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Automation and occupational change in the German automotive industry

15.4.2021, Technical workshop: The effects of automation in the
apparel and automotive sectors and their gender dimension, ILO

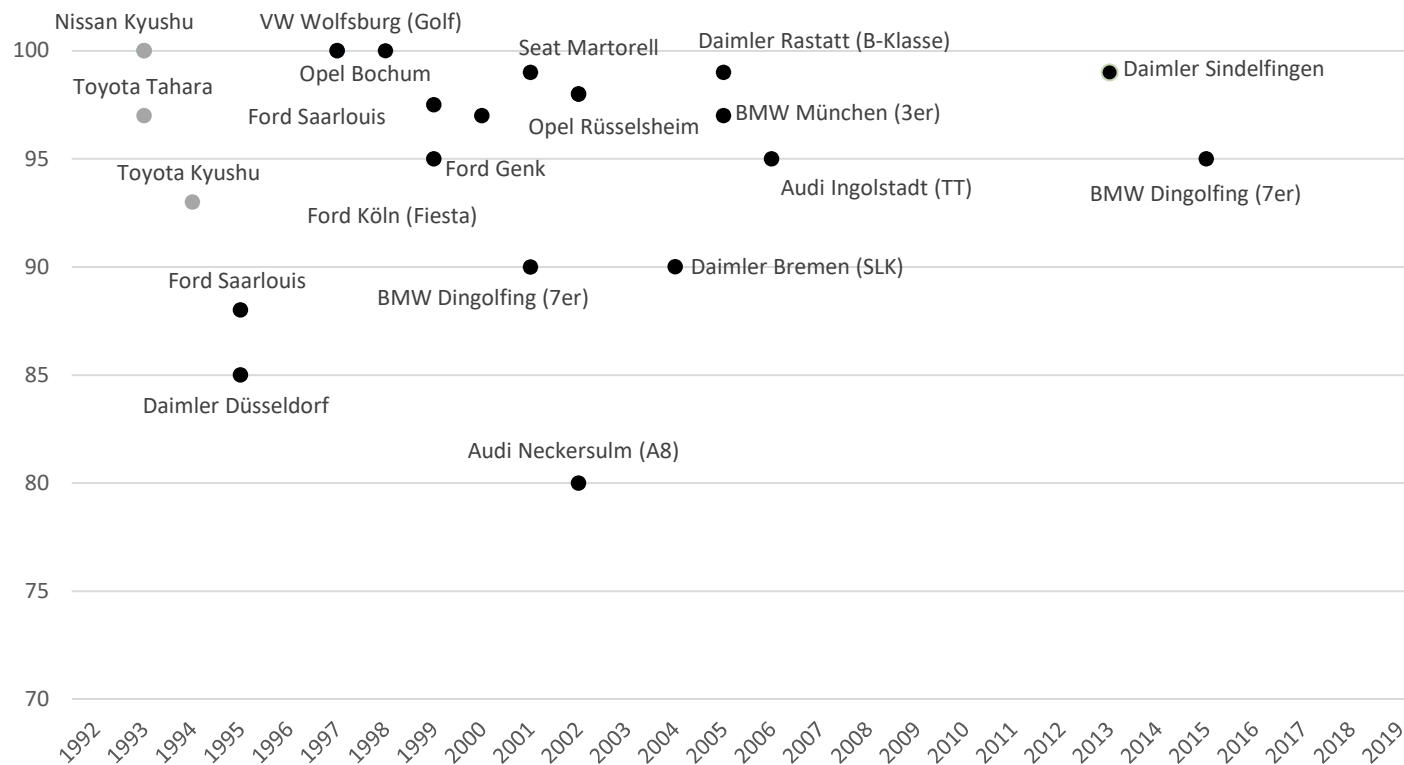
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Automation in the automotive industry (1)

- A number of core processes in the automotive industry has been automated since longer time:
 - Mechanical processing (machining, drilling, casting...) of parts (single-purpose machines at Ford since 1920s, NC and CNC machines after the WWII)
 - Welding since 1970s/1980s (and in form of the “Detroit automation” even earlier)
 - Pressing of parts possible only in an automated way; since 1980s automated press lines
 - Painting...
- OEM / supplier
- No particular push in automation observable in the last decade.

Automation in the automotive industry (2)

Body shop automation levels of selected automobile plants



Source: Automobil Produktion, volumes 1992–2019. The figure shows all plants for which information about automation levels was available.

Automation in the automotive industry (3)

- Example of the body shop (welding): major trend is increasing complexity and flexibility of automation
 - Growing need to reduce vehicle weight: use of aluminum and plastics requires different welding techniques (for aluminum) and leads to increased use of gluing (for aluminum and plastics)
 - Growing requirements for stability (safety of car body): increasing use of sophisticated laser welding techniques; use of multi-robot cells with higher demands for programming
 - Quality requirements: increasing use of inline measurement devices and geometry stations (several hundreds or even thousands of measurement points per vehicle)
- Trend of increasing product variety also increases complexity of production processes -> major challenge

Automation in the automotive industry (4)

- Assembly processes remain the domain of manual work
 - After automation efforts in the 1980s (Halle 54 at Volkswagen), the lean production turn in the 1990s leads to a more skeptical view on automation
 - Japanese and American companies more “automation skeptical”, German companies continue to look for possibilities of automation in assembly, BUT.... no major breakthrough
 - Lightweight robots are being implemented and tested but remain so far marginal in the assembly process -> no major automation push
 - A certain increase in automation possible due to the turn to electromobility -> the abandonment of the combustion engine reduces assembly complexity
 - Automation degrees in assembly shops of car makers today do not differ from the automation degrees in the 1990s: ranging from around 10% (Toyota) up to 30% in the most automated cases (VW)

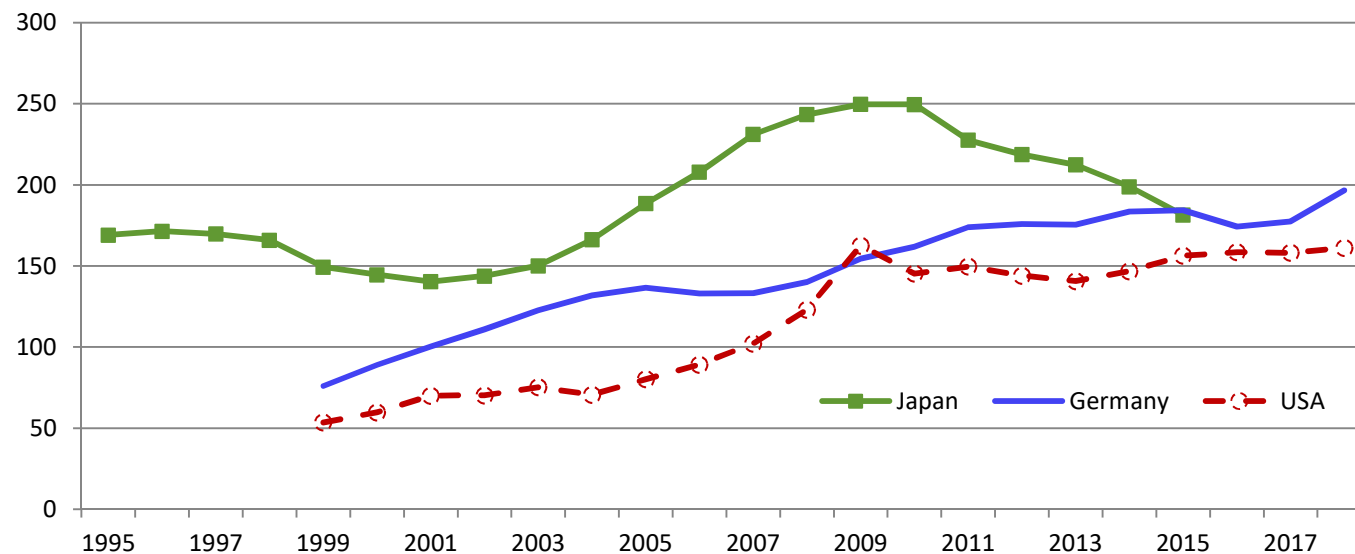
Automation in the automotive industry (5)

- Major efforts related to digitalization / Industry 4.0 are not related to increasing automation in production but to increasing efficiency of product and process development, commissioning, process monitoring and maintenance
 - Intense competition in the automotive industry leads to
 - Increasing product variety
 - Increasing sophistication of cars
 - Turn to electromobility and autonomous driving require huge innovation efforts from companies
 - All this means huge and ever increasing cost in product and process development
- Continuing efforts since the 1980s (see paper for more...):
 - Introduction of CAD since the 1980s; networking of production lines in the 1990s (switch from parallel wiring to serial wiring)
 - Digital Factory projects since the early 2000s: focused on integrating data and software systems in product and process planning; introduction of Industrial Ethernet simplifies networking in production
 - Since the 2010s: virtual commissioning, predictive maintenance...

Automation in the automotive industry (6)

- Robot intensity not a good indicator for automation: robots used only in some manufacturing processes; increasing number of robots often reflects increasing complexity of an already automated process

Stock of industrial robots in the automotive industry per thousand blue-collar workers in Germany, Japan, and the United States, 1995–2018



Source: Own calculations based on IFR, BLS, VDA.

Automation in the automotive industry (7)

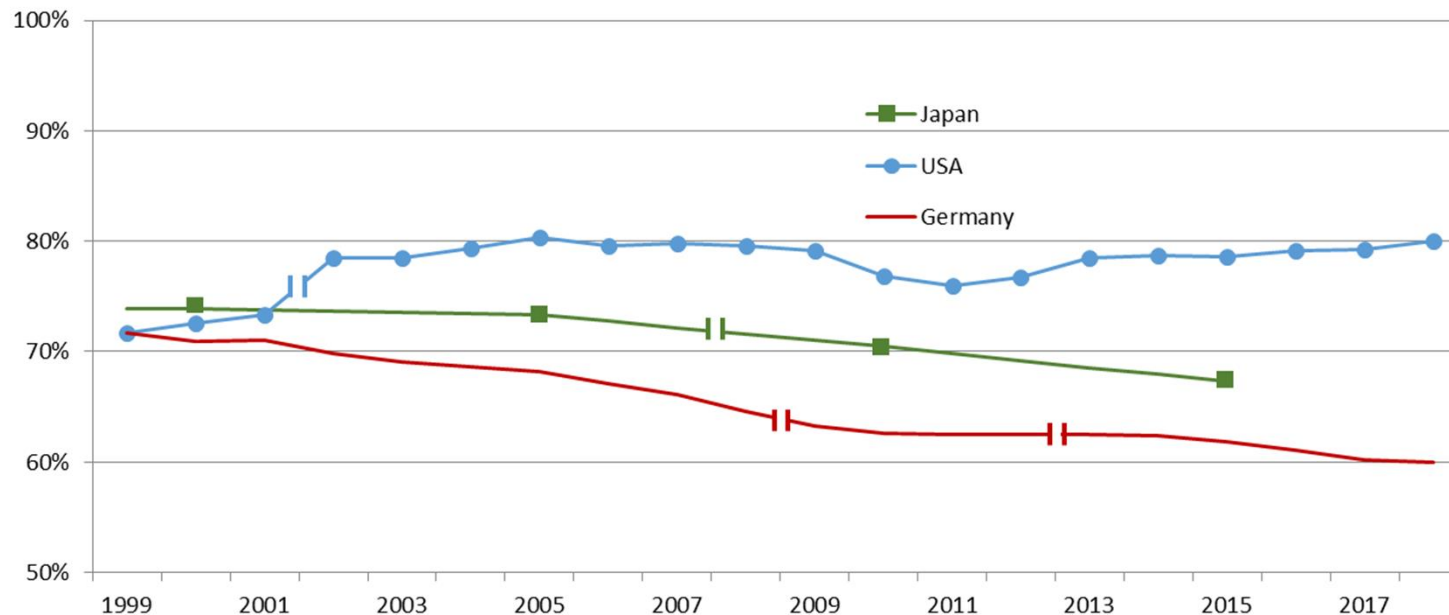
- What is driving automation? “Routine task” concept à la Frey and Osborne is in my opinion useless for analysis / prediction of automation
- Measurement problems: expert assessments of routine task intensity in many fields hugely underestimate the importance of creative and problem-solving activities
- Feasibility of automation in production is mainly dependent on process complexity, which itself depends on:
 - Variety of products and product variants to be produced,
 - Variety and number of parts and components to be assembled/processed,
 - Variety of specific production processes required,
 - Conditions of handling and fixing parts (hard parts, soft parts etc.),
 - Space and accessibility (e.g. assembly of parts within the car body),
 - Planned production speed,
 - ...

Occupational change (1)

Major problem: huge differences between national occupational statistics plus regular changes in the industry and occupational classification systems

Occupational change (2)

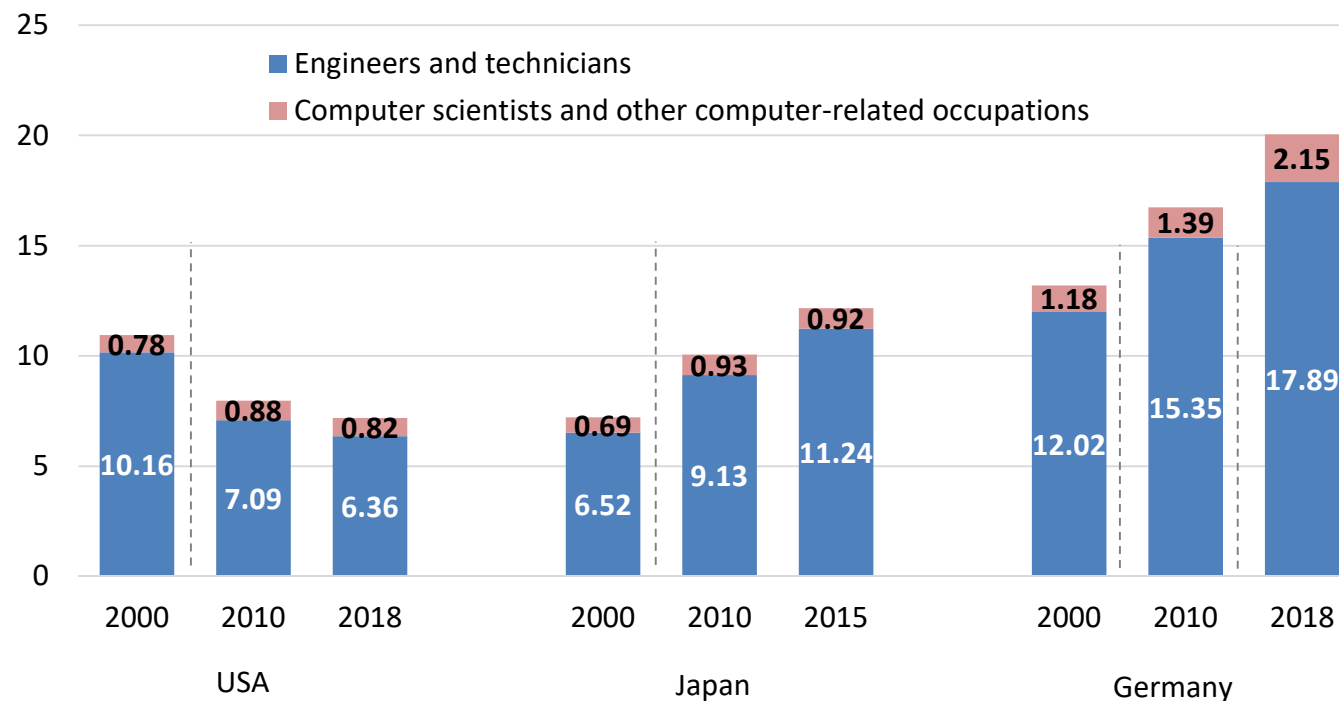
Share of blue-collar workers (production, logistics, construction) in the total employment in the automotive industry in Germany, Japan, and the United States



Source: Own calculation based on BLS, SBJ, and BA. Major statistical revisions are marked by ||.

Occupational change (3)

Share of engineers/technicians and computer scientists in the total employment in the automotive industry in Germany, Japan, and the United States



Source: Own calculation based on BLS, SBJ, and BA. Dashed lines mark major revisions of the industry and/or occupational classifications that limit the comparability of the data.

Occupational change (4)

- BUT:
- Remarkable resilience of manual assembly work -> no progress in assembly automation
- Decreases in the share of occupations mainly represented in highly automated areas -> (a) digitalization might reduce the number of people needed to monitor/maintain production equipment, (b) gradual increase of automation might eliminate last pockets of manual work in welding, painting etc.
- Increase in occupations related to automation (maintenance, commissioning)
- Caveat: occupational statistics do not really allow to examine the question of upskilling/deskilling

Occupational change (5)

Occupational composition of production workers in the German automotive industry

	1999	2007	2013	2018
Total	394,200 (100%)	410,400 (100%)	458,800 (100%)	487,500 (100%)
Assembly-related occupations	113,100 (28.7%)	135,500 (32.9%)	163,800 (35.7%)	169,800 (34.7%)
Metal occupations	185,500 (47.0%)	180,300 (44.0%)	152,000 (33.1%)	161,300 (33.1%)
<i>Of which:</i>				
<i>Metal-making occupations</i>	<i>5,100 (1.3%)</i>	<i>4,500 (1.1%)</i>	<i>7,400 (1.6%)</i>	<i>7,700 (1.6%)</i>
<i>Metalworking occupations</i>	<i>93,800 (23.8%)</i>	<i>89,900 (21.9%)</i>	<i>68,700 (15.0%)</i>	<i>69,300 (14.2%)</i>
<i>Occupations in metal constructing and welding</i>	<i>59,900 (15.2%)</i>	<i>57,700 (14.0%)</i>	<i>25,900 (5.6%)</i>	<i>26,200 (5.4%)</i>
<i>Precision mechanics and toolmaking</i>	<i>13,600 (3.4%)</i>	<i>13,000 (3.2%)</i>	<i>12,700 (2.8%)</i>	<i>11,500 (2.4%)</i>
<i>Plant and machine operators</i>	<i>13,000 (3.3%)</i>	<i>14,600 (3.6%)</i>	<i>37,200 (8.1%)</i>	<i>46,500 (9.5%)</i>
Other production occupations	61,800 (15.7%)	60,400 (14.7%)	82,000 (17.9%)	91,000 (18.7%)
<i>Of which:</i>				
<i>Color coating and varnishing</i>	<i>20,600 (5.2%)</i>	<i>16,200 (3.9%)</i>	<i>12,300 (2.7%)</i>	<i>11,900 (2.4%)</i>
<i>Technical occupations in quality control</i>	<i>19,500 (4.9%)</i>	<i>21,400 (5.2%)</i>	<i>25,400 (5.5%)</i>	<i>26,100 (5.4%)</i>
Automation-related occupations: technical staff in maintenance, mechatronics, automation and control technologies	19,000 (4.8%)	19,200 (4.6%)	39,100 (8.5%)	43,400 (9.0%)
Supervisors in production	11,200 (2.8%)	11,400 (2.8%)	19,200 (4.1%)	19,000 (3.9%)

Source: Author based on BA. Major revisions of statistical classifications that limit the comparability of data are marked with bold lines.

Final remarks

- Automation – the story is much more complicated than routine-task intensity theory suggests.
- Do not just look at the robots.
- Major transformations of employment are not related to automation (at least not directly), but to the changes of the product -> Electric mobility!

Thank you very much for your attention!

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