would make operating systems easier to use, also as regards shop floor operators, by using digital technology interfaces. Some loss of competence in certain activities could also be expected through the deployment of artificial intelligence. Areas mentioned were evaluation and quality assurance, which currently depended on high levels of worker experience but which were tasks that could potentially be replaced by artificial intelligence and machine learning. Otherwise, respondents tended to believe that many aspects of working in digital networked environments would become more demanding and interesting. This was the case because the activities would become more diverse and less repetitive and would include new topics and areas of expertise.

8. Impacts on the value chain

As one interviewee put it, ‘the automobile industry is one of the most globally networked and logistically optimised industries’ (VW-5). Because of this, all the respondents felt that, when it came to strategies for introducing digital technologies abroad, it was
necessary to include all the actors in order for the system to work the way it should. This not only goes for the OEMs but the suppliers as well. Thus, the idea is to link not only the various sites and tier one suppliers, as is the case now, but in the future also the tier two and even tier three suppliers. Only in this way can the advantages of Industry 4.0 technologies be optimised. EDAG is one of those tier one suppliers, but it also carries out work as a general contractor for OEMs. The EDAG respondent pointed out that everyone along the chain must have the same tools and methods. ‘To put it bluntly, I can’t have my colleagues in India use a drawing board while we work with CATIA V5 [an engineering software program].’ The main argument why digital transformation will tend to upgrade the individual parts of the value chain is that the desired increases in efficiency, transparency, monitoring and control systems cannot be achieved without an overall coordination between all of the actors, including suppliers and remote sites. It is an economically-driven logic, not one based on empowerment or a strategy for upgrading.

What implications the resultant upgrading has for the organisation of work, the division of labour and workers’ competencies and qualifications at individual sites seems to be a secondary consideration. The local sites have to adapt because the requirements come from the headquarters to deploy certain technologies and achieve targets.

9. Reshoring?

There is a fair amount of hype in the current discourse in Germany about the potential for reshoring, in particular in connection with the increased deployment of Industry 4.0 applications. The argument is that new investments in digital technologies that bring high levels of efficiency and capital utilisation, together with synergy effects concerning production, services and customers, makes reshoring increasingly attractive (Strange and Zucchella 2017).

Quite frankly, the evidence for this position is not particularly convincing. For one thing, the levels of Industry 4.0 deployment in Germany are still so marginal that it is hard to mount arguments that it is leading to reshoring. Certainly, there has always been a certain amount of reshoring by companies which underestimated the transaction costs and the long-term investments involved in outsourcing, especially for complex products and processes. Levels of reshoring have actually remained amazingly constant over the last decade (Eurofound 2016). Nevertheless, the extremely high levels of outsourcing characterising the latter part of the 20th century have slowed down, partly as a result of saturation levels having been reached and partly as a result of the post 2008-2009 financial crisis.

Companies which have a longer track record of outsourcing, however, a category to which carmakers belong, have complex value chains which are part of a dynamic process of growth and change. Once offshoring or outsourcing has taken place, various forms of upgrading usually occur: products, processes, functions, shifting to new sectors or shifts in complete value chains – all of which have labour and capital dimensions (Gereffi et al. 2011; Gereffi and Kaplinsky 2001). In the development of value chain integration, the
movement tends to be from lower to higher level activities within sectors, for instance to high value added and more knowledge-intensive activities (Meil 2019). The automobile sector is, naturally, part of the industrial group which has high levels of knowledge-intensity (MGI 2019).

There are basically three scenarios that can be hypothesised as outcomes for offshored or outsourced sites as a result of the introduction of Industry 4.0 digital applications:

1. The central sites invest in new technologies at home and thereby pursue a reshoring strategy. This would mainly result in the downsizing or closure of offshored or outsourced sites over time

2. Value chains undergo a shift – this can occur in two directions:
   — an upgrading of the site through investment and the introduction of new digital technologies
   — a downgrading of the site through a lack of investment in new digital technologies, thereby reducing it to carrying out low-level tasks with low levels of skill. The site would service mainly as a cost-cutting destination, based on standardised products

3. There is no clearly discernible change in the relationship between offshored or outsourced sites and the headquarters, and roles in the value chain are not affected by Industry 4.0 technological transformation.

The vast majority of respondents in this sample did not believe that digital transformation would lead to an increase in reshoring. The consensus was that value chains across sites were already highly integrated and interconnected and that new investments in Industry 4.0 were unlikely to change this.

As we have seen, some respondents here did mention the possibility that companies could decide to concentrate their ‘old’ technology or products, i.e. diesel motors or cars using the combustion engine, in sites outside Germany while building plants for new products and applications at home. The opinion was that, given core competencies and quality considerations, it made sense to keep important processes and products for the future in Germany. Some companies, such as Festo in this sample, concentrate on high-end products and in any case manufacture largely within Germany. Indeed, they expect that, with such new technologies as 3D printing, specialised niche production could be carried out more easily in domestic plants.

Festo’s position on reshoring was most definitely a minority position among respondents in this sample, however. Among the rest, a common position did exist that, for new and proprietary products, it might be worthwhile considering what could be produced at home rather than be externalised. On the other hand, it was considered highly unlikely that production that had already been outsourced would be brought back, nor that not investing in the digital transformation of existing remote sites across the value chain was a realistic option. In general, the strategy of differentiating between old and new products in terms of site use does not appear to be particularly clear-cut at present. It
would be worthwhile considering which areas of Europe might be most susceptible to strategies geared to differentiating between old products and new ones.

10. Concluding remarks

OEMs and tier one system suppliers who would, presumably, be the companies dispersing new digital and Industry 4.0 applications across their value chains are still in the process of undergoing transformations themselves. Certainly, some applications, particularly in the automobile industry, are quite advanced: those involving logistics, ERP systems, automation with standard robots and some shop floor digital interactive software. Others are currently being introduced in the form of pilot projects. But for now, it is hard to discern any clear trend in terms of shifts in the division of labour or jarring changes in the organisation of work.

It does seem clear, however, that change facilitated by digital tools will continue and that it will have effects as regards job losses and job gains, shifts in occupational and competence profiles and, possibly, adjustments in the position and role of various sites across the value chain. For production in the carmaking industry, it does not appear that there will be major differences among sites further down the chain when re-tooling for more digital processes and networking of systems. It does not make sense to have sites at quite different stages of development. However, it is particularly in assembly, where the lowest-skilled parts of production exist, that the greatest moves toward automation, and accompanying employment loss, will take place. Although there might be some time lag in re-tooling between sites – old or new, outsourced or at home – the planning is for it to occur at all sites along the chain. This does not necessarily mean that the situation for all sites along the chain will be the same. In times of recession, as in the current corona crisis, employment reduction will tend to occur in places where the conditions for labour are more precarious. That is, those with less labour protection and union organisation.

In terms of decision-making, strategy, steering, etc. there are also differences across the chain. The companies examined here have their design, development and innovation management facilities mainly at home. It is at the headquarters where high-end developments in digital transformation take place and which ultimately decides what technologies get developed and where they are implemented. It is largely left to local sites to find ways to adapt to these changes, for instance, in the preparation of their workforces. Although local units have a say in capacity utilisation and other control issues relevant for their plants, decision-making is generally becoming more centrally-managed at company headquarters. This is especially evident for VW which, formerly, had a large network of different brands with fair amounts of autonomy to operate in their particular areas. Now, there is a push by Production or Group Components to streamline the use of sites. In all the cases described here, this has certainly not meant a phasing-out of sites located outside the home country; at least, not up to now. In fact, there are sites in eastern Europe that, although small, are some of the most modern in the company portfolio.
Ultimately, it does seem that there will be a shift in value chains with some upgrading occurring for those sites that survive the new demands. However, it appears that there will also be an increase in the monitoring and centralised analysis of data and that the design, engineering and development tasks linked to Industry 4.0 will remain, mostly, at home.

**Sars – Cov-2**

It would be remiss not to try to consider what effects the pandemic – the most significant event of our time – might have on the issues discussed here.

Some of the interviews and the writing of this chapter took place during the corona crisis. It should not be expected that this crisis would have a particularly strong impact on the results of this study but it was, nonetheless, an all-embracing topic on the minds of participants. Firstly, a great deal of their work, as well as some of the empirical work carried out for this project, was moved to the digital world. Many respondents felt this would have a lasting impact on how work is carried out and that much more would now be done virtually. It also made it all the clearer how inextricably integrated and interconnected were their supply and production chains within the global world of the automobile sector. This was not necessarily a soothing thought. They did not feel this would necessarily change post-corona, but it did bring to the forefront the interdependence and fragility of systems. Thus, there were some new considerations of whether proprietary systems or technologies that were of particular significance for the company’s future should, perhaps, be kept closer to home. However, these cautionary thoughts seemed to apply less to Europe and rather more for sites further afield.

Nonetheless, the major recession which is confronting the global economy, and which is hitting the automobile sector as much as any other, is most likely to lead to job loss and site closure. It is easier to cut employment in countries in which labour protection and job regulation are low, and additionally in which the role of local markets is not so high. This could be bad news for the sites of German carmakers in the emerging economies of eastern Europe. It may be temporary, but it could well lead to a delay in shifts toward digital transformation across the value chains.
References


