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Foreword

Since its inception in 2018, the World Economic Forum’s Global Lighthouse Network of advanced manufacturers has demonstrated how leading companies can work towards realizing the full potential of the innovations and advances at the core of the Fourth Industrial Revolution. Beginning with a select collection of leading-edge organizations, the network has seen how lighthouse factories can help entire organizations navigate their modernization journey, inspiring and catalysing change among partner organizations along the way. That is why the Global Lighthouse Network now comprises 54 sites, with 10 sites added in the third quarter of 2020. These manufacturers have excelled at Fourth Industrial Revolution transformation at scale while others have fallen behind, still stuck in “pilot purgatory”.

The Global Lighthouse Network includes companies that have achieved remarkable Fourth Industrial Revolution advancements within the four walls of factory sites, or have effectively implemented end-to-end digitization across the value chain. In both cases, Fourth Industrial Revolution technology has been powering the reimagination of manufacturing and supply chains across industries and sectors. Moreover, an essential aspect of lighthouses’ success lies with a dedicated focus on workforce development and capability building through a variety of means. Indeed, these organizations have prioritized their people by transforming the nature of work through intentional upskilling and/or reskilling efforts, empowering workers to realize their potential through new ways of working.

Recent world events, most notably the COVID-19 pandemic, have led to significant disruptions on a scale unprecedented in recent times, affecting nearly every aspect of global industry. While supply chain shocks have uncovered operational vulnerabilities, they have also presented transformative opportunities for manufacturing and supply chain leaders. The advances in technology and new ways of working implemented by these trailblazing organizations have been able to adapt quickly during disruption, while remaining viable and operational. This level of agility and resiliency sits at the core of true Fourth Industrial Revolution innovation, with valuable assets that serve as critical levers during unexpected adversity. The benchmarks and achievements heralded in previous findings about these leading companies remain impressive in their own right. Nevertheless, the turmoil of recent events affords organizations an even more sophisticated appreciation for the very qualities that have sustained them.

Thus, it is in this context of unprecedented challenge that lighthouses serve as models of transformation and beacons of light that can guide companies through the storm into a stronger, more resilient future. These companies are leading the way by demonstrating how to reimagine and rebalance operations into the next normal. They are showing how companies can provide value not only to their shareholders, but also to a broader set of stakeholders including workers, consumers and the environment, and society at large.

Perhaps most importantly, today’s challenges make clear that lighthouses are not at the end of their transformation journeys – they are only just starting to unlock the true potential of Fourth Industrial Revolution technologies. As the network of lighthouses grows, its light will shine brighter, helping even more organizations be better prepared to weather the inevitable future storms, whenever and wherever they occur.

Francisco Betti
Head of Shaping the Future of Advanced Manufacturing and Production, World Economic Forum

Enno de Boer
Partner and Global Leader Manufacturing, McKinsey & Company, Inc.
The World Economic Forum’s Global Lighthouse Network comprises 54 leading companies that have succeeded in the adoption of Fourth Industrial Revolution technology at scale, at individual sites and/or end-to-end across the value chain. This growth reflects the accelerating adoption of core Fourth Industrial Revolution technologies and their infusion in daily manufacturing and supply chain operations, as organizations act on a new urgency to remain competitive. Recent world events have only amplified this urgency, calling for a “Great Reset” across all sectors of the global economy. This Great Reset represents a decisive set of actions oriented towards delivering value not only to companies themselves, but to society as a whole.

The agility and resilience of lighthouse organizations have shown that in light of adversity the same qualities that set them apart before the pandemic are, in fact, part of the strong foundation essential to withstanding the tremendous forces unleashed by the powerful waves of change it has brought forth. Likewise, these qualities are what equip them to drive the Great Reset among industrials.

The Global Lighthouse Network encompasses a diverse range of manufacturing contexts across varied industries. Because of this diversity, these frontrunner companies shine a far-reaching light that extends far and wide. Thus, the learning opportunities they offer are widely relevant and not limited to a specific type of manufacturer. Indeed, the accumulated experiences of lighthouses present a valuable set of learning opportunities to companies of any size looking to transform their operations. This light offers a dual benefit: it is illuminating both what is possible and what is required to succeed in the face of adversity.

Fourth Industrial Revolution transformation is not an arbitrary goal. Even before the massive disruptions imposed by the pandemic, the gap between Fourth Industrial Revolution frontrunners and others was growing rapidly. Now, global economic challenges emerging in the wake of recent world events mandate a Great Reset among industrials, and a number of “durable shifts” are proving key to achieving this. Four durable shifts in manufacturing and supply chain have emerged as particularly critical: agility and customer centricity, supply chain resilience, speed and productivity, and eco-efficiency.

Improved agility and customer centricity across the end-to-end manufacturing and supply chain facilitates faster recognition of customer preferences. This, in turn, enables quicker adjustments to manufacturing flows at next-generation, small-scale modular plants to allow higher levels of customization. Supply chain resilience provides a competitive advantage, requiring connected, reconfigurable n-tier supply ecosystems and regionalization. Speed and productivity are attained through increased levels of automation and workforce augmentation coupled with upskilling and reskilling efforts. Eco-efficiency is increasingly considered a must-have to remain in business and ensure compliance with an increasingly complex regulatory landscape.

Global Lighthouse Network members, both within the four walls of individual sites and end-to-end across the value chain, are demonstrating how to engage these durable shifts across varied industries and production contexts. In each case, lighthouses have shown how commitments to workforce development coupled with strategic, courageous deployment of Fourth Industrial Revolution technology can position organizations not only for sustainability, but also for success in light of the next normal. By engaging these durable shifts, frontrunner organizations are leading the way to the Great Reset. Even as they themselves realize the benefits of these transformative changes, they likewise chart a course that helps other companies navigate these rough waters. At the same time, these adaptations help ensure the kind of resilience that will be key to sustaining operations in the face of future challenges. Ultimately, lighthouses, as they lead the Great Reset among industrials, are key to helping shape and realize a stronger, more resilient and inclusive future in which creative entrepreneurism and technological innovation can benefit private enterprise and society at large, along with the natural environment.
How the Global Lighthouse Network Is Leading the Way for Industrials
The Global Lighthouse Network comprises 54 leading sites as of June 2020. These forerunners have succeeded in the adoption of Fourth Industrial Revolution technology at scale. In some cases, this evolution has occurred within the four walls of the factory at an individual site, whereas other “end-to-end” lighthouses have implemented such advances across the value chain. Of these 54 sites, 10 are recent additions. In keeping with the variety characteristic of the Global Lighthouse Network, these 10 include a range of sectors as diverse as apparel, oil and gas, automotive, energy procurement, pharmaceuticals and electronics.

There has been acceleration in the adoption of core technologies driving Fourth Industrial Revolution innovation. That is to say, a steadily increasing number of organizations have been acting on a new urgency to integrate transformative technologies to refine their business operations and remain competitive. Recent world events, most notably the global pandemic, have amplified the sense of urgency, thus increasing the motivation for Fourth Industrial Revolution transformation at scale.

The scope and breadth of manufacturing industries represented in the Global Lighthouse Network underscores a key observation – that the key differentiators identified in previous white papers have a nearly universal relevance. Global Lighthouse Network member organizations run the gamut, encompassing a broad range of manufacturing contexts. No matter the specific nature of their business, lighthouses stand apart from the majority and provide an example to all.
The Global Lighthouse Network includes 54 sites as of 17 June 2020.

- **End-to-end connected value chain lighthouses**
- **Four-wall factory lighthouses**

1. Zymergen
   Biotechnology
2. DCP Midstream
   Oil and gas
3. Fast Radius with UPS
   Additive manufacturing
4. Schneider Electric
   Electrical components
5. Johnson & Johnson Vision Care
   Medical devices
6. Groupe Renault
   Automotive
7. MODEC
   Oil and gas
8. Johnson & Johnson Janssen
   Pharmaceuticals
9. Johnson & Johnson DePuy Synthes
   Medical devices
10. GSK
    Pharmaceuticals
11. Schneider Electric
    Electrical components
12. Groupe Renault
    Automotive
13. Tata Steel
    Steel products
14. Henkel
    Consumer goods
15. Phoenix Contact
    Industrial automation
16. AGCO
    Agricultural equipment
17. Rold
    Electrical components
18. Bayer
    Division pharmaceuticals
19. BMW Group
    Automotive
20. Procter & Gamble
    Consumer goods
21. Novo Nordisk
    Pharmaceuticals
22. Sandvik Coromant
    Industrial tools
23. Nokia
    Electronics
24. Arçelik
    Home appliances
25. Petkim
    Chemicals
26. Ford Otosan
    Automotive
27. Saudi Aramco
    Oil and gas
28. Unilever
    Consumer goods
29. Siemens
    Industrial automation products
30. Infineon
    Semiconductors
31. Schneider Electric
    Electrical components
32. Micron
    Semiconductors
33. Foxconn Industrial Internet
    Electronics
34. Petrosea
    Mining
35. Alibaba
    Apparel
36. FOTON Cummins
    Automotive
37. Unilever
    Consumer goods
38. Danfoss
    Industrial equipment
39. Midea
    Home appliances
40. Johnson & Johnson DePuy Synthes
    Medical devices
41. SAIC Maxus
    Automotive
42. Haier
    Home appliances
43. GE Healthcare
    Medical devices
44. Micron
    Semiconductors
45. Bosch
    Automotive
46. Procter & Gamble
    Consumer goods
47. Baoshan Iron & Steel
    Steel products
48. POSCO
    Steel products
49. Weichai
    Industrial machinery
50. Hitachi
    Industrial equipment
### 10 new industrial lighthouses at the forefront of the Fourth Industrial Revolution

**Asia**

<table>
<thead>
<tr>
<th>Site</th>
<th>Change story</th>
<th>Top 5 use cases</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alibaba</td>
<td>Combining powerful digital technologies with consumer insights, Alibaba’s pilot Xunxi factory brings a fully digitized new manufacturing model to life. It empowers end-to-end on-demand production based on consumer needs, and enables small businesses to be competitive in the fast-paced fashion and apparel market by shortening delivery time by 75%, reducing the need to hold inventory by 30%, and even cutting water consumption by 50%.</td>
<td>Predictive market insights and demand forecasting</td>
<td>40% Sell-through rate</td>
</tr>
<tr>
<td>Hangzhou</td>
<td></td>
<td>Artificial intelligence-enabled product design and testing</td>
<td>66% Product development lead time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Production planning optimized by advanced analytics</td>
<td>75% Production lead time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>E2E automated inhouse logistic</td>
<td>3x Warehouse workforce efficiency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Digital-enabled flexible manufacturing</td>
<td>98% Minimum order quantity compared to industry average</td>
</tr>
<tr>
<td>Micron</td>
<td>To drive the next wave of productivity improvement, Micron’s high-volume advanced semiconductor memory manufacturing facility developed an integrated Internet of Things and analytics platform, ensuring that manufacturing anomalies can be identified in real time while providing automated root cause analysis to accelerate new product ramp-up by 20%, reduce unplanned downtime by 30% and improve labour productivity by 20%.</td>
<td>Artificial intelligence-powered material handling system</td>
<td>22% Bottleneck tool idle time</td>
</tr>
<tr>
<td>Taichung</td>
<td></td>
<td>Artificial intelligence-powered optical inspection</td>
<td>10% Product downgrades from unexpected events</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IoT real-time energy data aggregation and reporting dashboard</td>
<td>15% Energy consumption</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analytics platform for yield management and root-cause analysis</td>
<td>20% Time to ramp new product</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analytics platform for deviation root-cause identification</td>
<td>34% OEE unplanned downtime</td>
</tr>
<tr>
<td>Midea</td>
<td>Faced with intense appliance industry competition and increasing complexity and speed in the e-commerce field, the Midea Group leveraged Fourth Industrial Revolution technologies to transform from an automated factory to an end-to-end connected value chain, improving labour efficiency by 28%, reducing unit cost by 14% and shortening order lead time by 56%.</td>
<td>Market insights generated by advanced analytics</td>
<td>34% Online (e-commerce) sales</td>
</tr>
<tr>
<td>Guangzhou</td>
<td></td>
<td>Production planning optimized by advanced analytics</td>
<td>70% Labour efficiency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Artificial intelligence-powered optical inspection</td>
<td>55% Inspection cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End-to-end digital logistics management</td>
<td>56% Order lead time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Digital tools to enhance a connected workforce</td>
<td>28% Labour efficiency</td>
</tr>
<tr>
<td>Unilever</td>
<td>With e-commerce booming in China, Unilever built a pull-production model by deploying Fourth Industrial Revolution solutions such as flexible automation and artificial intelligence at scale across production, warehousing and delivery, reducing order-to-delivery lead time by 50% and e-commerce consumer complaints by 30% while reducing costs by 34%.</td>
<td>Digital-enabled automatic material call-off system</td>
<td>50% Inventory levels</td>
</tr>
<tr>
<td>Hefei</td>
<td></td>
<td>End-to-end real-time supply chain visibility platform</td>
<td>50% Order to delivery lead time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Supplier material delivery by e-Kanban</td>
<td>50% Supplier delivery time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lights-off packing</td>
<td>30% OEE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Artificial intelligence-enabled safety management</td>
<td>80% Unsafe behaviour</td>
</tr>
</tbody>
</table>
Global Lighthouse Network: Four Durable Shifts for a Great Reset in Manufacturing

Europe

Groupe Renault
Maubeuge

To protect the plant competitiveness (recognized as the best-performing light commercial vehicle plant in the Alliance), Groupe Renault deployed Fourth Industrial Revolution technologies at scale in their 50-year-old plant, reducing warranty incidents by 50%, increasing their flexibility to deal with the many vehicle configurations, and reducing manufacturing costs by 16%.

Site | Change story | Top 5 use cases | Impact
--- | --- | --- | ---
Groupe Renault Maubeuge | To protect the plant competitiveness (recognized as the best-performing light commercial vehicle plant in the Alliance), Groupe Renault deployed Fourth Industrial Revolution technologies at scale in their 50-year-old plant, reducing warranty incidents by 50%, increasing their flexibility to deal with the many vehicle configurations, and reducing manufacturing costs by 16%. | Digital tools to enhance a connected workforce | 40% Right first time
|  |  | Connected people for performance driving | 3.5% Cost per unit
|  |  | Digital track and trace | 10% Warranty incidents
|  |  | Cycle time optimization through big-data analytics on line robots | 10p.c. CEE
|  |  | Sensor-based data collection for energy management | 11% Energy consumption

Janssen Large Molecule Cork

With a fast-changing and increasing demand for biological products, Janssen has digitally connected R&D, their internal manufacturing and their external manufacturing, and deployed advanced process control solutions to drive near real-time visibility of supply chain status, improve reliability by 50%, and accelerate technology transfers while reducing costs by 20%.

Site | Change story | Top 5 use cases | Impact
--- | --- | --- | ---
Janssen Large Molecule Cork | With a fast-changing and increasing demand for biological products, Janssen has digitally connected R&D, their internal manufacturing and their external manufacturing, and deployed advanced process control solutions to drive near real-time visibility of supply chain status, improve reliability by 50%, and accelerate technology transfers while reducing costs by 20%. | End-to-end real-time supply chain visibility platform | $17MM Inventory
|  |  | Artificial intelligence-powered process control | 50% Speed of technology transfer from R&D
|  |  | Analytics platform for deviation root-cause identification | 80% Process failures
|  |  | Digital tools to enhance a connected workforce | 30% Design changes
|  |  | Sensor-based data collection for energy management | 22% CO2 emissions

Novo Nordisk

Facing volume growth and rising complexities, Novo Nordisk has invested in digitalization, automation and advanced analytics, building a robust Industrial Internet of Things operating system to be scaled across their manufacturing footprint, increasing equipment efficiency and productivity by 30%.

Site | Change story | Top 5 use cases | Impact
--- | --- | --- | ---
Novo Nordisk Device Manufacturing & Sourcing Hillerød | Facing volume growth and rising complexities, Novo Nordisk has invested in digitalization, automation and advanced analytics, building a robust Industrial Internet of Things operating system to be scaled across their manufacturing footprint, increasing equipment efficiency and productivity by 30%. | Production line optimization by advanced analytics | 70% Downtime by station
|  |  | Digital shopfloor applications | 10% Problem-solving speed
|  |  | Digital Scheduling | 3p.p. CEE
|  |  | Automated OEE data collection | 7% Productivity
|  |  | Digital performance management | 9% Productivity

Middle East

Saudi Aramco
Khurais

As part of Aramco dedication to increase the resiliency of their operations, the Khurais oil field was built as a fully connected and intelligent field, with over 40,000 sensors covering over 500 oil wells spread over 150 x 40 km. This enabled autonomous process control, remote operation, and monitoring of equipment and pipelines, resulting in maximizing the oil well production with at least 15% attributed to smart well completion technology alone.

Site | Change story | Top 5 use cases | Impact
--- | --- | --- | ---
Saudi Aramco Khurais | As part of Aramco dedication to increase the resiliency of their operations, the Khurais oil field was built as a fully connected and intelligent field, with over 40,000 sensors covering over 500 oil wells spread over 150 x 40 km. This enabled autonomous process control, remote operation, and monitoring of equipment and pipelines, resulting in maximizing the oil well production with at least 15% attributed to smart well completion technology alone. | Advanced IIoT applied to process optimization | 15% Oil production
|  |  | Autonomous control via advanced process control | 15% Power consumption
|  |  | Cost optimization of heavy operations through sensor analysis | 50% Workforce productivity
|  |  | Energy optimization by predictive analytics | 8% CO2 emissions volume
|  |  | Digitally-enabled pipeline leak prevention and detection | 80% Safety

North America

DCP Midstream
Denver

Driven by the need to combat market volatility with operational transformation and innovative efficiencies, DCP Midstream leveraged internally developed digital solutions and tech-venture partnerships to integrate the remote control of operations with their planning, logistics and commercial systems, allowing real-time optimization of margins and creating over $50 million in value.

Site | Change story | Top 5 use cases | Impact
--- | --- | --- | ---
DCP Midstream Denver | Driven by the need to combat market volatility with operational transformation and innovative efficiencies, DCP Midstream leveraged internally developed digital solutions and tech-venture partnerships to integrate the remote control of operations with their planning, logistics and commercial systems, allowing real-time optimization of margins and creating over $50 million in value. | Analytics platform for remote production optimization | 4% Commitment accuracy
|  |  | Artificial intelligence-powered contract review for decision making | 67% Contract team size
|  |  | Connected field worker using smart glasses | 83% Mean time to repair
|  |  | Digitally-enabled pipeline leak prevention and detection | 70k or Green house gas (GHG)
|  |  | Real-time equipment issue identification through sensor analysis | 99% Time to identify equipment issues

Schneider Electric
Lexington

To maintain a business and technological edge, Schneider Electric’s more than 60-year-old facility has implemented Fourth Industrial Revolution technologies to achieve a complete end-to-end transformation of its operations from supplier to customer, which have improved customer satisfaction by 20%, demand forecast accuracy by 20% and reduced energy costs by 26%.

Site | Change story | Top 5 use cases | Impact
--- | --- | --- | ---
Schneider Electric Lexington | To maintain a business and technological edge, Schneider Electric’s more than 60-year-old facility has implemented Fourth Industrial Revolution technologies to achieve a complete end-to-end transformation of its operations from supplier to customer, which have improved customer satisfaction by 20%, demand forecast accuracy by 20% and reduced energy costs by 26%. | Predictive demand forecasting | 20% Demand forecast accuracy
|  |  | Supplier data digital integration and exchange | 20% Procurement efficiency
|  |  | Descriptive analytics enabled by IoT to enhance a connected workforce | 5% CEE
|  |  | Digital energy management | 78% CO2 emissions
|  |  | Mobile application collecting real-time customer feedback fed to orders | 20% Customer satisfaction
Regardless of industry, common elements distinguish lighthouse organizations, and by harnessing these intelligent approaches to their business operations, they show what is possible with true Fourth Industrial Revolution innovation. They engage value drivers including big data decision-making, democratized technology on the shop floor, an agile working mode and new business models. Furthermore, they succeed by incorporating scale-up enablers across people systems, business processes and management systems, empowered by advanced Industrial Internet of Things (IIoT) data systems.

As a result, lighthouses showcase notable, measurable improvements across several key performance indicators (KPIs), including productivity, sustainability and eco-efficiency, agility, speed-to-market and customization. Productivity improvements include increases of factory outputs and overall equipment effectiveness (OEE), along with reduction in product cost, operating cost and quality cost. Sustainability gains mean waste is reduced along with water consumption while energy efficiency rises. More agility makes for inventory reduction, lead-time reduction and change-over shortening. Speed-to-market reduction reflects shorter design iteration time, and customization yields lot size reduction and improved configuration accuracy.

The sheer range of use cases across such a diverse collection of manufacturers makes clear just how much is possible for organizations willing to invest in transforming their operations. By recognizing these key areas required for success, forward-thinking companies can prioritize their resources, systems and people to realize this potential and succeed in the changing industrial landscape.

End-to-end (E2E) lighthouses are able to leverage digital technology to generate impact beyond productivity to build a more agile and customer-focused organization.

<table>
<thead>
<tr>
<th>KPIs improvements</th>
<th>Impact range observed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Productivity</strong></td>
<td></td>
</tr>
<tr>
<td>Factory output increase</td>
<td>4-200%</td>
</tr>
<tr>
<td>Productivity increase</td>
<td>5-160%</td>
</tr>
<tr>
<td>OEE increase</td>
<td>3-90%</td>
</tr>
<tr>
<td>Product cost reduction</td>
<td>5-40%</td>
</tr>
<tr>
<td>Operating cost reduction</td>
<td>2-45%</td>
</tr>
<tr>
<td>Quality cost reduction</td>
<td>5-90%</td>
</tr>
<tr>
<td><strong>Sustainability</strong></td>
<td></td>
</tr>
<tr>
<td>Waste reduction</td>
<td>2-90%</td>
</tr>
<tr>
<td>Water consumption reduction</td>
<td>10-30%</td>
</tr>
<tr>
<td>Energy efficiency</td>
<td>1-50%</td>
</tr>
<tr>
<td><strong>Agility</strong></td>
<td></td>
</tr>
<tr>
<td>Inventory reduction</td>
<td>10-90%</td>
</tr>
<tr>
<td>Lead time reduction</td>
<td>7-90%</td>
</tr>
<tr>
<td>Changeover shortening</td>
<td>30-70%</td>
</tr>
<tr>
<td><strong>Speed to market</strong></td>
<td></td>
</tr>
<tr>
<td>Speed-to-market reduction</td>
<td>30-90%</td>
</tr>
<tr>
<td>Design iteration time reduction</td>
<td>15-66%</td>
</tr>
<tr>
<td><strong>Customization</strong></td>
<td></td>
</tr>
<tr>
<td>Configuration accuracy increase</td>
<td>15-20%</td>
</tr>
<tr>
<td>Lot size reduction</td>
<td>55-98%</td>
</tr>
</tbody>
</table>
Fourth Industrial Revolution transformation does not occur in a vacuum. The myriad recent challenges affecting the entire global economy are proof. These include everything from demand uncertainty and supply chain disruptions caused by the pandemic, to economic recession, forced distancing, remote management, national security interests, trade barriers and logistics disruptions as displacement affects large parts of the workforce. And, of course, all of these exist against the ongoing challenge of climate change and the call for good environmental stewardship.

This new normal mandates a “Great Reset”, which, like any major shift on a global scale, implies significant challenge and opportunity in equal measure. Across sectors, the Great Reset calls for a taking measures that create a more resilient, more inclusive and more sustainable world. The alternatives – either giving in to negative impulses and tendencies or assuming things will go back to how they were – do not present a feasible path forward. This Great Reset will rely on companies prioritizing the needs of a broader set of stakeholders, beyond their shareholders. In so doing, they can create value for society at large as well as contributing to ecological sustainability through environmental stewardship. This next normal will require companies and governments to achieve a balance, wherein the creative and competitive spirits of entrepreneurship drive a thriving economy, but one in which accountability to this broader set of stakeholders guides decisions for the greater good.

Observation of these recent challenges discern notable shifts occurring in manufacturing and supply chain. While there are countless individual adjustments taking place across the global economy, four shifts have emerged as particularly notable, precisely because they are proving increasingly relevant in light of unprecedented challenges. These four durable shifts include agility and customer centricity, supply chain resilience, speed and productivity across the workforce, and eco-efficiency.

The four shifts are key to organizations’ sustainability in the face of disruption. Because lighthouses have acted successfully and have taken actions in keeping with these durable shifts, they are showing how organizations can remain sustainable and thrive, even amidst serious adversity.

### FIGURE 2

Many recent challenges in the global economy have created a need for a ‘Great Reset’ among many industrials

<table>
<thead>
<tr>
<th>What has changed in the world?</th>
<th>What are the shifts stemming from these challenges?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand uncertainty and disruptions are challenging planning systems</td>
<td>Agility and customer centricity</td>
</tr>
<tr>
<td>National security interests, trade barriers and logistics disruption will demand alternatives to globalized supply chains</td>
<td>Supply chain resilience</td>
</tr>
<tr>
<td>Disruption of global manufacturing and supply chains are challenging manufacturers</td>
<td></td>
</tr>
<tr>
<td>Forced transition to remote management and digital collaboration</td>
<td>Speed and productivity</td>
</tr>
<tr>
<td>Physical distancing regulations for safe return to work are forcing manufactures to reconfigure their manufacturing flows</td>
<td></td>
</tr>
<tr>
<td>Displacement of large parts of the workforce, unbalanced decline and growth between sectors</td>
<td></td>
</tr>
<tr>
<td>Economic recession necessitates rapid operational and capital cost reduction</td>
<td>Eco-efficiency</td>
</tr>
<tr>
<td>Increased global concern for environmental impact of human activities</td>
<td></td>
</tr>
</tbody>
</table>
Forefront Industrials Are Leading the Great Reset
2.1 Modelling the four durable shifts in manufacturing and supply chain

The four durable shifts did not appear suddenly in 2020. Rather, they embody the kinds of changes, adaptations and evolutions leading organizations were undertaking prior to the pandemic. Thus, it is unsurprising that lighthouses’ ability to engage the four durable shifts derives from the very qualities that differentiated these organizations from the majority before the pandemic.

A World Economic Forum Global Lighthouse Network white paper noted six scale-up enablers essential to scaling advanced manufacturing use cases: agile approaches, agile digital studios, IIoT stacks, tech ecosystems, IIoT academies and transformation offices. Lighthouses utilize powerful IIoT data systems to support people systems, business processes and management systems to drive new levels of performance. These scale-up enablers facilitate the four durable shifts, each of which is detailed below through a series of use cases illustrating how lighthouses have optimized Fourth Industrial Revolution technology in the next normal.

### Durable shifts

- **Agility and customer centricity**: Put at the centre of operations leading to faster recognition of customer preferences and corresponding adjustments of manufacturing flows at next-generation, small-scale modular plants.

- **Supply chain resilience**: As a competitive advantage requiring connected, reconfigurable n-tier supply ecosystems, regionalization and overall higher level of customization.

- **Speed and productivity**: Attained through increased levels of automation and workforce augmentation, increasing safety and competitiveness in a society where continuous reskilling and mobility are becoming the norm.

- **Eco-efficiency**: As a must-have to stay in business and ensure compliance with an increasingly complex regulatory landscape.
Alibaba, the world’s largest retail commerce company, has used an apparel Customization to Manufacturing (C2M) business model for small- and medium-sized enterprises (SMEs) to gain real-time understanding of consumer preferences and market trends. Alibaba’s pilot Xunxi factory addresses varied issues such as high trial-and-error costs, under- or overstock situations, and long reaction times using three stages: consumer intelligence, product development, and production.

**Consumer intelligence** leveraging Alibaba’s advanced digital technologies as well as consumer insights from various platforms across the Alibaba ecosystem, Xunxi provides small businesses with a better understanding of customer preferences around fashion trends to help them stay competitive in the fast-paced fashion and apparel market.

**Product development** is informed by development needs, supply chain status, and manufacturing scheduling. Optimized design utilizes an extensive library of patterns, while artificial intelligence (AI) maximizes durability. Products are matched to optimal manufacturing resources, both in terms of workforce capacity and machine availability.

The **production** stage enables small batch manufacturing — meaning only what is predicted to be needed, when, and in what quantity is produced. Automated configuration makes strategic use of operators and resources and utilizes digital simulations for risk evaluation. Real-time workstation load balancing is based on production data, and online quality checks enable instant issue detection.

The platform has powered a 70% reduction in product development lead time, a 67% reduction in equipment changeover time, manufacturing lead time cut by half, a near-100% reduction in mean order quantity, and a 40% increase in sell-through rate. Alibaba has demonstrated how a large company can achieve customer centricity at scale with real-time data analysis powered by digital technology. By knowing specifically what customers want in real-time, companies gain the agility to focus efficient production efforts to manufacture what is needed, when it is needed, and where it is needed.
The full potential of a consumer-to-manufacturer platform is shown by the solutions implemented at one of Alibaba’s plants.

Waste in China’s apparel industry caused by inventory problems are estimated to be higher than 30%. A move from a make-to-stock to make-to-buy operating model to solve this problem based on a customer-centric approach was implemented at one of Alibaba's pilot plants in Xunxi, illustrating the potential of consumer-to-manufacturer as a business model. A subsequent quick and large-scale expansion is planned.

### Key facts

- **−70%**
  Reduction in product development lead time

- **−67%**
  Reduction in equipment changeover time

- **−50%**
  Reduction in manufacturing lead time

- **−98%**
  Reduction in mean order quantity

- **+40%**
  Increased sell-through rate

### Consumer intelligence

Preferences expressed by consumers on social media processed by advanced analytics algorithms, providing inputs to product development and manufacturing processes.

### Product development

Tailored development of products effectively matching customer preferences.

### Automated development platform

Development needs driven by customer demand, supply chain purchase status and manufacturing scheduling.

### Optimized product design

Relevant patterns directly recommended based on extensive library; durability of final design ensured by computer vision AI.

### Tailored product requirements

Product requirements matched to workforce skill level, machine availability and craftsmanship requirements.

### Production

Immediate and small-batch production at manufacturers with rapid and flexible response capabilities.

### Automated production configuration

Operation strategy based on operator skill matrix, resource availability, digital production simulation and evaluation of potential risks.

### Dynamic line balancing

Real-time workstation load balancing, based on production data and simulation.

### Online quality inspection

Online quality inspection system to instantaneously detect and manage quality issues.
DCP Midstream, a Fortune 500 midstream energy company headquartered in Denver, Colorado, USA, has developed an Integrated Collaboration Center (ICC) and Decision Support System (DSS) that leverages internally developed digital solutions and open innovation venture partnerships. The ability to operate plants remotely affords major gains in resiliency. These developments have increased value chain productivity while enabling optimization of product margins in real time.

Cloud-based integrated data is gathered in real time from multiple sources, including IIoT sensors, commercial contracts, market prices and KPIs to comprise a single source of truth. Real-time value chain optimization uses live process simulations to maximize productivity. The DSS provides an analytics and visualization platform available on all devices across the company to all employees all the time. The ICC provides a hub wherein operators, engineers and business analysts can coordinate decisions, operate plants remotely and receive performance alerts.

A collaborative environment promotes teamwork and diversity of ideas. The DSS, which follows agile software development in partnership with the ICC, allows flexibility to build custom analysis of platform data on the fly. Because the web-based platform is cloud-enabled, the remote desktop platform allows employees to operate gas plants from the ICC or anywhere, as needed.

The impact of DCP’s effort has been substantial, including a +$50 million net income. The financial optimization of gas plants yielded a $13 million total incremental margin improvement realized in 2019 alone; 20 facilities are operated remotely from the ICC and home environment, and the company has seen a 4% increase in commitment accuracy. DCP shows how collaborative decision-making, informed by an optimized data platform and advanced analytics providing a single source of truth across the organization, can match production to demand in real time, thus bolstering supply chain resiliency.
Integrated Collaboration Center and Decision Support System allowing to operate plants remotely

DCP Midstream has implemented an Integrated Collaboration Center (ICC) leveraging internally developed digital solutions and open innovation venture partnerships. This has allowed to increase the value chain productivity and fully operate plants remotely integrating remote control of field operations with their planning, logistics and commercial systems to optimize in real time product margins.

Key facts

+$50m  
Net income

+$13m  
Total incremental margin improvement realized in 2019 alone

20  
Facilities operated remotely from the ICC and home environment

+4%  
Increase in commitment accuracy

Cloud-based integrated data

Integrated real-time data from multiple sources: operational (IoT sensor data), commercial contracts, financial (market prices), KPIs, becoming the single source of truth of data across the company

Value chain optimization

Real-time optimization of the full Value Chain using live process simulations of each plant to maximize productivity

Integrated Collaboration Center

Operators, engineers, business analysts can make coordinated decisions, operate the plant remotely and receive alerts about performance or issues across assets

Decision Support System

Analytics and visualization platform available on all devices across the DCP footprint

Global Lighthouse Network: Four Durable Shifts for a Great Reset in Manufacturing 17
Janssen, the pharmaceutical companies of Johnson & Johnson, employ more than 40,000 employees. By using advanced process control (APC) and multivariant analysis, Janssen has supported its efforts to move to a fully integrated, digitally connected, agile supply chain supporting dynamic customer needs. The system links R&D, internal and external manufacturing to accelerate new product development. Before implementation of APC, efforts to reduce variability and optimize performance had yielded little progress due to the inability to use all the data available, in real time, to correct process conditions. Janssen needed machine learning and multivariant methods to harness the full power of available data in real time.

A cloud-based data structure consolidates real-time manufacturing data from process equipment, ERP- and manufacturing execution systems on a large scale. Likewise, multivariant analysis enables the prediction of future and final batch outcome feed as parameters of the optimization model. This data structure combined with robust predictive modelling facilitates both internal and external laboratory product development. Prototype-level production of new product lines, along with testing and registration, is informed by the cloud-based data and modelling systems.

Therefore, when it comes to factories – both internal and external – the data structure and predictive modelling facilitates commercial production, enabling re-characterization of production process for large-scale manufacturing. The system provides extensive monitoring in the control room and on the shop floor, including model outputs and the full plant context viewable through green/yellow/red alerts for process status versus best case scenarios. Operators themselves drive the APC system, enabling higher yields, longer run times, better recovery, fewer process disturbances and the early termination of critical failures.

In small pilots, developers can adjust parameters, creating models that can be uploaded to the cloud and delivered directly to the production stage, available for manufacturing. By sharing information at the R&D and manufacturing stages within Janssen and with other companies, these speed and productivity gains are optimized at scale. The impacts Janssen has achieved with 20 models deployed, representing $16 billion in yearly sales, include reduced costs by 20% and a 50% increase in reliability.
Advanced process control system accelerates new product introduction and provides real-time insights to operators to improve reliability and reduce costs

An integrated advanced process control (APC) system linking R&D and internal and external manufacturing, using multivariant analytics in order to accelerate new product development and technology transfer and provide operators real-time insights, ultimately driving improved reliability and overall product costs. The applications are transforming Janssen’s operations towards being a smarter, more informed and self-learning organization with lower cost and enhanced robustness of its operations.

Key facts

- 20% Cost reduction
- 50% Increased reliability
- +20 models deployed impacting key brands
- $16 billion in annual sales

Extensive monitoring in control room and shop floor

- Models outputs and full plant context provided in the form of green/yellow/red alert for process status vs best case scenario

Operators drive APC system

- Operators are able to drive the processes towards higher yields, longer run times, better recovery, less process disturbances

Product development

In the laboratory. Prototype-level production of new product lines. Product testing and registration.

Manufacturing

In the factory. Start of commercial production. Re-characterization of production process for large-scale manufacturing.

Cloud-based data structure

Consolidation of large-scale, real-time manufacturing data from process equipment, ERP- and manufacturing execution systems

Robust predictive models

Multivariant analysis predicts future and final batch outcome fed as parameters of optimization model.
Eco-efficiency case study: Schneider Electric

Schneider Electric, a European multinational company headquartered in France, provides energy and automation digital solutions aimed at efficiency and sustainability. With operations in over 100 countries, Schneider Electric employs over 135,000 workers.

The company has made use of Fourth Industrial Revolution technologies over the past decade to connect end-to-end assets, divisions and customers, which has yielded efficiency gains, growth and improved sustainability. Facing several challenges, including a lack of summarized, measurable data, the inability to view capacity risks, the lack of a collaborative sales forecast, and generally scattered collaboration, Schneider Electric developed an end-to-end plan.

The plan implements end-to-end Internet of Things and predictive analytics solutions across several manufacturing sites, allowing optimized energy management at the plant level, thereby achieving energy and cost savings. The digital energy management strategy deploys internet-of-things connectivity, edge-based descriptive analytics, and cloud-based predictive analytics. Residing at the edge, the Power Monitoring Expert utilizes connected meters and sensors to create powerful visualizations and descriptive analytics of granular energy consumption by machines and processes. A cloud-based Resource Advisor pulls granular plant data and provides a data platform for energy management at a global level. The Resource Advisor solution provides predictive insights to energy costing trends and spend patterns that allow users to optimize their energy costs.

This digital energy management strategy has been utilized to reduce plant energy costs by 26%. Additionally, the facility has seen a 78% CO₂ reduction as well as a 20% water use reduction. The power of data sharing and analytics at a regional level have driven $6 billion in energy savings for North America. Schneider Electric has shown how end-to-end analytics, combined with a commitment to transparency around energy usage, has enabled better decisions for energy procurement, leading to eco-efficiency gains.

The facility has seen a 78% reduction in CO₂
Schneider implemented an End-to-end IoT and analytics predictive solutions across several manufacturing sites allowing to optimize the energy management at a plant level and achieving energy and costs savings.

**Key facts**

- **+26%** Energy Cost Reduction
- **+78%** CO₂ Reduction
- **+20%** Water Use Reduction
- **+20%** Energy demand forecast accuracy

**Cloud-based IoT connectivity**

IoT connectivity utilizing connected meters and Power Monitoring Expert designed to help maximize uptime and operational efficiency.

**Predictive analytics advisor**

Analytics models predicting energy pricing leading to optimized energy procurement management.

**Energy consumption descriptive analytics**

Cloud app analytics layer monitoring, reporting and analyse energy consumption with high granularity (time and per plant)

Resource Advisor Performance Analytics Module

*Global Lighthouse Network: Four Durable Shifts for a Great Reset in Manufacturing*
Conclusions and Outlook

Global Lighthouse Network organizations have surpassed benchmarks, redefined new, safer, better ways of working and achieved new levels of technology adoption at scale. These frontrunner companies were already demonstrating the great potential for transformation that could be realized by acting on a bold vision and investing courageously in people and technology – both within the four walls of individual factories and end-to-end, across the value chain. Then, with the onset of the global pandemic, the world suddenly faced adversity on levels unprecedented in recent memory. Obstacles quickly emerged that posed unfamiliar challenges at scale, across all sectors of the world economy. Qualities that have characterized frontrunner Global Lighthouse Network organizations are essential to maintaining viability in the wake of tremendous global disruption. Just as these organizations have developed the agility and collaborative working modes to drive business success, they have been able to engage these same qualities of excellence to withstand new pressures. Moreover, lighthouses are showing how to take operations to the next level in the face of immense adversity. We can look to lighthouses to see how industrial companies can affect a Great Reset by engaging the most consequential durable shifts that will enable sustainability through difficult times. But it is not just about enduring challenge – the Great Reset is a call to transformative action that delivers value to a broader set of stakeholders, including workers, consumers and the natural environment.

Four durable shifts – agility and customer centricity, supply chain resilience, speed and productivity, and eco-efficiency – have emerged as key requirements for industrials in manufacturing and supply chain to be ready to undergo the Great Reset. The use cases detailed in this paper offer illustrations of key lessons crucial for moving an organization in the direction of the four durable shifts. It is worth noting that, unsurprisingly, each of these use cases involves a combination of advanced digital technology and well-led, properly skilled human workers. This combination is essential in every case – neither can alone achieve the type of transformations characteristic of the 4 durable shifts without the other. This reinforces past findings that suggest frontrunner organizations keep people at the centre, even as they invest courageously in leading-edge technology.

Lighthouses are not at the end of the development pathway. Despite the impressive benchmarks and improvements these remarkable companies have achieved, the sheer number and diversity of use cases playing out at sites all over the globe suggest that plenty of further innovation and evolution lies head. For every metric of improvement, there are other related opportunities for enhancement to operations, practices and methodologies. Moreover, as the power and scope of digital technology continues to grow at exponential rates – even as cost reduction continues to democratize access to it – it will bring within reach new levels of productivity, efficiency and sustainability.

As Global Lighthouse Network sites continue to innovate, adapt and evolve, they shine even more brightly, illuminating the way for others to emerge. Individual Global Lighthouse Network members have themselves realized significant benefits in return for their investment and effort. But the shared benefit of their experience, and what it can teach other companies, extends across the world in various sectors of industry. As additional organizations join this group of exceptional frontrunners, the network only grows, casting more light across the industrial and economic landscape. This expanding network of guiding lights can illuminate the world in troubled times, making clear that human ingenuity and resilience, coupled with willpower and a belief in the future, can endure great adversity. Yet, lighthouse organizations make clear that they can do even more than endure these challenges – they can emerge ever stronger once the COVID storm has passed, so as to be better equipped to confront inevitable future challenges.

A call for applications. The Global Lighthouse Network continues to grow and encourages leading organizations to consider applying to join. Forward-thinking companies excited about contributing to the Great Reset as members of the network are invited to learn more by emailing LighthouseNetwork@weforum.org.
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