Our clients’ industries are extremely competitive, and the maintenance of confidentiality with respect to our clients’ plans and data is critical. Oliver Wyman rigorously applies internal confidentiality practices to protect the confidentiality of all client information.

Similarly, our industry is very competitive. We view our approaches and insights as proprietary and therefore look to our clients to protect our interests in our proposals, presentations, methodologies and analytical techniques. Under no circumstances should this material be shared with any third party without the prior written consent of Oliver Wyman.

© Oliver Wyman
Impact of Technology & Industry Insights – DIGITAL INDUSTRY / MFG 4.0

Contents

1. What is Digital Industry / Manufacturing 4.0?

2. Value Spaces & Impact of Digital Industry

3. Digital Industry – Obstacles & Checklist
Internet of services/Internet of things – Lead in

The internet of things & services, big data and advanced analytics are assumed to impact manufacturing firms business models in various ways.

**Possible impact**
- New business models will occur
- Value chains will be reshaped
- Extensive integration will appear
- Organizational changes are required
- Production systems will be redesigned

**Potential benefits**
- Increase in productivity
- Enabler of mass customization
- Optimization of production control
- Increase in resource efficiency
- Preventive maintenance & remote services
- Reduced costs (energy, scrap, …)

---

1. Cyber-physical systems

© Oliver Wyman
The 4\textsuperscript{th} Industrial Revolution
This fourth industrial era will dramatically transform value creation, processes, and businesses.

<table>
<thead>
<tr>
<th>Industrial era</th>
<th>Technological revolution</th>
<th>Transformational change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Mechanical loom operated with water/steam power, 1784</td>
<td>Substitution of labor by capital; process stability and speed</td>
</tr>
<tr>
<td>2.0</td>
<td>First electrically-powered mass production line, 1870</td>
<td>Division of labor (&quot;Taylorism&quot;); process flow and throughput</td>
</tr>
<tr>
<td>3.0</td>
<td>First programmable logic controller in manufacturing, 1969</td>
<td>Business process re-engineering; process quality and &quot;Lean&quot;</td>
</tr>
<tr>
<td>4.0</td>
<td>Cyber-physical systems, connectivity and big data, today</td>
<td>Transform value creation, processes, and businesses</td>
</tr>
</tbody>
</table>

Enabler but only limited share of value

True value is captured through transformation of processes

Source: DFKI (German Research Centre for Artificial Intelligence), Oliver Wyman

© Oliver Wyman
Different Initiatives across the globe
Different terms are used to describe national efforts to foster next generation manufacturing industry development, utilizing the internet of things/services

The focus of industrial (r)evolution is driven by industrial structures within countries; with “Industrie 4.0” having the broadest approach

Source: Oliver Wyman, GTAI, Sonecon, Press research
We define DIGITAL INDUSTRY as the 4th industrial revolution that will impact a manufacturer’s entire value chain across the product life cycle.

**Our definition**

Industry 4.0 stands for the 4th industrial revolution and a new approach of organizing and managing the entire value chain for the product life cycle.

**Key characteristics:**

- Connectivity along value networks
- Data collection,...data analysis (analytics)...and deriving actions from analytics...in real-time
- Software/hardware integration (Cyber Physical Systems)
- Vertical and horizontal systems / process integration
- Smart Solutions

**Potential value-add:**

- Time-to-market
- Mass customization
- Innovation
- Productivity
- Efficiency
- Cost

Source: Oliver Wyman team, HBR
4th Industrial Area – A major topic & broad impact
Recent literature and studies around the topic and the expected impact of 4th Industrial Revolution vary as perspectives are different and not often holistic.

Management literature, governments, associations, think tanks, consulting firms and Industry players all deal with the topic, but have failed yet to identify “the real beef”

Expected penetration and impact of Industry 4.0

- **75%** improvement in productivity per unit of work
  - McKinsey & Company
- **USD 25-50 BN** economic impact in Automotive Industry by 2025 (value of products sold)
  - McKinsey & Company
- **EUR 23 BN** added value potential until 2025 in the machine- and plant building sector (~30% efficiency gain)
  - Böllhoff & Frauenhofer
- **85%** of companies claim to have their value chain digitized within the next 5 years (Germany)
  - Strategy&

Literature is contradictory, but rather optimistic on predictions concerning the expected speed and economic impact of the 4th industrial revolution.

Source: Oliver Wyman team, based on extensive desk research

© Oliver Wyman
Value Spaces of Digital Industry

Oliver Wyman has developed insights across manufacturing industries to determine the 9 key value spaces / levers

1. **Idea-to-produce**
   - R&D efficiency
   - Product launch

2. **Sales-to-delivery**
   - Demand forecasting & intelligent pricing
   - Production planning & dispatching automation
   - Smart purchasing & outsourcing
   - Next-generation inventory management
   - Flexible production & efficient mass customization

3. **Operations and services**
   - Smart maintenance & equipment performance
   - Plant network optimization

Source: Oliver Wyman
The Impact of Digital Industry

The transformation towards “Digital Industry” yields a global value space of up to ~1.4 US$ trillion by 2030

“Digital Industry” potential in 2030
Margin impact¹ (distribution per industry in %)

<table>
<thead>
<tr>
<th>Industry</th>
<th>Margins (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive</td>
<td>5%</td>
</tr>
<tr>
<td>Aerospace</td>
<td>13%</td>
</tr>
<tr>
<td>Rail</td>
<td>10%</td>
</tr>
<tr>
<td>Other Discrete Manufacturing</td>
<td>2%</td>
</tr>
<tr>
<td>Machinery/Engineering</td>
<td>6%</td>
</tr>
</tbody>
</table>


¹. Gross effect not including downside, basic production efficiency and pricing effects as well as concrete business case considerations (i.e. investments); Value spaces were estimated based on industry-specific cost structures and were applied on approximated global value creation in 2030 (GDP growth assumed)

Source: Oliver Wyman analysis, OECD, World Bank, United Nations
The Impact of Digital Industry
However, each manufacturing industry will see varying potentials

Value space potential
(in US$ BN in 2030)

<table>
<thead>
<tr>
<th>Potential per industry</th>
<th>(relative to industry revenues)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand forecasting &amp; intelligent pricing</td>
<td>600</td>
</tr>
<tr>
<td>Flexible production &amp; efficient mass customziation</td>
<td>300</td>
</tr>
<tr>
<td>Smart purchasing &amp; outsourcing</td>
<td>120</td>
</tr>
<tr>
<td>R&amp;D efficiency</td>
<td>120</td>
</tr>
<tr>
<td>Smart maintenance &amp; equipment performance</td>
<td>100</td>
</tr>
<tr>
<td>Plant network optimization</td>
<td>70</td>
</tr>
<tr>
<td>Production planning &amp; dispatching automation</td>
<td>30</td>
</tr>
<tr>
<td>Next-generation inventory management</td>
<td>20</td>
</tr>
</tbody>
</table>

Source: Oliver Wyman analysis
The Impact of Digital Industry
Implications will be company-specific but will also be based on overarching changes that apply across industries

Across industries
- Management awareness and workforce capabilities
- Adjusted organizational structures and decision making processes

Industry specific
- New competitive dynamics
- New entrants vs. established manufacturers vs. digital economy consumer players

Company specific
- Limited as-is readiness of many companies to unlock Digital Industries’ value spaces
- Digital strategy and roadmap
The Impact of Digital Industry
A number of advanced technologies act as important enablers

1. Machine to machine
Source: Oliver Wyman

3D printers
Quick creation of fully customized products
e.g. 3D prototypes

Collaborative robots
Combination of human flexibility with robots’ ability to perform exhausting or dangerous tasks
e.g. assembly of parts that are hard to reach

M2M communication
Communication between devices without human interaction
e.g. automatic communication of refilling request between bin and system

Simulation software
Virtual testing of products and processes under realistic conditions
e.g. “Hardware-in-the-loop” simulation of assistance systems of vehicles
### Digital Industry – Real world examples

Digital Industry solutions already find some application in various industries – with degree of innovation varying largely…

<table>
<thead>
<tr>
<th>Company</th>
<th>Industry</th>
<th>Industry 4.0 application</th>
</tr>
</thead>
</table>
| **BOSCH**        | Automotive supply                 | • **Build-to-order** production of diesel injectors  
• Raw component **guides itself through the production** (e.g. automatically order missing parts)  
• Customers are constantly informed about production and shipping status |
| **VW**           | Automotive                        | • 3D technology enables VW to **simulate assembly line process** leading to an **optimization of takt times**  
• Motion capturing allows simulating and optimizing ergonomics for their assemblers  
• Perspectival, the technology is supposed to facilitate virtual takt time workshops |
| **HOMAG GROUP**  | Equipment manufacturer (Wood processing) | • **Flexible furniture production** at **lot size one** (48 M variants)  
• Enabled by HOMAG’s **integrated hardware / software solutions**  
• Leads to a **productivity gain of 30%** while decreasing the **lead time to 15 days** (industry average > 5 weeks); reduction of material on stock by 90%  
• Investment of 10 M EUR |
| **JOYGLOBAL**    | Mining equipment                  | • Provides a variety of **Smart Services** for their mining equipment  
- **Remote- and preventive maintenance**  
- **Benchmarking and optimization of operations**  
• Joy Global **offers autonomously operating equipment** |
| **TRUMPF**       | Equipment manufacturer (Industrial laser) | • “Social” laser cutting machine  
- **Processes new raw materials effectively by automatically identifying** the raw material  
- Receives **operating instructions** from Trumpf’s cloud database  
- Reduced **ramp-up times** and **scrap**  
- Increases **quality** and **flexibility** |

Source: Company websites and press releases
Digital Industry – Obstacles for penetration
…and with several obstacles that will slowed down the broader implementation

<table>
<thead>
<tr>
<th>Obstacles (excerpt)</th>
<th>Description</th>
</tr>
</thead>
</table>
| Installed base                       | • The **installed base** (machine park, network infrastructure, software platforms, …) is partly **not ready** for Digital Industry and needs to be upgraded or replaced  
                                          • Typical **invest cycles** along industries do not support a quick & broad penetration                                                                 |
| Data security                        | • Protection of **product data, IP rights, production know-how** etc.  
                                          • Risk of theft of data, sabotage of production, hacking etc.                                                                                                                                           |
| IT-system and infrastructure         | • IT systems need to be “**Digital Industry**” ready (hardware, software, connectivity, …)  
                                          • Partly requires **high investments** in new systems                                                                                                                                                    |
| Technical standards/ interfaces      | • Setting of **common standards** (interfaces, system language), e.g. for M2M communication  
                                          • Highly complex interaction with other value chains if there are no common standards                                                                                                                      |
| Cultural barriers “Trust”            | • **Barriers within & outside organization** (knowledge sharing, transparency, motivation, …)  
                                          • People do **not “trust”** autonomous, smart factories and machines                                                                                                                                     |
| Capabilities and skill level         | • **Insufficient employee qualification** e.g. technical capabilities, interdisciplinary thinking                                                                                                                                 |
| Uncertain business case              | • **Uncertainty** with regard to **economic value added and payback** – is it worth it?                                                                                                                                 |
Digital Industry – Navigating the Value Chain

...especially the navigation along the Digital Industry value chain with various hardware component, application, services providers and varying standards

<table>
<thead>
<tr>
<th>Intelligent Objects / Machines</th>
<th>Explicitly Identification</th>
<th>Object networking and Sensory</th>
<th>Network Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Intelligent machines, components, products etc.</td>
<td>• Identification technologies (e.g. RFID, Object recognition) e.g. administration and coordination of unique Identifiers</td>
<td>• Networking of objects via the Internet of Things e.g. sensory for collection of real time information about objects and environments</td>
<td>• Management of physical network infrastructure</td>
</tr>
<tr>
<td>• Mfg innovation, e.g. prerequisite for Multi-Connectivity</td>
<td></td>
<td></td>
<td>• Support of wire- or wireless communication between Smart Objects (e.g. 4G/LTE, WLAN)</td>
</tr>
</tbody>
</table>

Intelligent Objects / Machines

Explicitly Identification

Object networking and Sensory

Network Operations

Operating Platforms

Applications & Automatization solutions

Big-Data-Analysis and Intelligence

Value add-Services

• Platforms for the distribution and management of data in the Internet of Things e.g. Cloud Services, data bases

• Internet of Things applications in the industrial context e.g. Controlling of Smart Machines in production

• Organization and analysis of large unstructured data in the Internet of Things e.g. Derivation of patterns in the data matrix for business applications

• Professional services for Industry 4.0 manufacturers e.g. Billing, CRM, Remote maintenance

Source: Oliver Wyman Analysis
Digital Industry – Checklist (1/2)

Key questions to ask yourself

Hardware

- What is my current set-up of Sensor-equipped products/machines?
- Do I have any Cyber-Physical Systems – global connection of equipment?
- What Communication technologies (WiFi, RFID) do I have where/for what?
- Do we use “Digital” production techniques, e.g. 3D manufacturing?
- What advanced mech. tools to cope with flexibility (e.g., min. setup times)?

Software

- What level of complete product digitalization (ideally at POS) exists?
- Do I have a unified IT structure?
- What Operating platforms (Data storage, processing) do we use?
- What level and for what do we use Real-time data flow?
- Do we use any Cloud-support?

Tools

- What level of Big data analytics?
- What type of Simulation do we use?
- What level of 3D product virtualization?
- What level of SCM (supply chain management) visualization do we use?
Digital Industry – Checklist (1/2)
Key questions to ask yourself

• Are we focused on end-to-end processes, not functions?
• How well are all interfaces with external partners defined?
• Is our staff trained, familiar with software solutions and processes?

• What level of production innovation process integrating R&D, production and in-field devices exist?
• Does our Sales-to-delivery process connect pricing, sales, production and purchasing?
• What level of infrastructure service processes exist?
• To what level is the data flow from sales integrated in production and other systems?
• To what level do our Processes leverage data flow?

• Is Digital Industry a topic of our management?
• Do we have a focus on revenue and cost opportunities?