What You Need to Know About Industry 4.0

In the last few centuries, the world has experienced three industrial revolutions that have shaped our industrial processes. In the first industrial revolution, labor-centric production processes were mechanized through the use of water and steam power. The second was driven by moving assembly lines and mass production driven by electricity. The third was driven by electronics and the application of information technology and increased automated production. The fourth revolution sees technology embed itself further in society with digital technological advances connecting all the major stakeholders in the core manufacturing activities.

Industry 4.0 is a combined integrated seamless connected network of machines, production processes, and the manufacturing control systems. It is a digital manufacturing enterprise with the physical product at the core driven by information from an integrated information network among the internal stakeholders, as well as external entities, such as customers, suppliers, etc. This digitization of physical assets and manufacturing activities along with a network of digital communications is fundamentally changing the manufacturing industry landscape. This end-to-end digitization is improving process efficiency, quality management, and productivity along with real-time insights into the whole manufacturing landscape, building a digital business model that supports data-driven decision-making and integrated platform-based services.

The use cases of Industry 4.0 include supply chain, marketing, and services, R&D of manufacturing engineering services, and other areas, but most of the opportunities and interest today are in the core manufacturing activities. Therefore, this report focuses specifically on manufacturers’ shop floor activities.
Industry 4.0 Framework: The Digital OneManufacturing Organization

Digital OneManufacturing is the abxility to do mass customization at scale so that manufacturing enterprises manufacture for one customer economically and efficiently. This is possible when manufacturing enterprises achieve a significant increase in cost efficiency, time productivity, and flexibility, by aligning and integrating their manufacturing processes and technology landscape, which is the vision of Industry 4.0.

Exhibit 1: Digital OneManufacturing Framework

The Digital OneManufacturing Organization

Customer-Driven Industry 4.0

Digital Manufacturing

Digital OneManufacturing is the ability to do mass customization at scale so that manufacturing enterprises are able to manufacture for “one” customer economically and efficiently.

This is possible when manufacturing enterprises achieve a significant jump in cost efficiency, time productivity, and flexibility, which is the vision of Industry 4.0.

Enable OneManufacturing by Aligning Organization Strategy, Culture, and Resources

Digital Underbelly


Implemented Single Tech/Multi-Tech Across

Scope

• Smart Components
• Smart Machines
• Digital Factory
• Connected Factories
• Industry 4.0 Enterprise

Supported by Digital Processes

Create Capability

Intelligent Digital Processes

Manufacturing processes that enable
• Visualization
• Analysis
• Control

Source: HfS Research, 2017

Industry 4.0 is all about smarter manufacturing—the use of technology so the sub-processes within the manufacturing system make adaptive and predictive decisions. We developed our Digital OneManufacturing framework that defines the DNA of digital connected plants that includes an intelligent, automated centralized control system with as minimal human intervention as possible.
This framework includes three pillars: the digital underbelly (technologies involved in Industry 4.0), scope (areas in which digital processes will be effective), and intelligent digital processes (manufacturing process enablement areas). Digital OneManufaturing represents an integrated manufacturing operation center that has digital prowess for a manufacturer to meet future manufacturing complexities.

In brief, Digital OneManufacturing is the platform on which digital technologies meet manufacturing engineering technologies and controls a manufacturing landscape in real time to serve clients. It’s where all the process elements are combined: Connectivity, the processes, and the intelligence come together as one integrated unit, with one set of unified business outcomes tied to manufacturing organizations.

The three pillars of Digital OneManufacturing are described below.

**Digital Underbelly:** We identified 13 major technologies that are shaping Industry 4.0. These technologies include Manufacturing Data Analytics, Robots, Manufacturing Automation, Digital Clone or Simulation, Three-Dimensional (3D) Printing, Manufacturing Internet of Things (IoT), Plant Cybersecurity, Manufacturing on Cloud, Virtual Reality in Manufacturing, Augmented Reality in Manufacturing, Artificial Intelligence in Manufacturing, Visual Analytics in Manufacturing, and Small Batch Manufacturing.

We used the following definitions for these technologies:

- **Manufacturing Data Analytics:** The systematic analysis of production and shop floor data to optimize manufacturing operations.

- **Robots:** Machines that can automatically carry out groups of complicated actions and that can collaborate with humans.

- **Manufacturing Automation:** Implementation of control systems to enable shop floor processes to work with minimal or no human intervention. This includes integration of disparate enterprise systems used in manufacturing for seamless data and information flow.

- **Digital Clone or Simulation:** Implementation of a virtual manufacturing environment, in which operations are configured, tested, and optimized by creating a digital clone of the actual production line.

- **3D Printing:** Additive manufacturing is used for prototypes, spares, actual parts, and ultimately entire products.
» **Manufacturing IoT**: The Internet of Things (IoT) is a network in which physical devices communicate and pass on data. The Manufacturing IoT exploits sensor data collected from machines on the manufacturing shop floor.

» **Plant Cybersecurity**: Security management of information technology (IT) and operation technology (OT) in manufacturing and plant operations.

» **Manufacturing on Cloud**: Implementation of manufacturing and production systems on SaaS- and IaaS-based cloud platforms.

» **Augmented Reality in Manufacturing**: The augmentation of a real-world view of manufacturing operations, assets, and people with additional computer-generated pictures. In manufacturing and plant operations, augmented reality can be used to help the development process by visualizing a product in situ before conception or in a factory setting by showing an engineer additional information, such as thermal characteristics or schematics, while the engineer views the real object.

» **Virtual Reality in Manufacturing**: The use of software to create images and sounds for imaginary or lifelike manufacturing plants or factories. Virtual reality in manufacturing and plant operations is used for many applications, including plant construction, plant maintenance, and operator training.

» **Artificial Intelligence in Manufacturing**: In this context, artificial intelligence refers to when a computer is used to mimic human cognitive functions, such as complex problem solving and learning. Use of artificial intelligence, machine learning in manufacturing, and plant operations includes setting the parameters for the plant operations and recognizing images and visuals using machine learning.

» **Visual Analytics in Manufacturing**: The science and technology of analyzing visual information from pictures and videos to aid reasoning and decision making. Use of image analytics within the manufacturing sphere includes machine vision and video analytics in manufacturing and plant operations.

» **Small Batch Manufacturing**: Implementing solutions that enable manufacturers to cost-effectively manufacture in small quantities.

**Scope**: These Industry 4.0 technologies can be implemented on the manufacturing shop floor at five levels: smart component, smart machine, digital factory, connected factories, and Industry 4.0 enterprise.
» **Level 1 - Smart Component:** A smart component is one that responds to feedback based on sensory information and makes predictive or adaptive decisions. Machine components are made smart, productive, and efficient by implementing technologies at the component or subsystem level.

» **Level 2 - Smart Machine:** A smart machine is a combination of several smart components and exhibits the same autonomous features as a smart component. A smart machine can control its operation and make predictive or adaptive decisions by responding to feedback based on sensory information. Machines are made smart, productive, and efficient by implementing technologies at the machine and system levels.

» **Level 3 - Digital Factory:** A digital factory is a combination of various smart machines in the plant and exhibits the same autonomous features as a smart component or a smart machine. The whole plant is made smart, productive, and efficient by implementing technologies at the plant or factory level. In a digital factory, machines and production systems are smart individually and collectively.

» **Level 4 - Connected Factories:** Connected factories are combination of various digital factories that may be spread across countries or regions. These connected factories can be managed through centralized connected digital plants operations ranging from product design to manufacturing and on-premise logistics management.

» **Level 5 - Industry 4.0 Enterprise:** An Industry 4.0 enterprise integrates its connected factories with other stakeholders, such as suppliers, customers, product designers, and service personnel. In this way, an Industry 4.0 enterprise can align manufacturing processes with other business processes, such as supply chain, procurement, product development, customer relations, and aftermarket services.

**Intelligent Digital Processes:** These processes enable smarter and more intelligent manufacturing. We have conceptualized three functions that are enabled by digital manufacturing processes: analysis, visualization, and control.

» **Analysis:** The ability to generate and analyze shop floor data and use it to manage, improve, and optimize manufacturing processes, efficiency, productivity, quality, and flexibility. The ability to predict manufacturing events and prescribe the best course of action for the above.

» **Visualization:** The ability to simulate and visualize prototypes, machines, production lines, plants, and finished products. Simulation can be done pre- or post-production, and visualization can be
done in real time. This can help in planning, improving, and optimizing production lines, and thus, in improving the product quality and making the production flexible.

» **Control:** The ability to control and drive production and shop floor activities in real time with the use of data, analysis, artificial intelligence, visualization, and control functions with minimum human intervention.

**Levers of Industry 4.0**

In our Digital OneManufacturing framework, we defined the components (the digital underbelly and intelligent digital processes) required for a manufacturing enterprise’s Industry 4.0 journey. How does the digital underbelly aid intelligent digital processes in an enterprise? The links between the digital underbelly and intelligent digital processes are the following capabilities or levers:

» **Cyber-Physical System:** Industry 4.0 connects all the manufacturing components and ecosystems, including processes, sub-systems, machines, customers, supplier networks, etc. Because every physical system has a digital existence in Industry 4.0, all the manufacturing activities can be controlled through a software interface. This interface gives a better view of the entire system, provides interconnected data to more clearly see system interdependencies, helps streamline the manufacturing activities, and increases the machine uptime.

» **Smart Machines:** The application of smarter control mechanisms to robots and artificial intelligence (AI)-enabled machines will differentiate Industry 4.0 manufacturing. To date, robots have been restricted to repeatable step-based tasks without autonomy or self-control or have been deployed in a restricted scope and not on the main assembly line. Industry 4.0 smart robots will work hand-in-hand with humans using human–machine interfaces. In addition, machines will be connected to the cloud with automated decision-making loops. These machines will communicate in real time with a central IT system and can be controlled accordingly. This application will improve productivity and monitor assets easily.

» **Data Flow:** Industry 4.0 will generate large amounts of real-time data. Part of the new challenge is to store and process the data effectively to make real-time decisions. Enterprises have to identify what data needs immediate processing and what data needs to be uploaded to the cloud and processed for further analysis. Because whole enterprises cannot be taken into the cloud, to make decisions in real time and effectively control this data flow, manufacturers need to deploy edge analytics.
› **Mass Customization**: As machines’ decision-making capabilities become more sophisticated, the machines will be able to respond automatically in a production step and will be able to adjust for different design parameters. To date, 3D printing has been used to develop prototypes, but with the adoption of increasingly intelligent machines, more custom designs will be possible, making mass customization an option for manufacturers.

› **Virtual Manufacturing**: Through digital simulation, any product or plant design will be conceptualized in a virtual environment. After the initial design change, the product or plant can be tested and verified. In addition, advanced visualization techniques, such as virtual and augmented reality, help develop precise digital clones. Therefore, when the physical model is established based on the virtual design, the scope of error or failure is low, saving a lot of money and time.

› **Lean Manufacturing and Resource Management**: Industry 4.0 data analysis examines the entire manufacturing process chain of activities in detail and can be used to identify areas for additional automation, quality improvement, and other important factors at the sub-process level. This will make better resource management possible through Industry 4.0 along with lean manufacturing as identifying the asset health at the component level helps with waste management.

The link of these Industry 4.0 levers to the digital underbelly and intelligent digital processes is shown in Exhibit 2.

**Exhibit 2: Digital Underbelly Link with Intelligent Digital Processes by Industry 4.0 Levers**

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Visualization</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Flow</td>
<td>Smart Machines</td>
<td>Lean Manufacturing</td>
</tr>
<tr>
<td>Manufacturing Data Analytics</td>
<td></td>
<td>Virtual Manufacturing</td>
</tr>
<tr>
<td>Robots</td>
<td></td>
<td>Cyber-Physical System</td>
</tr>
<tr>
<td>Manufacturing Automation</td>
<td></td>
<td>Mass Customization</td>
</tr>
<tr>
<td>Digital Clone or Simulation</td>
<td></td>
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</tr>
</tbody>
</table>
## Industry 4.0 Transformation Journey

In our Digital OneManufacturing framework, we mentioned the scope of Industry 4.0. It is a transformation journey to connect the whole enterprise with digitized manufacturing operations for greater autonomy and flexibility. The transformation journey is conceptualized in Exhibit 3.

**Table:**

<table>
<thead>
<tr>
<th>Technology</th>
<th>3D Printing</th>
<th>Manufacturing IoT</th>
<th>Plant Cybersecurity</th>
<th>Manufacturing on Cloud</th>
<th>Virtual Reality in Manufacturing</th>
<th>Augmented Reality in Manufacturing</th>
<th>AI in Manufacturing</th>
<th>Visual Analytics in Manufacturing</th>
<th>Small Batch Manufacturing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Source:</strong> HfS Research, 2017</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Advantages of Industry 4.0

In our Digital OneManufacturing framework, we mentioned the intelligent digital processes of Industry 4.0. During our interactions with manufacturing organizations and case studies of service providers, we identified business outcomes influenced by these intelligent digital processes. Exhibit 4 shows the business outcome mapping with the intelligent digital processes for Industry 4.0 implementation and the fundamental business impact of each process.

Exhibit 4: Intelligent Digital Processes Mapping with Business Outcomes and Fundamental Business Impact

<table>
<thead>
<tr>
<th>Intelligent Digital Processes</th>
<th>Business Outcomes</th>
<th>Fundamental Business Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis</td>
<td>Operational improvement in manufacturing processes</td>
<td>Cost: Green</td>
</tr>
<tr>
<td></td>
<td>Savings in OPEX through enhanced forecasting and predictive analytics</td>
<td>Cost: Green</td>
</tr>
</tbody>
</table>
### Visualization

- Identification of bottlenecks and optimization of workload
- Increased operator efficiency
- Increased energy efficiency
- Improved material handling through reduced error and waste management
- Optimization through simulation of plant design, product prototyping, and production
- Operators trained in the virtual environment
- Improved asset maintenance through AR environment
- Improvement in product testing
- Increased operator safety

### Control

- Plant management from remote locations
- Higher product quality and compliance management
- Harmonization and consolidation of manufacturing processes across plants
- Enhanced security of operations
- Implementation of flexible production, including 3D printing, small batch manufacturing, etc.
- Increased machine and plant reliability
- Reduced time to manufacture for new and existing products

Source: HfS Research, 2017
By combining these business outcomes and impacts, manufacturing organizations that implement Industry 4.0 will benefit from significant competitive advantages. We identified the following list of competitive advantages a manufacturing firm can expect from the implementation of Industry 4.0:

» **Manufacturing Process Optimization**: Industry 4.0 provides real-time data on physical assets that can be used to monitor and control AI-enabled automation. AI automation provides self-learning and autonomy within parameters, with central control dictating tasks and priorities. A fully integrated and automated shop floor can be designed, in which all the machines in the manufacturing process can be connected with automated decision-making and adjustment facility based on key performance indicators (KPIs). The manufacturing plant then adjusts the processes to maintain an optimized production throughout.

» **Streamlined Supply Chain**: As manufacturing execution system (MES) applications become integrated with Industry 4.0, the supply chain can be aligned with real-time production data. This integration will help develop an automated logistic ecosystem that will adapt automatically to production needs.

» **Improved Inventory Management**: In Industry 4.0, the machines are self-optimized with self-learning and decision-making capabilities. This means the machines can sense unfinished and imperfect products and can flag the necessary stakeholders if a malfunction occurs in the manufacturing process. This helps in waste management and enables the process to run at the minimum inventory level.

» **Better Resource Management**: Through Manufacturing IoT solutions, the machine data can be tracked in minute detail. This tracking helps identify whether resources have any idle time and the activities that can be automated or handled by the robotic systems, enhancing the planning and scheduling of manufacturing activities. Therefore, the manufacturing resources can be optimized and managed better.

» **End-User-Centric Manufacturing**: The manufacturing industry is entering a mass customization mode in which small batches will be manufactured with frequent changes in design. Industry 4.0 facilitates this trend with 3D printing and digital simulation, reducing the cost of developing prototypes and performance checks before building physical models. In addition, manufacturers will have the capability to develop an increasing number of versions and variations of their products.
About This Blueprint Market Guide

The Industry 4.0 market is an emerging area, and most service providers pointed to proof-of-concept (PoC) and very small project engagements with clients rather than to any large-scale implementations. The services market for this new technology is still evolving and has yet to enjoy the benefits of scale. Through consulting-led technology projects, service providers are helping manufacturers start on their Industry 4.0 journey. Academic institutions and original equipment manufacturers (OEMs) have generated a great deal of thought leadership for Industry 4.0. However, due to the active involvement of emerging technologies, getting from theory to reality requires additional skill sets the service providers are able to provide. This is leading to a number of collaborations between service providers and OEMs and academic institutions.

At this point, many of the leading players in the manufacturing industry are starting to learn from and adopt Industry 4.0. Manufacturers still in watch mode must start to investigate now so they aren’t left behind. The purpose of this Blueprint Guide is to help manufacturing firms think through the implications Industry 4.0 will have in the near future and to give a preliminary overview of the service providers we see offering Industry 4.0 services.

Industry 4.0 Services Value Chain Analysis

This Blueprint Guide provides a capability analysis of the services of Industry 4.0 service providers. We focused this analysis exclusively on the Industry 4.0 services value chain of R&D, Plan, Implement, and Operate across 13 technologies or the digital underbelly of Industry 4.0. The 13 technologies were previously described, and the value chain is described in Exhibit 5.

Exhibit 5: Industry 4.0 Services Value Chain

![Value Chain Diagram]

Source: HfS Research, 2017
**R&D:** These engineering and R&D projects are undertaken by service providers either for internal tool and platform development or for OEMs to support their Industry 4.0 solutions. There are three types of R&D projects:

- **OEM Product R&D:** R&D projects that include Industry 4.0–related product design and development for OEMs’ core products. For example, several manufacturing independent software vendors (ISVs) have started leveraging service providers in developing Industry 4.0–specific functionalities.

- **OEM Solution R&D:** R&D projects that include joint solution development with OEMs for specific Industry 4.0 use cases and business outcomes. OEMs leverage partnerships with service providers to extend the solutions reach, and service providers develop specific applications for OEMs’ products and platforms. For example, GE and Siemens are engaging numerous service providers to develop apps on the firms’ platforms.

- **Internal R&D:** Industry 4.0–related internal products, tool, technologies, and intellectual property (IP) development projects by service providers that can help enterprises in their Industry 4.0 journey. Almost all service providers are engaged in Industry 4.0–related internal R&D work.

**Plan:** These consulting services are provided by service providers to manufacturing enterprises to help them plan their Industry 4.0 journey. There are three types of consulting services:

- **IT Systems Consulting:** Providing IT strategy services that help to rethink the enterprise’s overall IT architecture to implement a new Industry 4.0 technology and to help predict and overcome integration challenges.

- **Technology Consulting:** Advising clients on implementing or upgrading specific manufacturing technologies to achieve the desired business outcome. In addition, developing a manufacturing technology roadmap for clients is part of technology consulting.

- **Business Consulting:** Formulating an Industry 4.0 transformation strategy and roadmap at the enterprise level, which includes business planning, wholesale process improvement, and change management.
Implement: These project execution engagements include IT implementation work and single and multi-technology implementation work.

» IT Implementation: Manufacturing IT implementation work that includes the IoT, analytics, automation, AI, and cloud-related engagements.

» Technology Implementation: Engineering technology implementation work that includes robots, 3D printing, augmented reality, and virtual reality–related engagements.

» Digital Factory Implementation: Transformation of the manufacturing environment at the plant or factory level through a combination of IT and multiple engineering technologies implementations.

Operate: These long-term annuity-based engagements help enterprises run their manufacturing operations in the Industry 4.0 environment:

» IT Operation: IT support and maintenance for applications, cloud, etc., to help run uninterrupted operations.

» BPO Operation: Manufacturing specific business process operations and management for productivity management and performance improvement.

» As-a-Service Operation: Intelligent, automated services in which service providers have increased responsibility for the outcomes. This can be achieved by offering services on platforms that leverage collaborative pricing that reduces risk and increases the value for customers.

The Current State of the Industry 4.0 Services Landscape

We talked to the 12 service providers that participated in this study and analyzed their 500+ customer case studies to understand the current state of the Industry 4.0 services landscape. We analyzed Industry 4.0 services use cases and Industry 4.0 services trends across technologies, geographies, services, and verticals. These insights are critical for all three stakeholders: enterprises, OEMs, and Industry 4.0 service providers.

Our research revealed several interesting use cases for Industry 4.0. In Exhibit 6, we list the use cases under each of the 13 technologies related to Industry 4.0.
<table>
<thead>
<tr>
<th>Technology</th>
<th>Use Cases</th>
</tr>
</thead>
</table>
| Manufacturing Data Analytics | • Business analytics platform to track production data for optimizing manufacturing processes  
                              • Predictive maintenance modeling by analyzing real-time machine data  
                              • Developing smart manufacturing use cases for quality management from asset data monitoring |
| Robots                  | • Testing and validation of products through robotic inspections  
                              • Precision manufacturing, such as drilling, riveting, etc., and other critical requirements handled by robots  
                              • In-house autonomous logistics using a robotic fleet that can interact with humans and other elements |
| Manufacturing Automation | • Regulatory compliance management through automated data collection  
                              • Automated workflow for manual data entry and machine control  
                              • A central repository of data and improved reporting, driving the standardization of operation performance and easy benchmarking |
| Digital Clone or Simulation | • Improved product design and process improvement through virtual modeling  
                                • Simulation software for less physical tests and validation of manufactured products  
                                • Performance analysis by simulating real-life scenarios through digital simulations |
| 3D Printing             | • Reduction in the number of assemblies and weight reduction of components  
                              • Design innovation through 3D printing  
                              • Usage of 3D printers in manufacturing follows the lean manufacturing principle |
| Manufacturing IoT       | • Remote monitoring of manufacturing assets on a broad number of parameters ranging from small footprint embedded devices to large distributed control systems  
                              • Improved machine design based on the extensive data collected for critical machine parameters  
                              • The shift in the asset maintenance system, i.e., from calendar-based maintenance to condition-based maintenance |
| Plant Cybersecurity     | • Cybersecurity solution to protect plants and the infrastructure that include sensors, communication and data platforms, and software applications  
                              • Security solution to comply with industry standards, and governance |
### Manufacturing on Cloud
- Centralized serialization and genealogy solution for different manufacturing parts of assembly lines for future reference
- Digital collaboration among different plants through a cloud-based hosting solution
- Tracking and accessing sensor data across the manufacturing value chain

### Virtual Reality in Manufacturing
- Virtual reality–enabled engineering platform to develop new products or virtual factory layouts with an improved and interactive visual aid
- Training of factory operators and other professionals in a real-time view of actual surroundings combined with an overlay of intelligent virtual objects

### Augmented Reality in Manufacturing
- AR assisted in-service product performance monitoring and maintenance system that can be connected to a remote system for interactive assistance
- AR-enabled geo-fencing applications to identify the material locations where the right material is available for the machine or operation

### AI in Manufacturing
- Cognitive analysis of machine data and to identify process parameters responsible for plant productivity and product quality
- Deriving insights from unstructured data and feeding the data to the product development stage
- Process optimization, including automation through operational data analysis

### Visual Analytics in Manufacturing
- Visual Analytics–based solution for inspecting components and detecting defects on a shop floor
- Visual-enabled interactive console application for images and export results analysis, to provide real-time monitoring and alert functionalities

### Small Batch Manufacturing
- Planning and development of processes that enable small-batch manufacturing
- Implementation of small-batch manufacturing technologies

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Source: HfS Research, 2017

We classified the 13 technologies associated with Industry 4.0 into three categories—Good Adoption, Building Capabilities, and Niche Areas—based on the number of case studies for each technology and validated the classifications with discussions with the service providers and buyers.
The Good Adoption category includes three technologies that have been mastered by almost all the service providers. The Building Capabilities category contains five technologies that are still evolving and that the majority of the service providers have yet to master. The Niche Areas include five technologies that are provided by only a few service providers and can be a differentiating factor in Industry 4.0 offerings today. Exhibit 7 shows the technology classification based on the number of case studies, and Exhibit 8 shows the percentage of case studies for each technology.

Exhibit 7: Segmentation of Industry 4.0 Technologies

- **Niche Areas**: AR, VR, Visual Analytics, Plant Cybersecurity, Small Batch Manufacturing
- **Building Capabilities**: 3D Printing, Robots, AI in Manufacturing, Manufacturing IoT, Manufacturing on Cloud
- **Good Adoption**: Manufacturing Data Analytics, Digital Clone or Simulation, Manufacturing Automation

Source: HfS Research, 2017
Exhibit 8: Distribution of Industry 4.0 Engagements Across 13 Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing Data Analytics</td>
<td>19%</td>
</tr>
<tr>
<td>Manufacturing Automation</td>
<td>19%</td>
</tr>
<tr>
<td>Digital Clone or Simulation</td>
<td>13%</td>
</tr>
<tr>
<td>Manufacturing IoT</td>
<td>11%</td>
</tr>
<tr>
<td>3D Printing</td>
<td>6%</td>
</tr>
<tr>
<td>Manufacturing on Cloud</td>
<td>6%</td>
</tr>
<tr>
<td>Robots</td>
<td>5%</td>
</tr>
<tr>
<td>AI in Manufacturing</td>
<td>5%</td>
</tr>
<tr>
<td>AR in Manufacturing</td>
<td>4%</td>
</tr>
<tr>
<td>VR in Manufacturing</td>
<td>4%</td>
</tr>
<tr>
<td>Visual Analytics in Manufacturing</td>
<td>3%</td>
</tr>
<tr>
<td>Plant Cybersecurity</td>
<td>3%</td>
</tr>
<tr>
<td>Small Batch Manufacturing</td>
<td>2%</td>
</tr>
</tbody>
</table>

Source: HfS Research, 2017

In Exhibit 8, the most frequently used technologies are manufacturing data analytics and manufacturing automation. Digital clone or simulation is also increasingly used for ergonomics study, plant outlet design, and other purposes. There is strong interest in the Manufacturing IoT among service providers, but there are not many shop floor IoT case studies. 3D printing is a hot topic for material and component research, prototypes, and spares, but we found few case studies of 3D printing in production lines. Robots are increasingly visible in main production lines and are working effectively in tandem with operators. Service providers are offering cloud capabilities in manufacturing, but it has yet to gain popularity among enterprises. As enterprises will require more automated intelligent decision-making capabilities, AI in manufacturing will evolve and could be a major differentiating factor for service providers.

Geography wise, North American manufacturing organizations are at the forefront of Industry 4.0 adoption followed by European and APAC enterprises as shown in Exhibit 9.
Exhibit 9: Distribution of Industry 4.0 Engagements Across Geographies

Source: HfS Research, 2017

In Exhibit 9, the rest of the world (ROW) primarily includes countries from Latin America. The early-adopter countries of Industry 4.0 are the United States, the United Kingdom, Germany, France, Japan, Russia, China, India, Brazil, Australia, etc. The number of greenfield Industry 4.0 implementations is very low, and most implementations occur in the existing manufacturing plant landscape.

The automotive, aerospace, and industrial equipment verticals are the leading verticals for Industry 4.0 services as shown in Exhibit 10.
Exhibit 10: Distribution of Industry 4.0 Engagements Across Verticals

<table>
<thead>
<tr>
<th>Vertical</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive</td>
<td>21%</td>
</tr>
<tr>
<td>Industrial Equipment</td>
<td>17%</td>
</tr>
<tr>
<td>Aerospace</td>
<td>16%</td>
</tr>
<tr>
<td>Energy, Chemical &amp; Process Industries</td>
<td>15%</td>
</tr>
<tr>
<td>Hi Tech &amp; Consumer Electronics</td>
<td>10%</td>
</tr>
<tr>
<td>CPG &amp; Food Processing</td>
<td>9%</td>
</tr>
<tr>
<td>Pharmaceutical &amp; Medical Devices</td>
<td>5%</td>
</tr>
<tr>
<td>Semiconductor &amp; Telecom</td>
<td>3%</td>
</tr>
<tr>
<td>Others</td>
<td>2%</td>
</tr>
</tbody>
</table>

Source: HfS Research, 2017

In the automotive and aerospace verticals, a significant number of engagements were prevalent among the auto parts and aerospace parts suppliers. Although at present Industry 4.0 adoption is on the lower side in high-tech and consumer electronics domain, we expect the adoption rate will be higher in the near future.

In Exhibit 11, we show the adoption rate of Industry 4.0 technologies by geography. Clearly, North America leads the pack in all 13 technologies followed by Europe. Clients in APAC and ROW countries constitute a larger percentage in niche areas in Industry 4.0.
Exhibit 11: Industry 4.0 Technology Distribution for Industry 4.0 Engagements Across Geographies

<table>
<thead>
<tr>
<th>Technology</th>
<th>North America</th>
<th>Europe</th>
<th>APAC &amp; ROW</th>
</tr>
</thead>
<tbody>
<tr>
<td>3D Printing</td>
<td>64%</td>
<td>27%</td>
<td>9%</td>
</tr>
<tr>
<td>AI in Manufacturing</td>
<td>56%</td>
<td>33%</td>
<td>11%</td>
</tr>
<tr>
<td>AR in Manufacturing</td>
<td>50%</td>
<td>33%</td>
<td>17%</td>
</tr>
<tr>
<td>Digital Clone or Simulation</td>
<td>54%</td>
<td>8%</td>
<td>38%</td>
</tr>
<tr>
<td>Manufacturing Automation</td>
<td>64%</td>
<td>27%</td>
<td>9%</td>
</tr>
<tr>
<td>Manufacturing Data Analytics</td>
<td>57%</td>
<td>30%</td>
<td>13%</td>
</tr>
<tr>
<td>Manufacturing IoT</td>
<td>33%</td>
<td>50%</td>
<td>17%</td>
</tr>
<tr>
<td>Manufacturing on Cloud</td>
<td>57%</td>
<td>29%</td>
<td>14%</td>
</tr>
<tr>
<td>Plant Cybersecurity</td>
<td>44%</td>
<td>33%</td>
<td>22%</td>
</tr>
<tr>
<td>Robots</td>
<td>43%</td>
<td>29%</td>
<td>29%</td>
</tr>
<tr>
<td>Small Batch Manufacturing</td>
<td>50%</td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td>Visual Analytics in Manufacturing</td>
<td>50%</td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td>VR in Manufacturing</td>
<td>40%</td>
<td>40%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Source: HfS Research, 2017

Exhibit 12 shows our analysis of the adoption of Industry 4.0 technologies across vertical markets. For each of the 13 technologies, the top three verticals were identified. The automotive, industrial equipment, and aerospace industries have adopted all 13 technologies at varying percentages.
### Exhibit 12: Industry 4.0 Technology Distribution for Industry 4.0 Engagements Across Industries

<table>
<thead>
<tr>
<th>Technology</th>
<th>Automotive</th>
<th>Industrial Equipment</th>
<th>Aerospace</th>
<th>Energy, Chemical &amp; Process Industries</th>
<th>Hi Tech &amp; Consumer Electronics</th>
<th>CPG &amp; Food Processing</th>
<th>Pharmaceutical &amp; Medical Devices</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>3D Printing</td>
<td>21%</td>
<td>21%</td>
<td>11%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>47%</td>
</tr>
<tr>
<td>AI in Manufacturing</td>
<td>22%</td>
<td>22%</td>
<td>11%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>44%</td>
</tr>
<tr>
<td>AR in Manufacturing</td>
<td>31%</td>
<td>23%</td>
<td>15%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>31%</td>
</tr>
<tr>
<td>Digital Clone or Simulation</td>
<td>38%</td>
<td>21%</td>
<td>14%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>28%</td>
</tr>
<tr>
<td>Manufacturing Automation</td>
<td>13%</td>
<td>24%</td>
<td>13%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>51%</td>
</tr>
<tr>
<td>Manufacturing Data Analytics</td>
<td>19%</td>
<td>19%</td>
<td>26%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>36%</td>
</tr>
<tr>
<td>Manufacturing IoT</td>
<td>23%</td>
<td>32%</td>
<td>15%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30%</td>
</tr>
<tr>
<td>Manufacturing on Cloud</td>
<td>27%</td>
<td>18%</td>
<td>36%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18%</td>
</tr>
<tr>
<td>Plant Cybersecurity</td>
<td>29%</td>
<td>14%</td>
<td>14%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>43%</td>
</tr>
<tr>
<td>Robots</td>
<td>25%</td>
<td>13%</td>
<td>19%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>44%</td>
</tr>
<tr>
<td>Small Batch Manufacturing</td>
<td>25%</td>
<td>25%</td>
<td>25%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25%</td>
</tr>
<tr>
<td>Visual Analytics in Manufacturing</td>
<td>14%</td>
<td>29%</td>
<td>14%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>43%</td>
</tr>
<tr>
<td>VR in Manufacturing</td>
<td>27%</td>
<td>36%</td>
<td>18%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18%</td>
</tr>
</tbody>
</table>

Source: HfS Research, 2017

In Exhibit 13, we classified the Industry 4.0 engagements by overall engagement type such as Proof of Concepts (PoCs), single technology engagements, and multi-technology implementations.
Exhibit 13: Distribution of Industry 4.0 Engagements Across Engagement Types

The chart shows that most of the Industry 4.0 engagements were single technology oriented followed by PoC and multi-technology implementation. Most of the single technology projects were IT technology oriented. PoCs are related to engineering technologies.

Exhibit 14 shows the proportion of Industry 4.0 engagement’s for each category in the services value chain.

Exhibit 14: Distribution of Industry 4.0 Engagements Across the Value Chain

Source: HfS Research, 2017
The chart shows that the highest and lowest number of engagements were in the Implement and Operate phases, respectively. To date, service providers have been less active in the R&D phase, implying that manufacturing OEMs are still keeping research in-house and outsourcing a smaller amount of work. Each phase of the value chain is further analyzed below.

For each of the value chain elements shown in Exhibit 14 we have divided each value chain node into subcategories, these are shown in Exhibit 15 to Exhibit 18. Exhibit 15 shows the R&D-related projects.

Exhibit 15: Distribution of R&D-Related Industry 4.0 Engagements

![Distribution of R&D-Related Industry 4.0 Engagements](chart)

Source: HfS Research, 2017

The chart shows that service providers are mostly involved in Industry 4.0 R&D assignments in solution R&D with manufacturing OEMs and in their own internal R&D projects. OEM product R&D is not that prevalent. For manufacturing OEMs, Industry 4.0 research is still a strategic interest; thus, these OEMs are keeping a large part of product research in-house and co-innovating with service providers in solutions R&D for specific use cases and business outcomes. Internal R&D is very important for service providers as they need to develop tools, platforms, and IP that differentiate the firms and can be leveraged for rapid deployment of Industry 4.0 solutions.

Exhibit 16 shows the plan-related subcategories.
Exhibit 16: Distribution of Plan-Related Industry 4.0 Engagements

The chart shows that most of the consulting engagements were IT systems consulting oriented followed by technology consulting and business consulting. In general, IT system consulting assignments are followed by project implementation. Typically, technology consulting engagements are related to the feasibility study, cost-benefit analysis, and other aspects primarily for engineering technologies. Business consulting projects involve roadmaps and business plans, and global service providers lead in this area more than their Indian counterparts.

Exhibit 17 shows the implement-related sub-categories.
Exhibit 17: Distribution of Implement-Related Industry 4.0 Engagements

Source: HfS Research, 2017

You can see from the chart that most of the implementation engagements are IT heavy implementations followed by technology implementations and digital factory implementations. Industry 4.0 is a centralized solution, and the control system (thus, system connectivity and monitoring) is the first priority. For that reason, IT implementation is the first step followed by integration of the engineering technology. Most of the engineering technology solutions act as point solutions. A digital factory signifies the true state of smart manufacturing that is the amalgamation of most of the 13 technologies. Very few engagements that are the true spirit of a digital factory were found.

Exhibit 18: Distribution of Operate-Related Industry 4.0 Engagements

Source: HfS Research, 2017
Overall, the number of Industry 4.0 Operate engagements was very low. As shown in Exhibit 18, most of the support projects were pure-play IT operation support. Business process operations (BPO) operation support engagements were found mainly for IoT and analytics projects. The As-a-Service model is the ideal state of Industry 4.0 operations, and these types of offerings demand more enterprise and solutions maturity of the service providers. We observed some early examples in this area, but the volume was low.

The scope of the Industry 4.0 engagements differed across the levels of manufacturing operations (refer to the Digital OneManufacturing framework). The distribution of Industry 4.0 engagements across smart components, smart machines, the digital factory, and connected factories is described in Exhibit 19.

Exhibit 19: Distribution of Industry 4.0 Engagements Across Levels

Source: HfS Research, 2017

The chart shows that most of the engagements are observed at the smart machine and smart component levels followed by digital factory engagements. To date, connected factories are rare as manufacturing enterprises are still conceptualizing Industry 4.0. At the smart machine level, the IoT is the most important technology whereas at the digital factory level, analytics, automation, AI, and digital clone/simulation technologies are mostly used.

In our description of the Digital OneManufacturing framework, we discussed how Industry 4.0 can be effective for a digital connected enterprise by enabling intelligent digital processes.

Exhibit 20 shows the distribution of Industry 4.0 engagements across intelligent digital processes.
Exhibit 20: Distribution of Industry 4.0 Engagements Across Intelligent Digital Processes

Source: HfS Research, 2017

Exhibit 20 shows that the objectives of most of the engagements were related to analysis followed by visualization. When analysis and visualization processes are integrated in the decision support model for automated decision-making with minimum human intervention, then we will have real control capabilities.

**Service Providers’ Strategy for Industry 4.0**

During our research, we came across different Industry 4.0 growth and investment strategies for the 12 service providers we evaluated, which we discuss in detail here. We analyzed this trend and discuss the top strategies adopted by the service providers to expand their Industry 4.0 business, key differentiators as a provider of Industry 4.0 services, and the major changes recently implemented to boost Industry 4.0 services capabilities. These insights are critical for enterprises and Industry 4.0 service providers. These service providers can use these insights to compare and benchmark their strategies, investments, and differentiation with their industry peers and identify areas for improvement. The enterprises can also use these insights to compare and benchmark their internal Industry 4.0 capabilities and investments.

Exhibit 21 shows the different strategies employed by service providers to grow their Industry 4.0 business.
Exhibit 21: Distribution of Service Providers’ Growth Strategy in Industry 4.0

<table>
<thead>
<tr>
<th>Service Strategy</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consulting &amp; PoC led engagement</td>
<td>58%</td>
</tr>
<tr>
<td>Verticalized platform based solution</td>
<td>58%</td>
</tr>
<tr>
<td>Collaboration with digital initiatives</td>
<td>50%</td>
</tr>
<tr>
<td>Industry 4.0 Innovation centers</td>
<td>50%</td>
</tr>
<tr>
<td>Strong partner ecosystem &amp; thought leadership</td>
<td>42%</td>
</tr>
<tr>
<td>End-to-end solutions provider</td>
<td>42%</td>
</tr>
<tr>
<td>Workforce expansion &amp; capability development</td>
<td>42%</td>
</tr>
<tr>
<td>Rapid implementation focus</td>
<td>17%</td>
</tr>
<tr>
<td>Acquisition for Industry 4.0 capability</td>
<td>17%</td>
</tr>
<tr>
<td>New business model adoption</td>
<td>8%</td>
</tr>
</tbody>
</table>

Source: HfS Research, 2017

Consulting and PoC-led engagement and verticalized platform-based solutions are the top growth strategies followed by Industry 4.0 innovation centers and collaboration with digital initiatives.

As starting the manufacturing transformation journey is a big decision for clients, the role of consulting and PoC is very important. The manufacturing processes of different industries vary, so service providers are developing Industry 4.0-specific offerings. Industry 4.0 requires the integration of many digital technologies; thus, digital collaboration is necessary with a focus on emerging technologies related to Industry 4.0.

When we asked service providers about their differentiation in Industry 4.0 services, they gave interesting responses, and there were a few common threads. Exhibit 22 shows the key differentiators of service providers in Industry 4.0 services.
Exhibit 22: Distribution for Key Differentiators of Service Providers in Industry 4.0 Service Offerings

<table>
<thead>
<tr>
<th>Differentiator</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing industry experience</td>
<td>83%</td>
</tr>
<tr>
<td>Industry 4.0 consulting &amp; technology expertise</td>
<td>75%</td>
</tr>
<tr>
<td>Strong innovation focus</td>
<td>67%</td>
</tr>
<tr>
<td>Strong partnership ecosystem &amp; thought leadership</td>
<td>50%</td>
</tr>
<tr>
<td>End-to-end transformation partner</td>
<td>42%</td>
</tr>
<tr>
<td>Industry 4.0 talent pool</td>
<td>33%</td>
</tr>
<tr>
<td>Global delivery presence</td>
<td>33%</td>
</tr>
<tr>
<td>Verticalized Industry 4.0 solutions</td>
<td>25%</td>
</tr>
<tr>
<td>Rapid implementation focus</td>
<td>17%</td>
</tr>
<tr>
<td>Flexible business model</td>
<td>8%</td>
</tr>
</tbody>
</table>

Source: HfS Research, 2017

Manufacturing industry experience is a key differentiator followed by Industry 4.0–related consulting and delivery expertise and strong innovation focus.

Previous experience in manufacturing challenges and consulting and technology expertise enable service providers to draw a roadmap and implement Industry 4.0 effectively. Innovation has strong visibility for vendors as Industry 4.0 involves several emerging technologies that need to be used effectively according to the business use cases. A strong partner ecosystem, an end-to-end solutions provider, and a dedicated Industry 4.0 talent pool are also important differentiators.

Exhibit 23 shows how service providers are changing operational organization plans to account for Industry 4.0 services.
Exhibit 23: Distribution of Service Providers’ Organizational Capability Plans for Industry 4.0 Services

<table>
<thead>
<tr>
<th>Capability Plan</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global CoE for innovation &amp; execution</td>
<td>92%</td>
</tr>
<tr>
<td>Dedicated partnerships with vendors &amp; institutions</td>
<td>83%</td>
</tr>
<tr>
<td>Verticalized/Platform based solution development</td>
<td>58%</td>
</tr>
<tr>
<td>Industry 4.0 consulting capability development</td>
<td>42%</td>
</tr>
<tr>
<td>Workforce skill upgradation</td>
<td>42%</td>
</tr>
<tr>
<td>Investment in sales enablement</td>
<td>25%</td>
</tr>
</tbody>
</table>

Source: HfS Research, 2017

Establishing a global center of excellence (CoE) for innovation and execution is the key agenda for service providers followed by a dedicated partnership ecosystem and the development of verticalized/platform-based solution.

A global center of excellence (CoE) for Industry 4.0 is imperative for building capabilities in engineering, analytics, the IoT, and other areas. Many of the Industry 4.0 use cases demand theoretical research and core business knowledge; thus, partnerships with enterprises and institutions are necessary. In the future, once Industry 4.0 matures, and the benefits can be easily realized, industry-based Industry 4.0 solutions will emerge. Thus, service providers have already started to address that point.

Why are clients not moving fast on Industry 4.0? What challenges are customers facing? Exhibit 24 shows client challenges in Industry 4.0 implementation.
Exhibit 24: Distribution of Client Challenges for Industry 4.0 Implementation

Low Industry 4.0 readiness is the biggest client challenge followed by the lack of digital maturity and poor data quality or a lack of data insights.

Low Industry 4.0 readiness includes uncertainty about the scale of benefits, lack of clarity about Industry 4.0 benefits, confusion over internal buy-in across the various business units, and people’s perception of fewer jobs for Industry 4.0 implementation. Digitization of manufacturing activities is a must for Industry 4.0, but most clients are not willing to modernize legacy systems or infrastructure very soon. Industry 4.0 generates a huge amount of data, and enterprises are not sure how to convert the information and data into useful business insights to unlock operational results. Thus, poor data insight remains a big concern for clients. The other factors include a lack of standards, data security, the lack of vast skills for Industry 4.0, and the openness of new business models.

What internal challenges are service providers facing for Industry 4.0? Exhibit 25 shows the challenges for service providers in Industry 4.0 business.
Collaboration among internal teams and an external ecosystem poses the biggest challenges followed by a shortage of specialized talent and client readiness and Industry 4.0 adoption.

As CoE teams and innovation centers are located across the globe, internal integration with external partners is necessary. Workforce skills and retention are also important. To date, a large number of manufacturers have yet to commit to Industry 4.0, and this is leading to the slow adoption of digital manufacturing. Although some clients are testing the waters, the engagements are very small, and service providers are not getting the benefit of economies of scale.

## Recommendations for Buyers

In addition to the various recommendations and potential insights for buyers implicit in the other sections of this Blueprint Guide, buyers should consider the following specific recommendations:

- **Start the Industry 4.0 journey with small engagements**: Most of the client examples provided by the service providers we surveyed were PoCs and small implementation projects, which makes sense given how quickly Industry 4.0 is emerging as a manufacturing transformation driver. However, these experimental engagements do not signify that Industry 4.0 is still a dream.
Buyers need to dig into what’s possible from a business model perspective, from a technology perspective, and from a governance perspective. Although the first movers will reap the benefits early, experimentation is still a viable option. However, buyers need to strategize their goals at the corporate level and implement the same as a business function basis. Later, they can evaluate a specific outcome or business result. This will help buyers revisit their visions and reprioritize their goals along with the area of experimentation.

**Prepare for radical change:** Industry 4.0 will be a radical change for all manufacturing organizations. It will fundamentally transform how manufacturing processes are managed and will influence the value chain through digitization. Manufacturing control will be more automated and driven by more technology and changed user expectations. Thus, buyers should opt for service providers that can support them to understand and embrace these radical changes and help innovate internal processes and provide external plug-and-play services that address the impacts of digital smart manufacturing, finding a new balance and interplay between internal and external capabilities.

**Be aware of your opportunities and goals:** Mature connected digital manufacturing can create business advantages if it is aligned with a broader product and corporate strategy. It is possible to unlock the value of the Industry 4.0 services, but doing so requires a clear strategy and goals. Many service providers have technical execution skills but are light on business acumen in creating and realizing value from smart and connected manufacturing objects.

**Leverage service providers’ expertise to assess Industry 4.0 maturity:** Many service providers have developed frameworks to help their clients assess digital manufacturing and customer experience maturity and will often take a consultative approach to help clients understand where they are and where they need to be.

**End-to-end security is essential:** As Industry 4.0 standards and use cases are still evolving, concern remains about data breaches of hardware and software components. Industry 4.0’s extensive use of IoT components provides dangerous physical opportunities in addition to data theft unless careful thought is given to all stages of connectivity and operation.

**Integrated broader data flow solutions are needed rather than point solutions:** Gathering data from all the digital elements will not solve problems for manufacturing activities. The real challenge is to integrate all the data points and to extract actionable insights. Thus, buyers must watch for service providers based on their ability to provide deep expertise and capabilities in data and information management to support all manufacturing activities.
» **Look to service providers beyond cost and efficiency:** Because Industry 4.0 is still in the very nascent stage, buyers must look for strategic partnerships for a long time horizon rather than short-term benefits, such as cost reduction and efficiency improvement. Thus, buyers must align their future goals with service providers that mention milestones at every time interval. This will help services buyers achieve a manufacturing transformation that will mature in the coming years.

» **Increase the trust factor:** In Industry 4.0, service providers retain the manufacturing control systems. Thus, for execution and future innovation, buyers and service providers need to be more collaborative and inclusive. Both parties need to discuss business challenges at regular intervals and proactively bring up innovative ideas to improve business outcomes.

» **Develop collaborative pricing models and KPIs for Industry 4.0 adoption:** Industry 4.0 will transform the pricing model that can be defined based on the number of connected devices on a platform, the data volume, the business outcome, or other similar metrics. Thus, buyers should work closely with service providers to develop pricing models and KPIs that incentivize the models.

**Industry 4.0 Services Blueprint: The Grid**

Given the newness of this space, HfS did not develop a full Blueprint at this time. However, we have a perspective on where the vendors stand and how they’re positioned for future success. To give you a picture of how HfS sees the market landscape at the moment to evaluate these capabilities within Industry 4.0 service providers, we looked at two primary areas:

**Execution**

» “Skin in the game” in the form of R&D, other impactful investments, and all other relevant indications of sustained commitment to this capability area. These indications might include crafting an associated business case and roadmap, co-creating use cases with customers, pursuing relevant acquisitions, effectively articulating an Industry 4.0 vision and having a blueprint for executing on it, or bringing the 13 technology capabilities in different shop floor business operations. Any relevant customer examples provided, notwithstanding the relative newness of this capability area, were heavily considered in our detailed scoring model.

We analyzed the execution capability of each service provider based on the following parameters:

» Solution Offerings

» Case Studies
» Customers

Innovation

» Innovation starts with the service provider’s existing and planned examples of technology innovation (or even innovative thinking) in this capability area, including the depth of their surrounding analysis. Service providers often get very excited about new offerings and tout them as the end-to-end solution provider that encompass all the business challenges, while leaving it to clients to envision how that technology might be applied to their specific business problems. Thus, we also credited providers that could explain the business value and the potential of the new capabilities in ways that would resonate with buyers (and with us) over vendors with more grandiose but perhaps not very tangible ideas about how to progress in this area. The ecosystem, partnerships, investments, tools, and thought leadership activities are very important in Industry 4.0, and we took them into account while evaluating the service providers’ current innovation capabilities.

We analyzed the innovation capability of each service provider based on the following parameters:

» Strategy
» Tools, Technology, IP
» Investments and Organizational Capabilities
» Business Outcomes
» Partnerships
» Acquisitions
» Industry Groups
» Thought Leadership

HfS employs a weighted (evaluation factor) scoring model, with eight to ten criteria for Innovation and Execution. Weightings are based on a combination of responses from more than 1,300 crowdsourced survey participants and intel gathered in customer calls about what is driving or impeding business value. We use a 1–10 score for each criterion and then rank within each scored criterion to confirm the internal consistency of our thought process and the application of that thought process.
The data-gathering effort for this Blueprint Guide included vendor briefings and an abbreviated request for information (RFI) process, reviewing vendor collateral (including case studies), and evaluating the information presented in relevant third-party presentations (e.g., on YouTube). We also interviewed several enterprise customers and industry experts in our network to validate some of the findings.

Exhibit 26: Industry 4.0 Services Grid

Source: HfS Research, 2017
Blueprint Guide Grid Summary

To make it into the Winner’s Circle of an HfS Blueprint Market Guide, a vendor organization needs to demonstrate an ability to consistently deliver excellence in Execution and Innovation within the capability area covered. Given that Industry 4.0 services are still in the early stages of evolution and customer deployment, seven of the 13 service providers have shown a high number of promising solutions and thus qualified for the HfS Winner’s Circle: Accenture, HCL, IBM, Infosys, L&T Technology Services, TCS, and Wipro. Four of the vendors were evaluated as High Potentials: Altran, Atos, Cognizant, and Tech Mahindra. Genpact is ranked as a High Performer in this Blueprint Guide.

Overall, however, if a standard deviation test were applied to assess the degree of variability between the vendor scores (and ultimately grid placement), it would reveal only a modest variability, particularly between the Winner’s Circle and High Performers groups.

You should see this grid as a starting point. Without question, buyers and vendors will start to see more proof points and then more capabilities added over time. Different service providers will emerge as being out in front at different times, including in first-to-market ways. It would be pure conjecture to assert which ones will be leading in this capability area two to three years down the road, but the vendors that demonstrated a continuing commitment have done so for good reasons, and that will drive future Industry 4.0 investments and innovations.
# Industry 4.0 Service Provider Profiles

## Accenture

### Key:

<table>
<thead>
<tr>
<th>A good number of use cases validated by a number of customer case studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absence or a low number of use cases and customer case studies</td>
</tr>
</tbody>
</table>

**Winner’s Circle**

### Technology Areas in Industry 4.0:

- Manufacturing Data Analytics
- Robots
- Manufacturing Automation
- Digital Clone or Simulation
- 3D Printing
- Manufacturing IoT
- Plant Cybersecurity
- Manufacturing on Cloud
- Augmented Reality in Manufacturing
- Virtual Reality in Manufacturing
- Artificial Intelligence in Manufacturing
- Visual Analytics in Manufacturing
- Small Batch Manufacturing

### Strengths:

- Accenture has a deep understanding of manufacturing with clients across the sector and has used its experience to develop Industry 4.0–related tools and frameworks. In addition, the company’s integration of digital capabilities in Industry 4.0 solutions has provided a differentiator. Accenture has strong delivery capabilities across the Industry 4.0 value chain and is focusing its workforce training on emerging technologies, such as robotics, augmented reality, virtual reality, etc.

- Accenture has demonstrated strong thought leadership in the Industry 4.0 space by publishing among the highest numbers of Industry 4.0–related articles in the last 12 months. In addition, the company is associated with a number of industry...
bodies and participates in keynote presentations at conferences and forums throughout the year.

- Accenture leads in scale for Industry 4.0 services. It has had more than 500 Industry 4.0 clients and engagements, among the highest of the service providers evaluated for this study. Many engagements are very large spanning multiple manufacturing locations across continents. In addition, Accenture has long-standing strategic partnerships with almost all of the key players in the Industry 4.0 space, such as GE and Siemens, and the firm has built extensive libraries of frameworks, APIs, and other assets for them.

### Challenges

- Accenture's Industry 4.0 services offerings include the overlap of several business units within the company. As the Industry 4.0 market is still evolving, customers will expect flexibility from Accenture to deliver service offerings that overcome organization complexity and can streamline project execution for large and medium-size clients.

- The war for talent in this market is heating up. As extensive niche expertise is needed for Industry 4.0 technical competencies, service providers, including Accenture, could benefit from greater depths of expertise. As Accenture is rapidly expanding its Industry 4.0 client portfolio, talent readiness and retention are a challenge for the company. Accenture is addressing talent readiness by leveraging its acquisitions in the digital and engineering space.

### Key Partnerships

<table>
<thead>
<tr>
<th>Tools/Platforms/Frameworks/IP</th>
</tr>
</thead>
</table>

### Key Customers

<table>
<thead>
<tr>
<th>Key Customers</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABB, Airbus, Amazon Web Services, Bombardier, GE, Google, Marathon, Microsoft, ThyssenKrupp CSA, and Woodside</td>
</tr>
</tbody>
</table>

### Examples/Results

- Supporting an automotive Tier 1 manufacturer in transforming its global manufacturing operations to become a global agile manufacturer

- Working with a leading household appliances manufacturer to integrate 3D printing in the client’s supply chain operation model

- Developing augmented reality solutions for an aircraft manufacturer to improve its processes and for better visualization
- Engaged with a major petrochemical company for industrial cybersecurity and compliance with quality assurance standards
- Working with an energy company to build a digital simulation solution to improve operational performance ranging from maintenance to compliance management

**In Brief**

Accenture’s Industry X.0 Practice spans all five Accenture businesses (Strategy, Consulting, Digital, Technology, and Operations) and integrates the know-how and expertise of more than 10,000 professionals across Accenture businesses. The company has integrated several digital initiatives, such as blockchain, security, AI, etc., with Industry 4.0 offerings along with the capabilities of a number of acquired organizations specializing in these areas. Accenture’s broad consulting skills, marquee customer list, and complex multi-country technology implementation of Industry 4.0 have provided an edge over the other companies. We will watch how Accenture manages the growth of its Industry X.0 Practice and continues its global Industry 4.0 leadership.
What to Watch

» Industry 4.0 buzz has been around the market for quite some time, but now we are observing traction in the manufacturing industry. Although enterprises are following a phased approach for the implementation of Industry 4.0, we expect a significant investment plan in the coming years. Developed countries in North America and Europe have taken the leap in implementing Industry 4.0, but Asian countries, such as Japan, China, and South Korea, are also coming up faster in this space. The front-runner enterprises in this space will reap the first-mover advantage in digital products and services.

» Data analytics is at the core of a successful implementation outcome for Industry 4.0. The whole digital ecosystem is dependent on the actionable insights derived from data analysis. To date, enterprises are using social data analytics to identify trends, associations, and patterns; however, for Industry 4.0 engineering, data analytics is the need of the hour. Data interpretation must be aligned with the physical world to understand the machine behavior and predict the future state of manufacturing. Thus, enterprises must identify specialized data analysts with knowledge of core engineering activities.

» Manufacturing performance improvement through Industry 4.0 is evolving from talk to action. Enterprises that have successfully implemented Industry 4.0 are realizing benefits, such as inventory management through lean manufacturing, asset connectivity and monitoring, AI-based decision-making through real-time data analysis, augmented reality— or virtual reality—based digital simulation of manufacturing activities and product prototypes, component design through 3D printing, etc.

» The organizational culture is the main driver of Industry 4.0 adoption. Enterprises lack a digital culture in their organizations, and this is creating a roadblock for Industry 4.0 implementation as employees need digital skills to drive digital manufacturing processes. Thus, enterprises need to focus on building the digital culture and train employees who are comfortable in the digital ecosystem.

» The maturity of Industry 4.0 is largely dependent on the security effort and governance. As the data flow in Industry 4.0 starts from the sensor level, the security firewall must encompass the hardware components, communication protocols, software platform, and front-end applications. Because supply chain and logistics networks are increasingly intertwined with Industry 4.0, in the future regulatory bodies must figure out shared information, such as customer information from the services platform.
In Summary

The Industry 4.0 services capability area that is the focus of this research generally started slowly and conservatively in terms of investment from most vendors and customers. Large manufacturing organizations are using some of the Industry 4.0 technologies in isolation, but the true potential of smart manufacturing will be achieved when all the technologies are leveraged in tandem. The main open question is how long it will take before manufacturing organizations take Industry 4.0 adoption to the next level, that is, the digital factory and then connected factories. The Industry 4.0 implementation costs in terms of time and effort are not insignificant, but enterprises could start with a modest investment of time and effort. That second wave of early adopters can then go further into this realm when the business impacts are obvious. In time, HfS believes they will be, and early adopters often hold on to competitive advantage once they have it.
About the Authors

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Pareekh Jain is Senior Vice President and Managing Director India at HfS Research. He is also the lead analyst for engineering services, IoT, telecom, and manufacturing. He established the global engineering services practice at HfS Research which covers mechanical engineering services, embedded engineering services, software product engineering services, PLM services, and Industry 4.0. His IoT coverage includes the Consumer IoT, the Industrial IoT, and smart cities. He also tracks telecom and manufacturing verticals. He has authored various industry-leading engineering services research reports, including HfS engineering services blueprints, HfS engineering services top 20, HfS engineering services quarterly trends, etc. He is regularly quoted in the media on engineering services, IoT, and outsourcing trends, including Harvard Business Review (HBR), NDTV, Times of India, Economic Times, Business Standard, Hindu, Business Line, Livemint, Financial Express, Rediff, Voice of America, and Business Insider.

A seasoned outsourcing consultant, Pareekh has seen the engineering services outsourcing industry from three perspectives: service provider, advisor, and buyer. He started his career as a software engineer with Geometric, which gave him the service provider perspective. He was then with neoIT, an outsourcing advisory firm. At neoIT, he was a key contributor in a number of engagements with leading US and European clients, which spanned the outsourcing lifecycle. He also produced neoIT’s seminal report on city competitiveness for outsourcing. In his last assignment, he gained the perspective of an outsourcing buyer as he led strategic planning, sales planning, product planning, and R&D initiatives for the APAC region of Emerson Network Power—a Fortune 100 manufacturing multinational whose APAC operations are based in Kuala Lumpur, Malaysia.

Pareekh is a thought leader, having authored various publications on topics related to outsourcing, engineering services, technology, and regional competitiveness in outsourcing. He loves business fiction writing in his free time, and his first novel, Who Is That Lady?.

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Tanmoy has more than four years of research, pre-sales, and market intelligence experience at TCS, HCL, and Tracxn. In his TCS and HCL roles, he worked on preparing RFP responses, including solution constructs and commercial propositions. He was responsible for analyzing the business scenario for ERP implementation for different industry verticals and participated in several Enterprise Transformation projects across domains to optimize the IT landscape, increasing IT integration among client business verticals, improving productivity, and reducing business incidents. At Tracxn, he was part of the emerging technology team that helps find companies (startups) specializing in upcoming technologies (virtual/augmented reality, drone, etc.) for acquisition and portfolio investments for PE and VC firms.

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HfS Research is The Services Research Company™—the leading analyst authority and global community for business operations and IT services. The firm helps organizations validate and improve their global operations with world-class research, benchmarking, and peer networking. HfS Research was named Independent Analyst Firm of the Year for 2016 by the Institute of Industry Analyst Relations which voted on 170 other leading analysts. HfS Chief Analyst Phil Fersht was named Analyst of the Year in 2016 for the third time.

HfS coined the terms “The As-a-Service Economy“ and “OneOffice™,” which describe HfS Research’s vision for the future of global operations and the impact of cognitive automation and digital technologies. HfS’ vision is centered on creating the digital customer experience and an intelligent, single office to enable and support it. HfS’ core mission is about helping clients achieve an integrated support operation that has the digital prowess to enable its organization to meet customer demand—as and when that demand happens. With specific practice areas focused on the digitization of business processes and design thinking, intelligent automation and outsourcing, HfS analysts apply industry knowledge in healthcare, life sciences, retail, manufacturing, energy, utilities, telecommunications, and financial services to form a real viewpoint of the future of business operations.

HfS facilitates a thriving and dynamic global community that contributes to its research and stages several OneOffice™ Summits each year, bringing together senior service buyers, advisors, providers, and technology suppliers in an intimate forum to develop collective recommendations for the industry and add depth to the firm’s research publications and analyst offerings.

Now in its tenth year of publication, HfS Research’s acclaimed blog Horses for Sources is the most widely read and trusted destination for unfettered collective insight, research, and open debate about sourcing industry issues and developments.

HfS was named Analyst Firm of the Year for 2016, alongside Gartner and Forrester, by leading analyst observer InfluencerRelations.