# THINK ACT

BEYOND MAINSTREAM

February 2016

# Digital factories

The renaissance of the U.S. automotive industry

Roland Berger

PLUS
AUTOMOTIVE USE CASES
→ P. 17

# THE BIG 3

## 32,000,000,000

dollars is the estimated total productivity gain of automotive digital factories in the U.S.

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reasons why now is the time to invest in automotive digital factories

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requirements for automotive digital factories that make the U.S. the ideal playground

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# All change. Automotive manufacturing goes digital. The industry's survival depends on it.

Car buyers get digitization. Connected vehicles, autonomous driving, and new business models such as Uber provide material for lively public debate. The next digital revolution however, is not only about the consumer; it's even more about productivity. Digitizing the manufacturing process promises not only greater efficiency and reduced costs, but significantly addresses three of the U.S. automotive industry's most pressing challenges:

### 1. MORE VEHICLE DERIVATIVES, MORE NICHES, MORE OPTIONS

Global platform sharing will rise significantly with platforms decreasing from 500 in 2015 to 460 in 2020 while the total light vehicle market is expected to grow from 88 m units to around 100 m by 2020 (Source: IHS). The result: One platform (and all the standardized manufacturing processes behind) has to support more vehicle models and options than ever before. Also, the average cycle time of one vehicle generation in the market is predicted to decline for North American OEMs by 10% to below 5 years per vehicle cycle until 2020. **THE ANSWER:** Manufacturing needs to react with faster assembly line changeover and an improvement in time-to-market.

### 2. MARKET VOLATILITY

The growth of the overall automotive market can be predicted. But its composition, e.g. demand per model or the success of new niche models has become more unpredictable than ever before. Inflexible capital expenditures are a risk in such an environment. Manufacturing equipment needs to be adaptable to change should models not achieve the anticipated market success. Demand patterns between vehicle types and options are shifting; new technologies need to be adapted. **THE ANSWER:** Set up production processes that are flexible and reliable.

### 3. LABOR INTENSIVE, INFLEXIBLE AND EXPENSIVE PRODUCTION

The Detroit-based car manufacturers are experiencing severe cost pressures. Any vehicle produced in a plant in Michigan comes with a significant labor cost share, which gives the product a profitability disadvantage. The same is true for other sites in the United States, e.g. where foreign OEMs have based their U.S. subsidiaries. **THE ANSWER:** Factories in the U.S. need to improve their competitiveness constantly, and this includes lower manual work content.

# A solution in sight.

# The arguments for digital factories are compelling. It's all about speed, customization and cost.

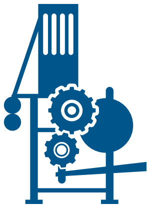
Digital factories will produce higher quality products, including a greater number of derivatives, with fewer failure parts (PPM), faster time-to-market – and, most importantly, lower costs. These ambitious goals can be reached by following a trend known as the fourth industrial revolution, or simply "Industry 4.0". → A
Physical objects are being integrated seamlessly into the information network. The internet is combining with intelligent machines, systems production and processes to form a sophisticated network. The real world is turning into a huge information system. Productivity gains will not only occur within the factory itself (during production) but can be expected all along the value chain, starting with engineering and product development (e.g. through virtual prototyping and testing or 3D printing), in supplier management, logistics, and much more. These changes result not only in a better utilization of capacities and balanced plant and staff deployment. Moreover, affordable product diversity – "cost of one = cost of thousand" – is within reach. A "digital factory" is born.

# A

# THE FOUR INDUSTRIAL REVOLUTIONS

## Giant leaps in industrialization over last two centuries

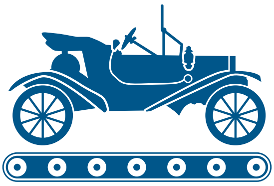
**1.0**



**MECHANICAL PRODUCTION**

End of the 18th century: In England, a **STEAM ENGINE** powers a loom for the first time – the dawn of mechanical production.

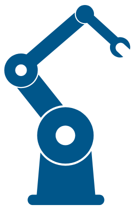
**2.0**



**MASS PRODUCTION**

End of the 19th century: **ELECTRIFICATION** enables mass production to be broken down into specialized activities on the production line – in American abattoirs to begin with, and later in the auto industry, with Ford Motors' "moving" assembly line. Quality improves, prices decline.

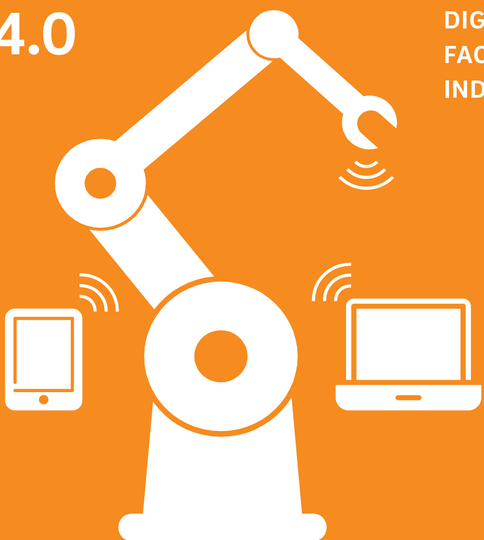
**3.0**



**AUTOMATION**

50 years ago: Aided by microelectronics and IT, and in particular by programmable logic controllers, the **AUTOMATION** of production gains ground. Machines take ever more complex tasks out of human hands and raise productivity.

**4.0**



**DIGITAL FACTORIES AND INDUSTRY 4.0**

Today: Cyber-physical systems (CPS) are central to the **DIGITIZATION** of production. Work pieces, tools, production plant and logistics components with embedded software are all talking to each other. Smart products know how they are made and what they will be used for. Customized mass production – in "segments of one" – is on the march on affordable terms. Smart, inter-connected products that can stay in touch with the manufacturer even after they are sold open up the possibility of new services and business models. Producers are offering value-added services to their customers. Trust in a secure and reliable technological infrastructure is allowing deregulated and highly competitive markets to emerge.

Source: Roland Berger

Three major groups of players need to work together to make this happen: Providers of infrastructure, like telcos, Cisco, or Amazon need to provide supporting structures and services, e.g. cloud computing or storage for big data. Technology companies, such as GE, Siemens or ABB need to provide collaborating robots or remote maintenance systems. And globally operating manufacturers, including the Detroit-based automotive manufacturers FCA, Ford, and General Motors or all the other major global OEMs can be the heart of Industry 4.0. The three groups can thus create a new six-dimensional industrial landscape → **B** to make better products, which are more tailored to individual requirements.

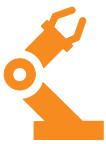
The most compelling argument is likely to be the remarkable productivity gain, that can be expected from digital factories. The Fraunhofer Institute for Manufacturing Engineering and Automation (IPA) has analyzed the benefits in detail. Overall, the IPA's experts come up with savings potential of 10-20% of addressable costs, which includes spending for manufacturing, logistics, inventory, quality, complexity and maintenance. Considering that these costs in the automotive sector (OEMs and suppliers) on U.S. soil sum up to roughly 160 billion dollars (Source: US Census Bureau) this constitutes a range of 16-32 billion dollars of cost reduction, which is up for grabs. While this figure is impressive, it is even more remarkable when we consider that it does not yet include savings on imported materials and components. Looking a bit deeper into the details, IPA estimates the savings per production function as follows. → **C**

## B

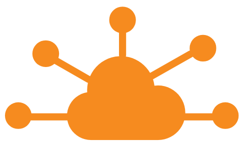
**DIGITAL FACTORY ELEMENTS**

Six characteristics of the new industrial landscape

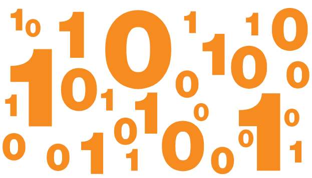
**Cyber-physical systems (CPS) and marketplace**
IT systems built around machines, storage systems and supplies linked up as CPS



**Smart robots and machines**
Multipurpose "intelligent" robots able to adapt, communicate, and interact with each other and with humans based on remote control

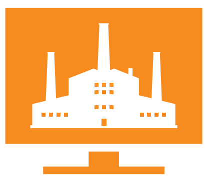


**New quality of connectivity**
Connection of digital and real worlds with constant exchange of information between machines, work pieces, systems and human beings



**Big data**
New methods to handle huge amounts of data and tap into the potential of cloud computing

**Energy efficiency and decentralization**
Energy decentralization for plants due to climate change and scarcity of resources



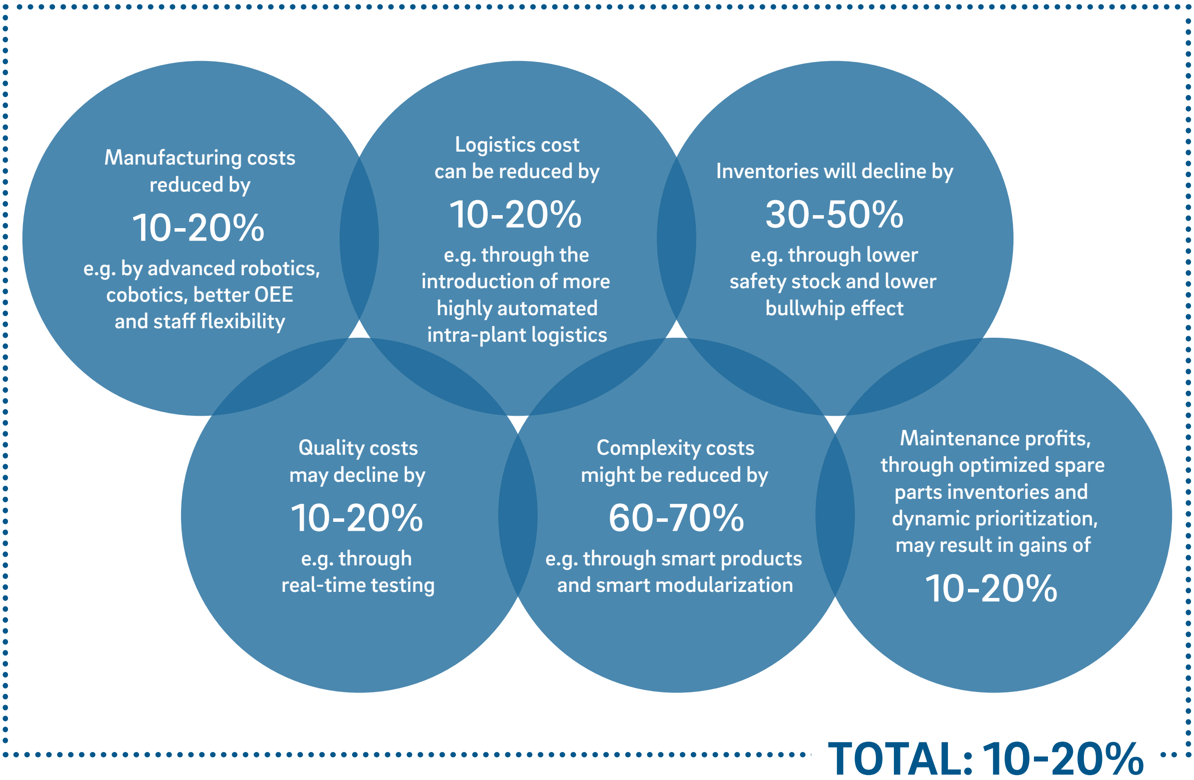
**Virtual industrialization**
Virtual plants and products to prepare physical production via simulation, verification and physical mapping

Source: Roland Berger

## C

**PROMISING EFFICIENCY GAINS**

Digital factories are predicted to reduce cost in almost all operations functions




Source: Fraunhofer Institue for Manufacturing Engineering and Automation (IPA), Roland Berger

### 1. MANUFACTURING

Digital factories are expected to reduce manufacturing costs by 10-20% as compared with pre-digital levels. One major factor driving improvement in manufacturing will be increasingly advanced robotics/ machinery, as technologies such as self-reconfiguring machines and the human-robot collaboration of "cobotics" become increasingly mainstream. Other cost saving factors include the development of self-optimizing systems and the use of virtual plants and products (before and after physical production begins). Another related driver of cost savings will be increased staff flexibility as job functions adapt to new requirements. As these advances are implemented, positive effects will range from increased operational equipment efficiency (OEE) and reduced machine idle time to quicker production ramp-up times, shorter changeover times and improved process control loops.

### 2. LOGISTICS

In general, increasingly integrated supply chains and highly automated intra-plant logistics are expected to bring steady improvements to logistics efficiency in the coming years. These overall changes will be driven by technologies such as smart storage (enabling optimized internal logistics planning) and demand driven provision of materials and goods. Cumulatively, advances in this area are expected to improve manufacturers' logistics costs by 10-20%.

## 3. INVENTORY

The digital factory of the future will give manufacturers better visibility and control over both their current inventory levels and future inventory needs. It is estimated that new technologies in this field will provide the opportunity for manufacturers to yield a 30-50% reduction in inventory costs over time. Solutions such as cyber physical systems that improve the manufacturer-customer interface and the connection to supplier networks allow manufacturers to hold less safety stock and manage the bullwhip effect.

## 4. QUALITY

The digital factory will also have important ramifications on product quality levels and related processes, as it is expected that a further 10-20% of cost savings can be found in this area. Digital factory technology will allow manufacturers to increasingly monitor and even predict where and when quality issues may occur. In addition to this predictive quality control, the increasing prevalence and enhancement of real-time quality testing (if needed, at every production step) will also work to gradually reduce manufactured defects and other quality related costs.

## 5. COMPLEXITY

New technologies will lead to a reduction in cost associated with manufacturing complexity. Advances such as smart robots, smart products and modularized production are designed to handle complex production processes efficiently. In this way digital factories will be designed to troubleshoot production problems and other issues related to manufacturing complexity as quickly as possible. Potential savings in this area are estimated at between 60-70%.

## 6. MAINTENANCE

Finally, maintenance will face significant improvements in both effectiveness and overall cost levels when compared with previous manufacturing eras. Numerous technologies will work to streamline the task of keeping a plant in optimal working order, ultimately driving cumulative maintenance cost savings of between 10-20%. Examples of use cases within the maintenance area include predictive maintenance, optimization of spare parts inventories, and the dynamic prioritization of maintenance tasks.

In addition to lowering production costs, the digital factory also brings considerable benefits to the customer with a corresponding knock-on effect on sales. For example, manufacturers may offer a truly bespoke and made-to-order vehicle fulfilling exactly the requirements laid out by customers when they configured their car online. While this is already available today, demand has thus far been very limited. Reason: It often takes months for a bespoke vehicle to be delivered to the customer and this is a no-go in the U.S. market.

# TIME TO INVEST.

## Conditions have never been more favorable for digital factories.

I

### Cost pressure due to emissions regulations and electrification

The emissions targets set by the governments in all major global markets will push further hybridization and electrification of vehicles. This will inevitably come with significant investments and higher vehicle costs for new powertrain components (such as the electric engine). End customers do not show a strong willingness to pay for them in the future – except perhaps a few technology-fascinated early adaptors. In the end, the costs of electrification will need to be borne by manufacturers and suppliers. The savings from digital factories are an ideal opportunity coming at the right time to compensate for this. Not to mention that a complete reconfiguration of the powertrain will allow new manufacturing setups. And if production needs to be updated as a matter of course, then why not get it right first time?

II

### Need for more capacity

U.S. vehicle production capacities are close to exhaustion – at the moment they are at 90% utilization, reaching an almost all-time high. Meanwhile global vehicle markets continue to grow, offering sales opportunities for the U.S. OEMs. This means the car manufacturers, and with them the full value chain of different supplier tiers, will need to invest in further capacity sooner rather than later.

III

### Cash rich OEMs and easy access to capital

Many OEMs are currently experiencing strong financial performance driven by a cyclical boom in durable goods (including automobiles). Automotive sales in the U.S. have risen 8.6% p.a. since 2009, pushing Ford and GM to their highest levels of profitability in years and increasing cash in hand for investments. The Detroit Big Three (FCA, Ford and GM) alone can mobilize a combined USD 70 bn at very short notice (cash and short term investments). The U.S. corporate bond market topped one trillion dollars in lending in 2015 – an all-time record. Many central banks, including the U.S. Federal Reserve, are maintaining interest rates near zero to stimulate investment as the global economy recovers from the 2008 financial crisis. This combination of willing lenders and low interest rates makes investing the capital for digital factories much more palatable.

# Go USA. Clusters, capital and competency: The U.S. is the playground of choice.

Can the U.S. be the winner in a competition against low cost countries for the best location for a digital factory? Roland Berger compared the prerequisites for digital factories with the location factors in the United States and came to a clear conclusion: The U.S. ticks all the right boxes.

## 1. DIGITAL FACTORY ECOSYSTEM

The United States maintains strong competitive advantages in establishing digital factories – the most pronounced of which is the existing technology clusters. The United States is home to eight of the top ten information technology companies including such vaunted names as Intel, Microsoft, and Google. The U.S. has a handful of tech clusters including San Francisco, Seattle and Boston. These clusters are crucial to the formation of talent pools necessary for all firms in the digital factory ecosystem and are supported by world-class educational facilities such as Stanford, the Massachusetts Institute of Technology and Carnegie Mellon.

Venture capital provides opportunities for experimentation and exploration beyond research grants and corporate funding. The presence of a venture capital industry sharing the start-up and development risk with traditional corporate R&D is a key feature of the U.S. market. In 2014, the United States venture capital industry deployed over 50 billion dollars of capital – a figure larger than Europe, China, and India combined. Of the venture capital funding provided in the U.S., 24 billion was invested in Silicon Valley with the second largest region of investment being New York with 5 billion. Furthermore, software was the number one funded industry by venture capitalists due to its scalability and strong margin potential. Software focused businesses received 41% of the U.S. investment.

This is highly relevant for digital factories and U.S. competitiveness as software capable of linking manufacturing equipment with the internet and integrating supply chains remains a crucial missing element. Software development will likely require experimentation with possible initial failure before clear platforms emerge. The strong global presence of venture capital – when coupled with the educational infrastructure and strong IT companies – provides the U.S. with a unique infrastructure and capabilities advantage that is hard to replicate.

Strong IT is critical for digital factories because IT competency is required to initially digitize the production process and maintain it. This ecosystem – connecting manufacturing machines to the internet, coordinating supply chains via software, etc. – will require the cooperation and coordination of industrial machine manufacturers and IT providers. Which party drives the innovation is still to be determined; however there is a strong argument for IT providing the lead innovation. There are more examples of software companies innovating and redefining businesses than incumbents "out-innovating" software players – consider how Apple redefined the cell phone market and Google redefined advertising.

That said, history is never a predictor of the future. Many industrial companies have witnessed the way software and internet companies have altered business models and are determined to lead through the transition to digital factories. General Electric realizes that software will lead innovation and is actively investing in software capabilities – via acquisitions and intelligent advertising campaigns. Software knowledge will become commoditized making the knowledge of production systems and processes the core differentiator (currently the core competency of industrial players).

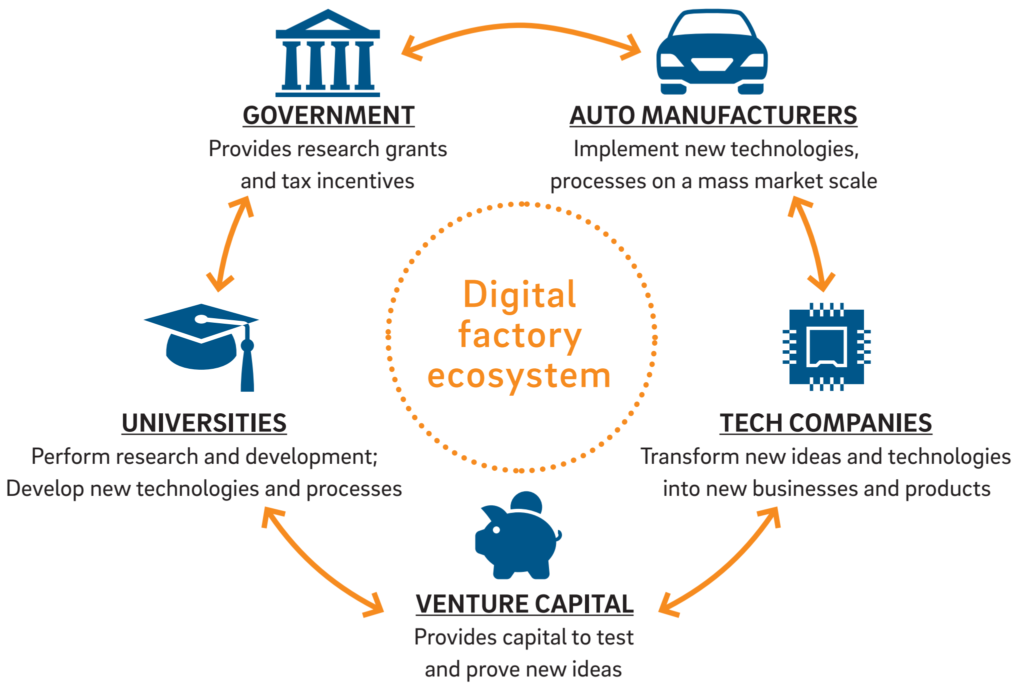
Once production has become entirely digitized, it will still require strong IT infrastructure to maintain investment. New white collar skilled workers will be required inside manufacturing facilities to oversee machine functionality and connectivity networks to maintain smooth operations. Their skills more closely reflect those found in tech clusters making it crucial for manufacturers to establish roots near existing tech ecosystems and collaborate with tech partners. Collaborations are already underway between manufacturers and IT providers, extending the benefits of these technology clusters into the automotive industry.

While there are numerous ways of pursuing digital factory strategies in automotive, it is clear that, on the one hand, leveraging existing knowledge from technology clusters and utilizing collaborative partnerships is crucial to getting ahead of the competition and, on the other, that the U.S. is singularly well-equipped to do so. → D

# D

## DIGITAL FACTORY ECOSYSTEM

Private and public players create an ideal basis for digital factories




Source: Roland Berger

### 2. MODERN INFRASTRUCTURE AND PROXIMITY

Reliable infrastructure and close proximity of supplier and OEM locations are critical in a digital factory ecosystem. When coupled with lot-size-one customization, supplier components are produced and then sent to the OEM plant for assembly just-in-time, and often, just-in-sequence. While not new to the automotive industry, these components are the key to unleashing the benefits of digital factories. If inventory stock is to be kept to a minimum, then transportation between production locations needs to be short and on the dot. This will allow supplier and OEM robots/equipment and supply chain software to be virtually linked, thus creating one massive virtual factory.

The infrastructure quality is a country-specific risk that firms cannot manage, however logistics risk can be mitigated to some extent through supplier-OEM proximity and a sufficiently well-developed road network. In essence, digital factories enhance the value of manufacturing clusters. The U.S. possesses a unique combination of automotive clusters, reliable transportation infrastructure and internet integration.

The United States has a long history of automotive manufacturing and supply chain integration – dating back to Henry Ford's vertically integrated Rouge River plant of the 1920s. America's 100-year legacy of automotive production established automotive clusters – areas with high specialization and a strong supply chain footprint. The U.S. automotive clusters stretch from Detroit down the I-75 corridor into Alabama and reach across the South from South Carolina to Mississippi. Here OEMs share resources easily.

The introduction of Toyota's production system and just-in-time manufacturing turbocharged the necessity of supply chain integration in automotive. Witnessing Toyota's success in improving product quality while lowering working capital, rival OEMs quickly adopted similar manufacturing policies and techniques. BMW, when moving serial production to the United States, insisted that suppliers also bring manufacturing capabilities to support the entire supply chain. This sequence of continuously improving production and supplier integration in the U.S. has created an environment prepared for further supply chain integration – thus setting the stage for the benefits of manufacturing digitization.

Behind the scenes, tying these automotive clusters together is the U.S. infrastructure – both physical and digital. While infrastructure may be viewed as simply a hygiene factor, digital factories require precision in timing, thereby raising the importance of a capable infrastructure network. On this front, America certainly delivers.

## Two examples

### MASERATI

Maserati teamed up with Siemens in launching the Maserati Ghibli in 2013 using a suite of simulation and tracking tools to streamline production and design. The complex production processes were planned, monitored and optimized using software. Maserati also employed software for flexible automation of the production line and even simulated the production process before committing to a production line configuration. Finally, Maserati elected to digitize the design using NX software to improve communications across functions and increase the pace of innovation.

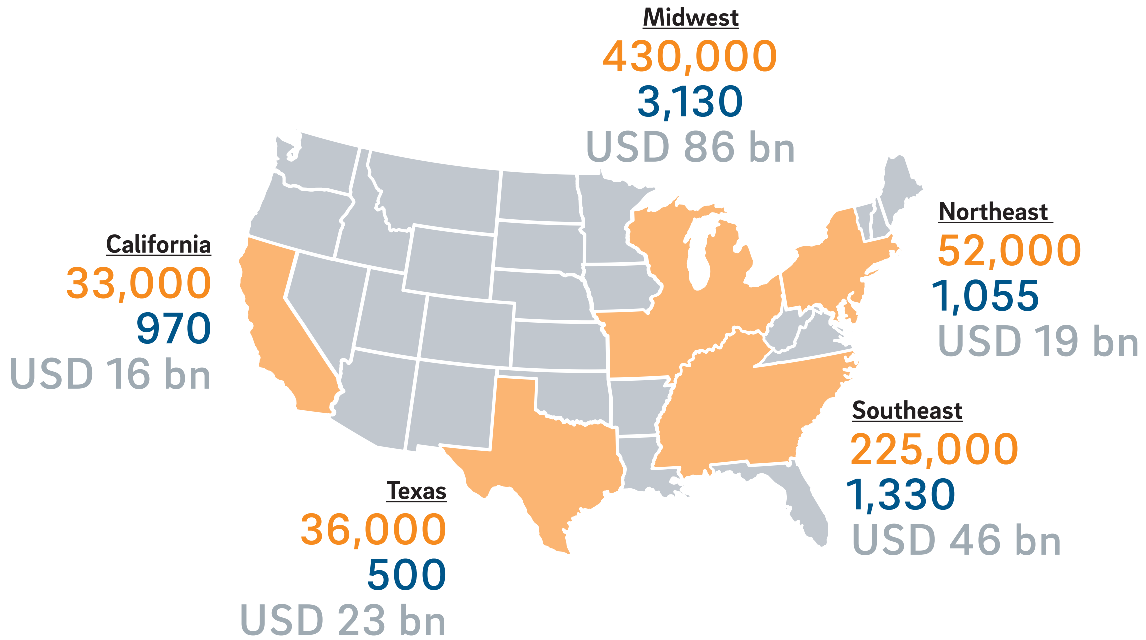
### BMW

In their Spartanburg plant in South Carolina, BMW is pursuing a different path to digital factories – focusing first on advances in ergonomic robotics to improve line productivity and reliable quality of output. BMW launched a collaborative robotics pilot program in their plant in 2013 by installing robots made by Denmark's Universal Robots. As well as reducing injuries , "the robots help to make the process even more stable, thus providing even greater quality assurance," says BMW CEO, Harald Kruger. Quality is crucial not only for consumer satisfaction but also for functional safety – similar to the aerospace industry – as the automotive industry is shifting increasingly toward advanced driver assistance and automated driving.

# E

## U.S. AUTOMOTIVE CLUSTERS

Vehicle production is consolidated in five major clusters with close proximity and good infrastructure within the clusters




Source: U.S. Economic Development Administration, U.S. Department of Commerce, Roland Berger

The U.S. maintains coast-to-coast highways and rail networks, and runs the largest shipping ports in the hemisphere. Furthermore, the U.S. IT infrastructure is available coast to coast and wireless data providers are able to blanket the vast majority of the U.S. with service coverage. These factors taken as a collective led the World Economic Forum 2014-2015 Global Competitiveness report to rank the U.S. in the top 10% globally in infrastructure capability and placed it #1 in the Americas. → E

### 3. EDUCATED LABOR FORCE

Digital factories will incorporate real-time information from assembly line robots that will need to be physically maintained as well as upgraded with software patches. This will require a balanced workforce of mechanical engineers and software engineers working together to adapt the factory to changing product requirements and day-to-day maintenance needs. Each zone of the manufacturing plant will be transformed with respect to work planning, physical production, monitoring and maintenance. This leads to a demand for skilled workers that are capable of meeting the changing requirements in each of these areas.

In a digital factory, work planning will be modeled in a virtual environment before it is implemented in the physical world. This will require plant managers with degrees in operations, mechanical engineering and software design. These experts will have to work together to virtually model and optimize the manufacturing plant with advanced algorithms, analytics and machine learning.

Then, once the plant is up and running, the role of the plant workers will evolve as well. While today's blue collar worker may often be responsible for only one work station on the assembly line, the future will be a different story. In a digital factory, the role of these workers will change from working hand-in-hand with the machines to monitoring and repairing the robots as well as overseeing multiple work stations and different assembly steps. This requires a broader skill set and the ability to adapt to different situations quickly.

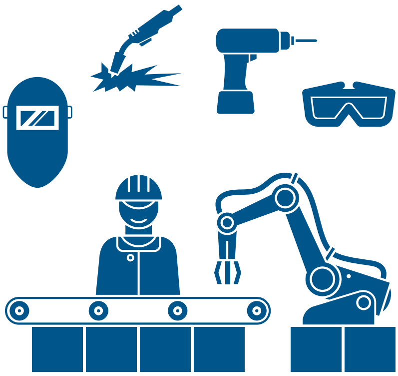
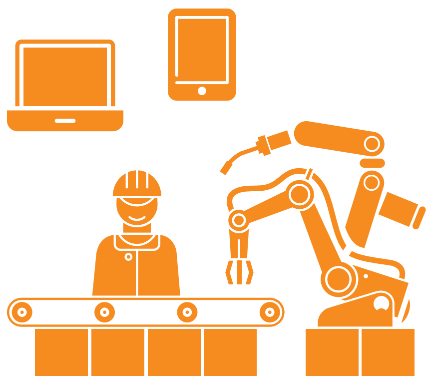
Monitoring and maintaining the machines and robots will also change in a digital factory. In the current environment, equipment is often not monitored in real time and maintained on a preventive maintenance schedule. In a digital factory environment, the use of remote monitoring and big data analytics will change the preventive maintenance schedules of today to predictive maintenance. Rather than fixing machines on a regular basis, engineers and data analysts will be able to predict when a robot will stop performing and repair it before a larger disruption or outage occurs. This reduces manufacturing downtime and costs.

Digital factories will need a large number of employees with degrees in science, technology, engineering and mathematics (STEM) and the U.S. has one of the best workforces for meeting these demands. The U.S. has over 3,200 colleges and universities that offer degrees in the STEM fields that turn out over 570,000 graduates each year (Source: National Center of Education Statistics). For an automotive OEM or supplier looking to implement a digital factory, the U.S. has the right talent base to meet the demand – especially compared to emerging markets. However, the "war for talents" is strong nowadays and it will be critical for any company investing in digital factories to plan and invest in this important human resource well ahead of time. → F

## F

**THE WORKER OF TOMORROW**

Day-to-day work and skill levels of people in digital factories are different from today's traditional workers

| | MODERN FACTORY WORKER | DIGITAL FACTORY WORKER |
| --- | --- | --- |
| |  |  |
| **Day-to-day activities** | > Direct value add<br>> Works hand-in-hand with machines<br>> Works on one process at a time | > Indirect value add<br>> Monitors robots and processes<br>> Works on multiple processes simultaneously |
| **Skills required** | > Mechanical skills<br>> Expertise for specific task(s), e.g. welding, soldering, ... | > IT interface handling<br>> Equipment maintenance<br>> Statistical/process analytics |

Source: Roland Berger

## 4. GOVERNMENT SUPPORT

The U.S. is an attractive place to invest in digital factories due to the amount of federal and local incentives being offered to invest in these technologies and create the manufacturing foundation of the future. The Federal Government's Advanced Technology Vehicle Manufacturing (ATVM) Loan Program provides loans to automobile and automobile parts manufacturers. These support the cost of re-equipping, expanding, or establishing manufacturing facilities in the United States to produce advanced technology vehicles or qualified components, and the associated engineering integration costs. Total funding for the program is 25 billion dollars and awards have ranged from 50 million to 5.9 billion dollars.

For example, the Ford Motor Company was awarded a 5.9 billion dollar loan to upgrade factories across Illinois, Kentucky, Michigan, Missouri, New York and Ohio to create state-of-the-art assembly and manufacturing plants that have enhanced flexibility capable of producing multiple-platform, fuel-efficient advanced vehicles. Nissan has also received a similar award of 1.4 billion dollars to retool its Smyrna, Tennessee, manufacturing facility and construct one of the largest advanced battery manufacturing plants in the United States. The plant will be capable of producing 200,000 advanced-technology batteries a year.

At the local level, many states have government sponsored economic development groups dedicated to providing tax incentives to manufacturers that will bring jobs and innovation to their state. For example, the Michigan Economic Growth Authority Board has the broad authority to promote economic growth and job creation and to redevelop brownfield sites in Michigan. This Board has the ability to approve and authorize high-tech tax credits and other incentives. Since its founding in 1995, MEGA has provided more than 12 billion dollars in tax credits to spur economic growth and development. General Motors, Ford and FCA have been awarded a combined 4.5 billion dollars in tax credits if they can retain more than 86,000 jobs in Michigan through 2032 and spend 5.5 billion dollars in upgrading assembly plants and other facilities in Michigan.

Further south, the Georgia Department of Economic Development provides automotive companies with a raft of measures to enhance productivity, streamline cargo transportation, and gain competitive advantage. These include longstanding industry best practices, a skilled workforce, robust tax incentives, and an excellent cargo transportation network. Just to emphasize how extensive tax benefits can be, the South Carolina State Government, besides offering a similar package of services to their colleagues in Georgia, also offers low corporate taxes and generous tax credits. The result is a competitive business environment with lower operating costs for manufacturers, suppliers and other companies. More specifically these incentives include jobs tax credit, corporate HQ tax credits, investment tax credit, job development credit, and finally property tax abatement.

Staying with tax, the Internal Revenue Service (IRS) changed its R&D tax credit rules in June 2014 to enable businesses to claim R&D tax credits on current and amended tax filings. This effectively enables businesses to simplify how they can file for research and development tax credits and further decreases the net cost of investing in new technologies.

All of these federal, state and local initiatives and incentives make it attractive for automotive OEMs and suppliers to invest in digital manufacturing capabilities. For example, an automotive supplier could apply to the federal ATVM program for a low cost loan to upgrade an existing facility with cyber-physical systems, smart robots, connectivity and big data analytics. Then it could further reduce the cost of its investments by applying for IRS and state level tax credits in the areas of R&D and job creation.

# One small step for digital. One giant leap for automotive. "Made in USA" can become the new rallying call of quality.

The digitization of industry is likely to develop in a more evolutionary than revolutionary manner. Thus far, we have witnessed companies implementing largely showcase examples. Expect full-scale pilot solutions for existing factories up until 2020, with greenfield digital factories possibly being developed earlier. Broader adaptation of standard solutions coupled with the gradual replacement of most machinery is likely to happen around the year 2025. The final "full" transition to Industry 4.0 and digital factories is projected for approximately 2030.

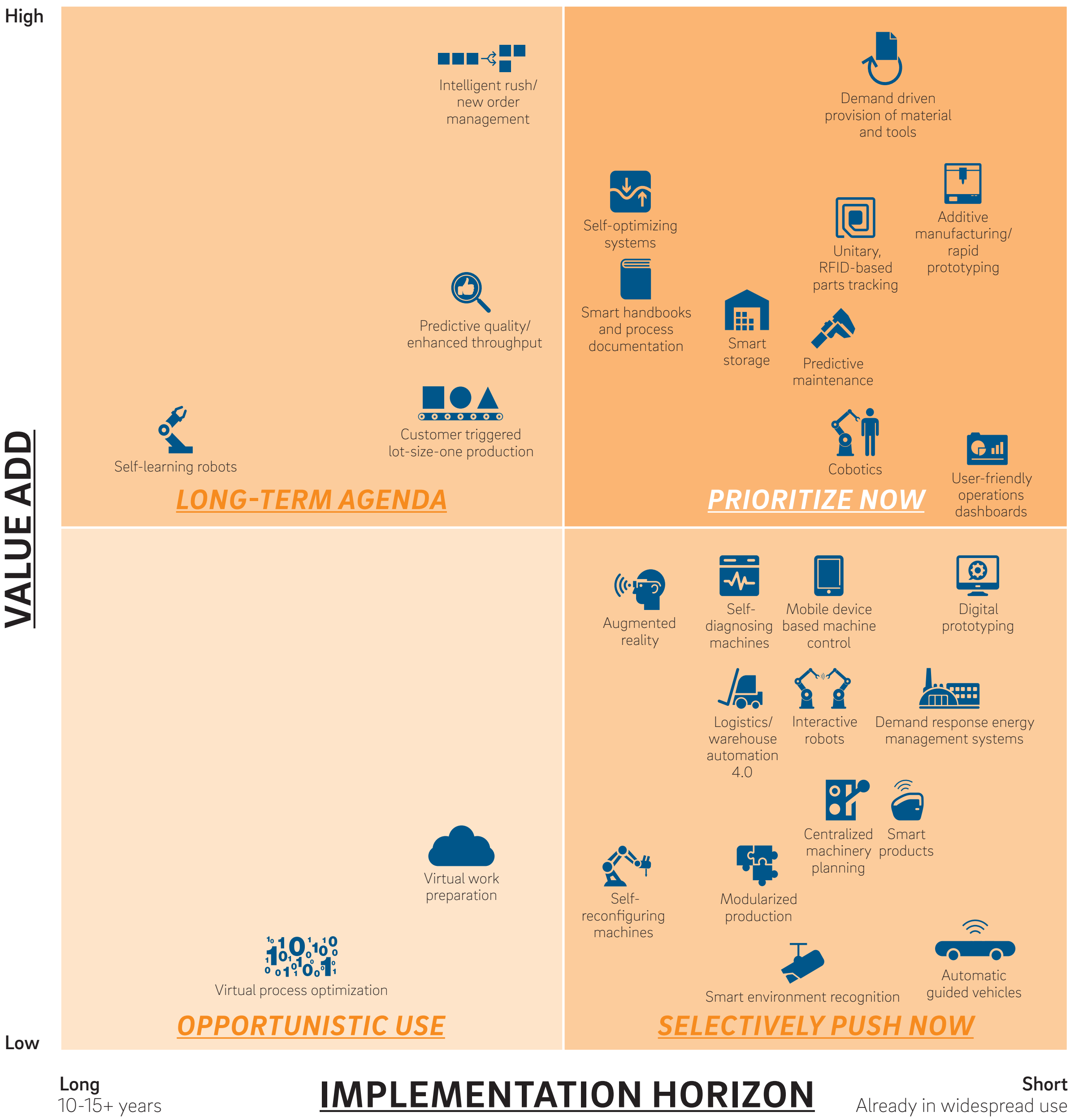
While this outlook is a cross-industry view of the penetration of digital factories, the automotive industry might be a front-runner. Automotive logistics applications in particular have great potential for rapid implementation. Fully self-optimizing systems and self-reconfiguring machines are expected within a medium implementation time of between five and ten years. Finally, self-learning robots and virtual process optimization are examples of applications that are only likely to come about in the long term. → G

But these achievements will not come from nowhere. Proactive actions are needed to kick off the digitization of manufacturing. Automotive companies need to develop their "own" digital factory ecosystem. This will result in changes in many – maybe all – departments and functions.

G

# AUTOMOTIVE USE CASES

Industry 4.0 offers a large number of use cases for the automotive industry




Source: Roland Berger

Besides the usual evergreens that tend to come up during transformational changes, there are a number of areas that should be specifically on senior management's radar:

**A COMPETENCIES**
A strategy on how to attract and retain required core competencies and human resources in both administration and on the shop floor.

**B STANDARDIZATION**
Rules and guidelines on how to apply equipment interfaces.

**C INFORMATION TECHNOLOGY**
Answer questions concerning cyber-security to protect the connected production system.

**D SUPPLIER MANAGEMENT**
Develop more collaborative supplier management models, based on real-time information sharing.

**E DECENTRALIZATION**
A decentralized organization and a fail-fast culture need to be adopted.

The path toward digital factories is typically a three step approach:

### 1. IDENTIFY ACCESSIBLE KNOW-HOW

Automotive players – especially the largest OEMs and the bigger suppliers – should start identifying their competencies and talent scattered across their business functions and divisions, and bundling it in digital factory expert groups and task forces. A solid network is indispensable. External partners range from digital factory equipment providers to IT firms and independent think tanks. In short: A digital factory team needs to be established and staffed with the right talent.

### 2. ASSESS YOUR COMPANY'S CAPABILITIES

The digital factory team helps with shaping the company's Industry 4.0 vision and strategy, quantifying benefits, defining priorities. The team kicks off with a status quo analysis of digital factory capabilities and applications within the company as well as the upstream and downstream value chain. The digital factory will impact largely on production and supply chain management. That said, procurement, engineering, sales and general management processes will all be influenced.

### 3. MAKE A PLAN

Finally, a road map for implementation can be derived. Measures include applications depending on the value added and/or the time to market (compare → G). Many applications will only come to light on a step-by-step basis. Enablers need to be established along the value chain and across the organization.

The hardest lesson of digital transformation is the need to design for loss of control. Yet by taking advantage of the unique resources and capabilities the U.S. has to offer, the automotive industry has an opportunity to get a jump on the competition in meeting the future demand of the U.S. and global markets with improved quality, reduced risk and lower cost. With stronger domestic production based on digital factories, "Made in USA" can once again become a true competitive advantage. ◆

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Roland Berger, founded in 1967, is the only leading global consultancy of German heritage and European origin. With 2,400 employees working from 36 countries, we have successful operations in all major international markets. Our 50 offices are located in the key global business hubs. The consultancy is an independent partnership owned exclusively by 220 Partners.

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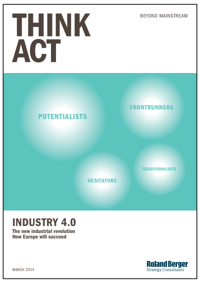
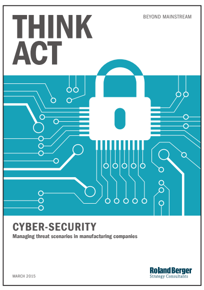



### INDUSTRY 4.0
In this study, Roland Berger experts explain what companies and policymakers should do to support the development of Industry 4.0 and leverage this opportunity for Europe.

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We share our thoughts on how the increasing reliance on digital processes to store and to share important data also increases the risk of companies falling prey to online attacks.

### PREDICTIVE MAINTENANCE
Our findings reveal that there are now emerging predictive maintenance solutions available that allow manufacturers to streamline maintenance operations.
http://bit.ly/RB-PredictiveMaint


### COO INSIGHTS
Our research across Europe shows that digital production has already begun to revolutionize value chains at many companies.

### AUTOMOTIVE 4.0
Roland Berger experts discuss the role of OEMs, suppliers, tech companies and new entrants in the emerging automotive landscape of advanced connectivity systems, innovative shared mobility concepts, and, of course, self-driving cars.
http://bit.ly/RB-Automotive40


### AUTOMOTIVE INSIGHTS
Roland Berger experts reveal where data-driven changes are impacting the business of OEMs and suppliers in a digitized automotive industry.

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