Industry 4.0: The state of the nations

First global asset efficiency study reveals maturity of cyber-physical system deployments
Using Industry 4.0 to run the factory of the future

Industry 4.0, better known as the fourth industrial revolution, succeeds great industrial innovations including the steam engine, the conveyor belt as well as (far more recently) the first phase of information technology.

Industry 4.0 is enabled by cyber-physical systems where electronics, intelligent sensors, computation, and networking is embedded into physical systems and processes. This combination of the cyber and the physical builds a complex, closed-loop system. Machines can operate in tandem with each other and their users in real-time. Factory processes become visible and controllable in a virtual space. With real-time decision-making, products can communicate to machines on how to process. Supply chains flexibly align themselves based on changes in demand or production capacity.

This uber-efficient scenario far exceeds today’s traditional processes in every way possible, and we believe this is a great opportunity for innovative companies and research institutes to dynamically shape the future.

Effective management of production systems in any industrial facility is one of the most important contributors to its profitability. Enterprises that implement the best-in-class strategies to manage their physical assets stand to succeed in the global marketplace. And with the technology strides that have taken place over the past five years, there are significant opportunities for enterprises to improve the efficiency of their assets and in turn increase their productivity and profitability.

With this in mind, Infosys, a global leader in consulting, technology, engineering, outsourcing and next-generation services, conducted the first global study on asset efficiency along with the Institute for Industrial Management (FIR) at RWTH Aachen, the largest and leading scientific, technical and research university in Germany.

The objective of the study was to find out how well today’s industrial organizations are taking advantage of technologies to leverage value from their assets. The study observes how organizations plan to undertake this technology journey in the years leading up to 2020.

This report also provides an interesting comparison among types of industries and nations by looking at the leading organizations in five advanced manufacturing countries. It provides insights that industrial enterprises around the world can use to help develop their roadmap for improving asset efficiency.
The research used the Industry 4.0 framework, conceptualized by the German government and developed by industry leaders, to investigate the effectiveness of existing asset management processes. This reference framework is therefore applicable to any industrial organization in the world.

The study polled 433 industrial manufacturing executives in five regions – China, France, German speaking countries, the United Kingdom and the United States. The results provide the first glimpse into the understanding of industry preparedness for Industry 4.0 and specifically into the critical aspect of asset efficiency.

Infosys and RWTH Aachen focused on the four most important asset efficiency levers namely, maintenance management, operational management, information management and energy management. Respondents were asked to outline their current maturity levels on these levers and their target for 2020 on a four point scale of ‘Not Implemented (lowest maturity)’, ‘Potential Recognized’, ‘Partially Implemented’ and ‘Systematically Implemented and Benefits Realized (highest maturity)’.

For the purpose of analysis, enterprises were categorized as “Early Adopters” or “Followers” based on their response to the levers of asset efficiency.

This paper reports the status today and the aspiration for 2020 by asset efficiency levers, industry and production type, and country.

The journey to Industry 4.0 excellence

Leaders of high-tech industrial enterprises understand that their most important assets are the machinery and assembly tools on their factory floors. These companies have often spent decades developing their manufacturing plants to produce an ever-increasing array of goods and products that they sell around the world. They have also spent decades improving their industrial processes – including just-in-time inventory – to be as efficient as possible. But given the technology developments that have taken place over the past five years, even the industrial enterprises that are the leaders in lean processes are in danger of being left behind in the 21st century. This is because merely the deep knowledge of industrial practices is not enough to succeed in today’s ultra-competitive and technology-enabled marketplace.

By tapping into the principles of Industry 4.0 and adopting emerging technologies, today’s asset-intensive organizations can hone their ability to stay ahead in a new world where machinery and tools are being amplified by digitization. This cyber-physical world offers the bold riches of enhanced global competitiveness and entry into radically new marketplaces.
Benchmarking global Industry 4.0 maturity

The study shows that awareness has not been reflected in action, yet.

While the vast majority (85 percent) of companies are aware of the high potential in implementing Industry 4.0 concepts to increase asset efficiency (this is consistent across countries and sectors), only 15 percent of enterprises surveyed have already implemented dedicated strategies for asset efficiency. An additional 39 percent have partially implemented these strategies.

Nearly half of the respondents surveyed (48 percent) want to implement Industry 4.0 solutions systematically for enhanced asset efficiency by 2020 (see Figure 1). Conversely, by 2020 still one fifth of the respondents will have made at best piecemeal progress.

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<th>Lever</th>
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<tr>
<td>Maintenance Efficiency</td>
<td>Using real time operational and conditional data for planning and scheduling maintenance and to implement preventive maintenance</td>
<td>An effective and relevant maintenance strategy can help in controlling maintenance cost, which is the single largest expenditure in an asset-intensive enterprise</td>
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<tr>
<td>Operational Efficiency</td>
<td>Integrated real-time visibility to monitor all levels from the individual asset to the entire supply chain</td>
<td>An integrated view on asset performance efficiency, production efficiency and logistics process efficiency automatically managed by closed control loops results in massive increase in overall equipment efficiency</td>
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<tr>
<td>Information Efficiency</td>
<td>The handling of available data. It provides high data quality and therefore interoperability for a seamless flow of data</td>
<td>Good asset information management significantly improves decision-making ability, especially in determining optimal asset performance and maintenance</td>
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<tr>
<td>Energy Efficiency</td>
<td>Optimizing the consumption of resources (energy, raw materials, water, chemicals and waste) of the plant</td>
<td>There is a direct relation between asset efficiency and energy efficiency. An efficient asset is also energy efficient</td>
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The survey found significant variance in the adoption levels in different markets. Figure 2, below, shows that in 2015 68 percent of respondents from China have partially or systematically implemented asset management programs, potentially rising to 89 percent by 2020. Comparable numbers for France are 27 percent and 61 percent respectively.

Figure 1: Use of Industry 4.0 concepts to manage assets

Figure 2: Country comparison of Industry 4.0 concepts implementation to manage assets
Industry 4.0 international comparisons

Across the five countries surveyed - China, France, Germany, the United Kingdom and the United States – the level of maturity in Industry 4.0 varied significantly.

While no country can claim to be the global early adopter in implementing Industry 4.0 in the context of asset efficiency, the percentage of companies in China that claim to be early adopters is significantly higher than anywhere else (see Figure 3).

It is expected that a number of factors are driving this; notably the focused initiatives and investment from the Chinese government to develop more sustainable industry growth. Also, manufacturing is core for China and the market is accustomed to rapidly implementing new technology, especially in green field sites free of legacy infrastructures.

Germany (21 percent), the United Kingdom (26 percent) and the United States (32 percent) have similar maturity footprints both in terms of 2015 status and 2020 ambition. This could be because of their historical leadership in manufacturing.

In France (14 percent), the Industry 4.0 implementation is comparatively less mature. The economic downturn and recent unsuccessful digitization programs could be contributing factors.

A comparison of the average maturity rate in 2015 and the expected rate in 2020 reflects this progress of Industry 4.0 adoption. The study also reveals that the rate of progress expected in each country over the next five years is expected to be the broadly the same. However, in France average maturity rates are expected to be lower in 2020 than Chinese companies are, on average, claiming in 2015 (see Figure 4).
Industry 4.0 asset management lever comparisons

Maintenance Efficiency:
The potential of a preventive maintenance strategy, driven by real-time-data and analytics, is viewed as important by most companies at 87 percent. Initial implementations of condition monitoring have already been started by 15 percent of those surveyed.

Four fifths (81 percent) of respondents are aware of the potential of machine status surveillance for maintenance purposes, but only 17 percent have put such principles into practice in their workflows. Only nine percent of German and a mere four percent of French companies are working to implement the appropriate practices.

Detailed root-cause analysis and predictive analytics to help analyze breakdown and predict failure is being systematically used by 14 percent of surveyed companies.
Operational Efficiency:
Operational efficiency is currently systematically monitored and optimized at an asset level by 16 percent of companies. The first systematic implementations to have an integrated view of asset performance, production logistics and services have happened. Manufacturing processes regulated in a closed control loop based on real-time data are emerging; reported in 13 percent of companies.

The survey showed that manufacturing equipment’s operating efficiency across the whole value chain is being measured with indicators, but that these figures are not systematically based on real-time data at 91 percent of surveyed companies in Germany. As for the use of real-time data in maintenance, Germany and France are at the bottom of the table with just nine and six percent respectively, in sharp contrast to the US, which is at 21 percent (see Figure 5).

Operational efficiency is already based on KPIs, but the required data is not yet real-time. The survey found that 57 percent optimized their assets based on KPIs; yet only 13 percent use real-time data from the factory.

Information Efficiency:
Today, the majority of the surveyed participants (89 percent) are well aware of the high potential of information and data standards. However, 83 percent want to use data at a more comprehensive level for further analytics (enterprise or across the supply chain) and beyond specific purposes.

Many companies are making the first implementations in the fields of information interoperability and missing data standards (47 percent), data security (57 percent) and advanced information analytics (60 percent). Further focused efforts are planned in the next five years with at least partly implementations of these same factors at 79 percent, 78 percent and 83 percent respectively.
While data security and data standards are important preconditions for data analysis, recognized by 82 percent, this is systematically implemented by only 11 percent.

However, the research revealed the largest improvements planned over the next five years are in the area of data standards and interoperability; the average score on the four point scale is set to move from 2.41 to 3.17. This is greater than for any other attribute surveyed.

Energy efficiency:
Today, the aspects of sustainability are only partly included in asset efficiency initiatives by 51 percent of those surveyed. Some 53 percent of companies are monitoring resource and energy consumption (raw materials, water, chemicals, waste) and 56 percent automatically optimize energy management. But only 14 percent have a systematic and integrated implementation of energy efficiency and overall sustainability of the plant.

A vast majority (88 percent) of the companies have identified energy management as one component during the planning and management of their assets. However, this has been systematically implemented by only 15 percent. Compared to Germany, where as many as 16 percent respondents have implement this, China fared poorly with just nine percent and the UK fared little better with 10 percent (see Figure 6).

![Figure 6: Comparison of recognition vs implementation of energy management as an asset management tool](image)
Industry 4.0 sector comparisons

The study was conducted across a variety of sectors including aerospace, automotive, electronics, machinery and process industry. Currently the automotive, electronics and process industries have the highest maturity levels and the process, machinery and electronics industries have planned the most extensive improvements between now and 2020 (see Figure 7).

![Figure 7: Comparison by industry sector](image)

However, these differences are not as pronounced as the country comparisons. While electronics and process industries currently have the highest maturity levels, this may be of little surprise as they are sectors which have benefited from significant investment in technology. The process industry, for example, has a long history in the application of sensors in processes to control and regulate complex process chains.

![Figure 8: Distribution of Early Adopters vs Followers by industry type](image)
Towards 2020: Leadership characteristics

The next five years will be vital to the adoption of Industry 4.0 for global manufacturing industries. The study reveals the largest improvements that companies will focus on, leading to 2020, will be in the following areas:

**Data standards and interoperability** between modern and legacy shop floor systems in a multi-vendor environment as a precursor for seamless interaction, which enables multiple aspects of efficiency up the value chain

**Effective root-cause analysis** and corrective actions that build a logical approach in solving problems at their source, rather than just fixing the apparent. This is therefore considered as a key for any continuous improvement program

**Dynamic asset classification** based on asset type, relation to other equipment, hierarchy, complexity and criticality is an important aspect to build the right model that enhances operational and maintenance efficiencies

**Real-time production planning and scheduling** can optimize all aspects of operations accurately by minimizing resources consumed and maximizing efficiency

**Knowledge capture and management** enables improved operations and maintenance of complex machines, as people and their knowledge are intangible assets in industrial manufacturing.

Manufacturing companies of today will need to adopt advanced technologies to improve in these areas if they plan to achieve higher maturity levels in their journey of Industry 4.0. Infosys has identified six leadership characteristics that will help ensure a strong foundation for success:

1. Fundamental shortage of skilled talent in a number of key areas, especially core engineering and advanced data and automation technologies, although there will be others over time. Being nimble and flexible in how these skills are resourced and managed will be critical

2. Information management needs to be improved for achieving maintenance and operational efficiency. Industry-wide data standards need to be agreed and implemented; data security must be a constant focus

3. Implementation needs to be faster than most companies are prepared for. Hence a robust ecosystem and open partnering behavior will be necessary

4. Those with legacy infrastructures can succeed, but they may need to adopt innovation more aggressively. This can be achieved not only by the bold use of technology, but also in building new partnerships with companies, large and small, research organizations and academic institutions

5. Focusing on quick wins and building on these can bring advantage. For example, energy efficiency is monitored, but not yet managed. Managing energy efficiency could be a simple first step to get traction

6. This is a revolution in manufacturing that can be predicted. Embracing the inevitable change and building a clear road map that can flex over time are critical. To stay a step ahead, companies must constantly look to learn from competitors and other companies outside their traditional sphere.

For more information, visit us at www.infosys.com/industry-4-0
Methodology and research partners

This comprehensive global research study assessed industry attitudes towards Industry 4.0 and specifically asset efficiency in the aerospace, automotive, electronics, machinery and process industries in China, France, German speaking countries, the United Kingdom, and the United States. The study polled 433 executives through an online survey as well as telephone interviews. FIR at RWTH Aachen and independent research firm Vanson Bourne conducted the study; FIR at RWTH Aachen surveyed German respondents between January and March, 2015 and Vanson Bourne surveyed the remaining countries between February and March 2015. To qualify for the survey, respondents had to be relevant executives involved in plant or production management (especially manufacturing managers, plant technical managers, COOs, and asset efficiency consultants as well as early adopters of R&D and manufacturing).