Developing the future of manufacturing
Industry 4.0 –
the new horizon

Industry 4.0 is the new source of sensational productivity gains.

Industry 4.0 spans an amazing array of digital technologies that are set to change industrial and commercial operations beyond recognition. These disruptive technologies, driven by the astonishing rise in data volumes, computing power, and connectivity, are giving companies new ways to compete and win.

Companies can use digital technologies to reach higher levels of operational effectiveness. These rewards are inspiring managers to rethink how their companies do business. They are adapting their business models to capture new value pools, and on the move to the next horizon – becoming digital companies. Those that succeed in getting the most value from Industry 4.0 are making significant gains.
Industry 4.0 brings many ways to create value, increase productivity, and get and stay competitive.

- **10–30%** reduction in design and engineering costs
- **20–50%** decrease in costs for inventory holding
- **20–50%** reduction in time-to-market
- **10–20%** reduction in costs for quality
- **3–5%** increase in overall productivity
- **45–55%** increase of productivity through automation of knowledge work
- **30–50%** reduction of total machine downtime
- **85% +** increase in forecasting accuracy

Mastering Industry 4.0 is critical to create value

McKinsey interviewed 300 qualified manufacturers and suppliers in three key markets (Germany, Japan, and the United States) and found that:

— More than half of the companies expect Industry 4.0 to increase their competitiveness
— But less than half have made real progress in 2016, with manufacturers lagging even further behind than suppliers

Five key challenges have been identified, many stemming from a lack of internal capabilities.

<table>
<thead>
<tr>
<th>Key challenges mentioned by manufacturers with little or no progress in Industry 4.0</th>
<th>Our core beliefs about creating value from Industry 4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difficulty in coordinating actions across different organizational units</td>
<td>Industry 4.0 needs to be led by the top management – it cannot be delegated</td>
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<tr>
<td>Lack of courage to push through radical transformation</td>
<td></td>
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<tr>
<td>Lack of necessary talent, e.g., data scientists</td>
<td>It is all about technology and people – the “analog” challenge remains</td>
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<tr>
<td>Concerns about cybersecurity when working with third-party providers</td>
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<tr>
<td>Lack of a clear business case that justifies investments in underlying IT architecture</td>
<td>Industry 4.0 is a business topic, not only an IT topic – a business case can be quantified</td>
</tr>
</tbody>
</table>

Successful transformations involve big shifts, more integrated processes, and new roles and skills for the operating system, management infrastructure, and employees.

Operating system
- Shift toward integrated process optimization (e.g., silo elimination, self-optimizing machines in decentralized production network)
- Change in physical process execution (e.g., collaborative human-machine interaction, smart in-line quality control)
- Shift from focus on visible waste to focus on digital waste

Management infrastructure (organization, IT, performance management)
- Wide spread use of real-time, centralized monitoring to transform insights into action
- Digital interfaces providing real-time process guidance
- Accelerating problem solving and analytics with the immense amount of data available

Capabilities, mindsets, and behaviors
- Significant change in job profiles across all plant functions
- Emergence of new roles (e.g., data analyst, IT integrator)
- New ways of thinking to leverage insights from advanced analytics
- Constant real-time control and monitoring of processes

To make the right decisions, companies need to take a holistic approach to Industry 4.0 and digital transformation.

Success with Industry 4.0 requires new capabilities at all levels of the organization, supported by change agents at every level
By immersing you in a realistic, interactive factory environment, our DCCs give you essential hands-on experience with real digital applications, real operators, and real products. Our proven model-factory environment is the ideal place for you to start gaining in-depth experience and build effective capabilities at each stage of a digital transformation.

**Comprehensive diagnostic**
You will experience how to identify sources of value through current performance baselining, assess key network infrastructure and security gaps, diagnose gaps in data capture and use, and identify key improvement areas and promising solutions.

**End-to-end roadmap and business case**
You will learn how to define a future-state vision and targets, create a roadmap of initiatives, flesh out your business case to create a self-funding program, and define an organizational model that supports the transformation.

**Value capture and integrated digital transformation**
You will explore the best ways to implement new solutions and systems, design new processes to lock in value capture, set up new capability training at the management and frontline levels, track progress, and introduce structural changes leading to value capture.
Our global DCC network provides a tailored capability-building support anywhere any time.

<table>
<thead>
<tr>
<th>Country</th>
<th>Key institutional partnerships</th>
<th>Full-fledged production lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td><img src="https://via.placeholder.com/150" alt="ITA Academy" /></td>
<td>Smart, customized wristband</td>
</tr>
<tr>
<td>USA</td>
<td><img src="https://via.placeholder.com/150" alt="DMDII" /></td>
<td>Compressor</td>
</tr>
<tr>
<td>China</td>
<td><img src="https://via.placeholder.com/150" alt="Tsinghua University" /></td>
<td>Iced-tea Gearbox/valve</td>
</tr>
<tr>
<td>Singapore</td>
<td><img src="https://via.placeholder.com/150" alt="EDB Singapore" /></td>
<td>Gearbox</td>
</tr>
<tr>
<td>Italy</td>
<td><img src="https://via.placeholder.com/150" alt="Lean Experience Factory" /></td>
<td>Compressor</td>
</tr>
</tbody>
</table>

Our DCC network – a winning partnership

- McKinsey & Company
- Leading academic and R&D institutions
- State-of-the-art technology providers
- Industry leading companies
- Government agencies
See and touch the impact of Industry 4.0 up-close and end-to-end.

Customer specific orders

Translate orders into RFID tag that dictates various criteria, from material to delivery

Product development

Use advanced analytics to evolve key design parameters
Combine design thinking and design to value to create unique value proposition

Procurement

Create value through digitized workflow and advanced analytics
E-procurement (e-sourcing, e-auction, e-catalogue)
Collaborative platform and supplier screening tools

Advanced analytics for operations – from capturing insights to cybersecurity
Advanced analytics for operations – from capturing insights to cybersecurity

Suppliers

- Delivery slip digitally retrieved
- Dynamic network configuration via analytics and real-time material tracking
- Digital warehouse with automated guided vehicles, pick-up, and inventory optimization

Production

- Mass personalization without waste
- Process re-invention through advanced analytics
- Advanced production technologies
- Human-machine interaction

Customer service

- Real-time access to product usage and condition data
- Track-back failure information to key drivers
- Predictive replenishment

Field data drives continuous improvement
The DCC Aachen was founded in 2017 by McKinsey & Company and ITA Academy GmbH as a joint partnership with PTC and other leading technology providers.
The DCC Aachen contains a complete production line that serves as a model factory and showcase for multiple digital-improvement applications.

The line encompasses multiple production steps, from warping to final assembly and testing. We will demonstrate the impact of Industry 4.0 in two scenarios. The “current state” scenario shows lean production only. In the “future state” you will then experience the advantages of digital operations solutions and their impact in real time.

We produce smart, customized wristbands with RFID technology – a real product with a large range of applications.
You can use the DCC Aachen to solve real production challenges and try out new solutions on the spot – individually and in detail.

Our Digital Capability Center provides a great setting for adult learning – interactive, experiential, with the freedom to experiment without risk. You will be able to test drive many different digital applications and learn how your company can benefit. For example:

**Augmented reality (AR) assistance for maintenance technicians**
Learn how to reduce time to repair, reduce skill variability between technicians, and improve machine reliability.

**Automated guided vehicle (AGV) for logistics**
Learn how to improve labor productivity and reduce picking errors with a robot that picks boxes in supermarket and brings them to production stations.

**Self-adjusting workstations**
Learn how to reduce ergonomics risks, reduce cycle time, and improve productivity with automatic adjustment of the workstation to operator ergonomics and to next work order.

**In-process control**
Learn how to reduce manual control and quality defects with real-time control of quality of critical manufacturing steps.

**Self-adjusting processes**
Learn how to untether operator from machine and improve quality rate, through automated quality control and ad-hoc adjustment of the machine parameters.
You will be able to explore state-of-the-art applications with the most effective digital technologies

Digital solutions will be implemented over the course of 2017 – starting with four solutions

**Condition monitoring:**
Learn how you can improve equipment reliability and reduce downtime and quality defects by:
— Monitoring process steps in real time
— Increasing data transparency
— Shortening reaction delays

**Quality control application:**
Learn how you can fully tailor inspection to specific product/client while reducing controller training time with a solution that will:
— Provide inspection criteria specific to the order
— Immediately escalate production defects to the relevant production steps
— Allow quality deep-dives with automatic generation of main defects to drive structured root-cause problem solving

**Digital assistant system:**
Learn how you can reduce training time and operators’ skill variability with a solution that will:
— Suggest optimal machine settings for performance
— Give access to tailored operating procedure and work instructions, taking into account experience level and language
— Escalate deviations to the maintenance and quality departments using pictures
— Communicate production changes or assembly defects spotted in downstream process steps

**Digital performance management:**
Learn how you can enable OEE improvement of as much as 20–50% with this gateway to digital manufacturing that allows:
— Real-time visualization of performance and health information on a digital whiteboard, smart watch, or tablet
— Big-data-based generation of breakdown reasons to drive structured root-cause problem solving
The DCC Aachen is a winning partnership of McKinsey, leading academia, and state-of-the-art technology providers to get you up to speed on the latest expertise and exciting new technologies.

**Founding members**

- **McKinsey & Company**
  McKinsey & Company, the world’s leading consulting firm for – digitally enabled – large-scale performance transformations
- **ITA Academy GmbH**
  ITA Academy GmbH, an international research and training service provider

**Technology partner network** (additional partners expected to join)

- **PTC**
  PTC, a global award-winning technology provider of the leading IoT and AR platforms
- **ark|group**
  ark|group, a provider of interdisciplinary development services for the digital transformation of companies
- **Intex**
  Intex, a provider of an integrated and innovative ERP software suite for textile manufacturers
- **Jakob Müller**
  Jakob Müller, market leader in ribbon and narrow-fabric technology
- **Stonegarden**
  Stonegarden, a systems provider for innovative tracking solutions and mobile data collection
- **LinUp**
  LinUp, a developer of ergonomic solutions, integrated tools and VR aiming to improve human behavior
- **UbiMax**
  UbiMax, a leading supplier for industrial wearable Computing solutions
- **Magazino**
  Magazino, a developer of mobile, perception driven picking and transport robots for warehouses and factories
- **Evolvea**
  Evolvea, a systems integrator specialized in virtualization, smart solutions for many different markets
McKinsey offering at the DCC Aachen

McKinsey offers a unique choice of capability building programs at scale to support companies across all stages of their digital transformation journey.

Typical stages of the digital journey

- Explore relevant Industry 4.0 solutions
  - Understand Industry 4.0 technology stack and its relevance for your business
- Experiment with targeted Industry 4.0 tools/levers
  - Experience and learn limitations of current industry practices and how Industry 4.0 technologies can address them
- Kick-start by piloting solutions
  - Pilot selected technologies on one production line or site, extract key lessons, and prepare roadmap for transformation at scale
- Scale up selected technologies
  - Scale up pilot across more manufacturing sites to achieve impact at scale
  - Secure long-term impact by building capabilities across the organization

How the DCC can help you

- CxO workshops
  - Build awareness on Industry 4.0 technologies
  - Explore potential avenues to identify potential at your own premises and ways to boost your ROI
- Deep-dive experiential workshops
  - Test state-of-the-art applications and solutions
  - Pre-select right prototype and embed lessons learned before embarking on a pilot
- Pilot preparation and assessment
  - Assess suitable pilots with technology and industry experts at the DCC
  - Outline implementation plan and end-to-end roadmap for on-site pilot
  - Collaborate with DCC partners to conduct pilot
- Capability building at scale
  - Generate lasting impact with the support of experienced consultants
  - Use the DCC as an accelerator for building internal capabilities at scale
  - Leverage partner network to create individual solutions
Each learning module focuses on delivering very practical takeaways.

Deep-dive experiential workshop – example predictive maintenance

Understand value of maintenance strategy
— Prioritize equipment and critical components
— Choose appropriate strategy for each component – e.g., condition-based or predictive maintenance using advanced analytics

Find the suitable predictive algorithm for your problem statement
— Regression models
— Classification models such as Support Vector Machine, neural networks

Learn to select the right predictive maintenance solution based on
— Data ingestion, threshold definition
— Model development and deployment
— Self-learning capabilities
— Visualization and alerts

Learn practical applications for output from predictive maintenance
— Impact on maintenance schedule
— Implications for spare parts inventory and budget management

Key takeaways from capability building workshops

- Technology basics
- Business case
- Implementation roadmap
- Scale-up planning across lines and sites
- Sustainability
The DCC will help build awareness of latest digital technologies and how to evaluate their potential in your company.

CxO workshop agenda example

<table>
<thead>
<tr>
<th>Module</th>
<th>Duration</th>
<th>Content</th>
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| Industry 4.0 basics           | 30 min   | — Industry 4.0 key concepts and themes  
                          |          | — Introduction to Factory of the Future                  |
| Observation of lean company   | 30 min   | — Tour of facilities and model line operating in good practice current state mode |
| Briefing                      | 15 min   | — Introduction to the case study (company profile)  
                          |          | — Digital diagnostic basics                              |
| Industry 4.0 waste walk       | 60 min   | — Digital waste walk  
                          |          | — Interviews with shop-floor operators  
                          |          | — Identify digital improvements                          |
| Industry 4.0 line shop-floor visit | 45 min | — Industry 4.0 showcase (e.g., predictive maintenance, automation/robotics, e-buyer) |
| Debrief and discussion        | 30 min   | — How to get started at your site – approaches to diagnostics |

Key takeaways from CxO workshop

- Shop-floor expertise of Industry 4.0
- Impact potential of digital solutions
- Implementation guidelines and capability building requirements
We offer world-class learning academies with a global curriculum covering 25+ experiential learning modules for digital operations.

Operating system

Resources
- Yield, throughput, and energy optimization

Processes
- Application of 3-D printing
- Digital twin for process and layout
- Production planning, scheduling, and demand leveling

Asset utilization
- Line balancing and smart routing in real time
- Predictive, remote, and self-guided maintenance
- Use of AR and VR support

Labor
- Digitally supported line leveling, I-cycle time, and variability analysis
- Advanced intralogistics with picking robots and AGVs
- Human/robot collaboration
- Workforce management
- Support through wearables

Quality
- Optimization of equipment working parameters
- Adaptive quality assistance

Inventory, time to market, supply/demand match
- Intelligent material storage, AGVs, production-sequence-linked storage
- Use of end-to-end digital thread

Management infrastructure

- Roles and responsibilities of manager in a digital operation
- Digitally powered performance management
- Expert system-supported root-cause problem solving
- Digitally supported SOP
- Digitally supported capability-building process

Capabilities, mind-sets, and behaviors

- Analytical skills for big data
- Understanding of all elements of IoT platforms and application design
- Abilities to work with new digital elements, e.g., collaborative robots
- Adaptation to fast-changing environment
Please contact the McKinsey experts to learn more about the DCC Aachen and get an individual solution for your business.

Dennis Küsters
Manager
Digital Capability Center Aachen

Dr. Jörg Bromberger
Senior manager
Global Manufacturing Practice

Dr. Nicolai Müller
Global leader
McKinsey Digital Manufacturing

Dr. Andreas Behrendt
European leader
McKinsey Digital Manufacturing

Erhard Feige
Global manager
McKinsey Capability Centers

Dr. Christoph Schmitz
Global leader
Manufacturing Practice

DCC_Aachen@mckinsey.com