

The Work Ahead in Manufacturing: Fulfilling the Agility Mandate

According to our research, manufacturers are well ahead of other industries in their IoT deployments and fully aware of the power of applying AI, analytics and automation to their processes and operations. However, they need to marshal the level of investment required to meet today's intensified demands for business resilience.

Executive Summary

The pandemic opened manufacturers' eyes to how advanced technology, digitized processes and real-time intelligence could protect operations in a world full of risk, uncertainty and emerging regulatory burdens.



When the pandemic hit, the manufacturers that executed quick business pivots drew headlines. There were the sportswear manufacturers that produced personal protection equipment for healthcare workers with the help of 3-D printers, and the electronics companies that rapidly repurposed their supply chains to make ventilators, using technical designs co-shared across disparate value chains.^{1,2} Advanced technologies and new ways of working were essential when the world went dark.

For others, however, it was a different story: mandatory closures of factories that required on-site staff to run them; disruption of global trade routes impacting product supply; scarcity of key materials, like the semiconductors needed in the manufacture of everything smart, from cars to phones. The pandemic opened manufacturers' eyes to how advanced technology, digitized processes and real-time intelligence could protect operations in a world full of risk, uncertainty and emerging regulatory burdens.

It also laid bare the gap between technology laggards and more advanced companies that were already moving toward the vision of the Fourth Industrial Revolution, with intelligently networked and fully

integrated production environments, and real-time data analytics optimizing manufacturing processes end-to-end.

To understand the changing nature of work for manufacturers in a world dominated by digital and disrupted by COVID-19, we surveyed 4,000 global executives globally, of which 285 were from the manufacturing industry. We found an executive class fully aware of the power of digitizing manufacturing processes but perhaps reluctant to marshal the level of investment required by the Fourth Industrial Revolution, not to mention the climate crisis and related legislation.



Five key themes emerged from our research and analysis:

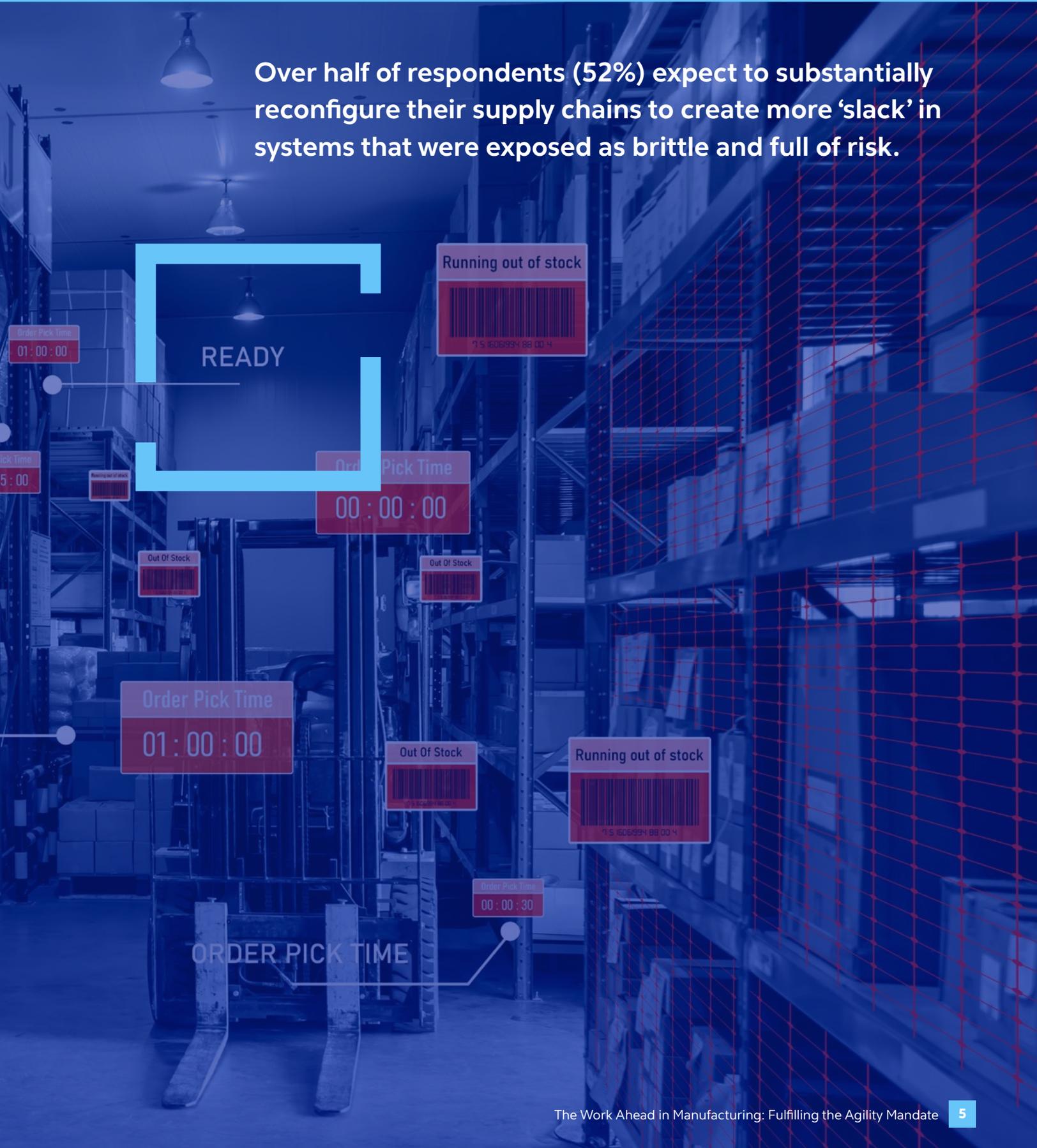
- 1 **Manufacturers are lagging other industries in tech investment.** The pandemic demonstrated why digitizing manufacturing processes matters. However, tech investment (as a percentage of revenue) among manufacturers is relatively low, especially outside of R&D, although European respondents are predicted to outspend their U.S. and Asian counterparts between now and 2023.
- 2 **Scaled IoT deployments underpin the shift to digitized manufacturing.** While manufacturers have been ahead of other industries when it comes to IoT deployment, the challenge lies in scaling these implementations. The explosion of data now surrounding processes and products offers the tantalizing prospect of instrumenting value chains and process flows end-to-end. However, realizing the full value of IoT investments requires automation tools to sift and sort through the vast quantities of data from business and engineering systems and converting the information into dashboards and tools that the workforce can utilize.
- 3 **Data mastery will require greater uptake of analytics and AI.** To maximize the impact of IoT, manufacturers will need to combine these implementations with other advanced technologies. Unfortunately, only 6% of respondents have implemented machine-learning technologies at any significant scale, which is misaligned with the volume of sensor data yielded by IoT. Applying technologies such as machine learning, augmented reality and even speech recognition can fuel a step-change in how people and machines work together post-pandemic.

- 4 **Employee jobs are changing as production tasks digitize.** A subset of manufacturing respondents who are involved with innovation, R&D and product development functions are in nearly universal agreement that work tasks will specialize, process flows will accelerate, and collaboration between teams will rise as manufacturing work digitizes and changes. The workforce of the future will need to raise its digital quotient, with workers on the factory or plant floor increasingly tasked with troubleshooting production lines, handling errors and providing flexibility when needed. Knowledge networks will harness the best workers to drive innovation into operational work.
- 5 **New worker competencies are needed.** Expect to see new interplays between people and machines, with the ability to exploit data, analytics and machine learning as critical competencies for the future workforce. Requirements for analytics and decision-making skills are front and center, according to respondents, as leaders look to transform their best workers into value generators who augment technical process work and spread knowledge throughout the organization.

Requirements for analytics and decision-making skills are front and center as leaders look to transform their best workers into value generators who augment technical process work and spread knowledge throughout the organization.

Shaping manufacturing in a post-COVID world

Over half of respondents (52%) expect to substantially reconfigure their supply chains to create more 'slack' in systems that were exposed as brittle and full of risk.



For manufacturers, the pandemic imposed a premium on the ability to seamlessly pivot, both to avoid shortages of essential supplies and to ensure the health and safety conditions of the workplace (see Figure 1). New approaches to supply chain resilience and the adoption of digital working practices are also predicted to accelerate.

Remote working infrastructure will likely prove essential as manufacturing employees return to work, enabled by the convergence of emerging technologies like augmented reality (AR), artificial intelligence (AI) and video collaboration tools. Such interfaces are critical for safety in manufacturing operations when applied to functions such as equipment maintenance and packaging operations, with AR enabling hands-off remote assistance, connecting those workers who were unable to travel to factories during the pandemic with skeleton crews that were.

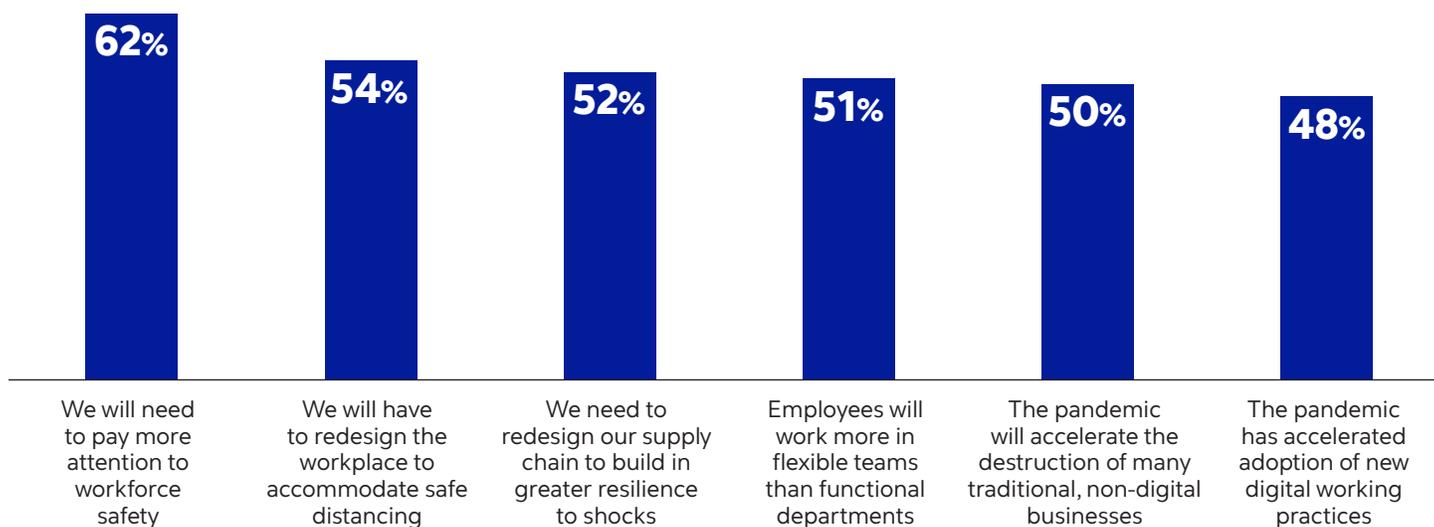
For example, a German manufacturer in our study enabled remote connectivity through a virtual automation commissioning service. “Even during this crisis, we reduced engineering time,

and we’re offering services such as remote connectivity for process industries,” the respondent told us. “We’ve started online training to make the best use of the downtime and production halts, and we’re working to optimize production operations and synchronizing it as per demand levels.”

Over half of respondents (52%) expect to substantially reconfigure their supply chains to create more “slack” in systems that were exposed as brittle and full of risk. Executives, it seems, plan on more stockpiling, excess capacity and duplicated systems, and are willing to tolerate greater levels of inefficiency to this end. “Just-in-time” models of manufacturing and distribution — prominent for the last few decades — will be superseded by a new focus on “just-in-case” approaches.

Post-pandemic dynamics underscore the change in work

Respondents were asked to rate their agreement with the following statements about the likely impact of the pandemic on their workforce. (Percent of respondents who agree or strongly agree)



Response base: 285 senior-level manufacturing executives
 Source: Cognizant Center for the Future of Work
 Figure 1

More tech investment needed

Spending on technology among manufacturing respondents will rise from 5.5% of revenue currently, to a predicted 8.5% of revenue by 2023, which is below the cross-industry average.



Clearly, tech investment is critical to rebuilding systems and processes for the work ahead. However, spending on technology among manufacturing respondents will rise from 5.5% of revenue currently, to a predicted 8.5% of revenue by 2023, which is below the cross-industry average of 7.8% and 11.7%, respectively (see Figure 2).

A closer look reveals stark regional differences. European manufacturers lead the U.S. and APAC in terms of tech investment, with spending levels closer to the average (7.3% of revenue today and 11% by 2023). This compares with just 8% for APAC manufacturers by 2023 and 6.5% in the U.S. in that timeframe.

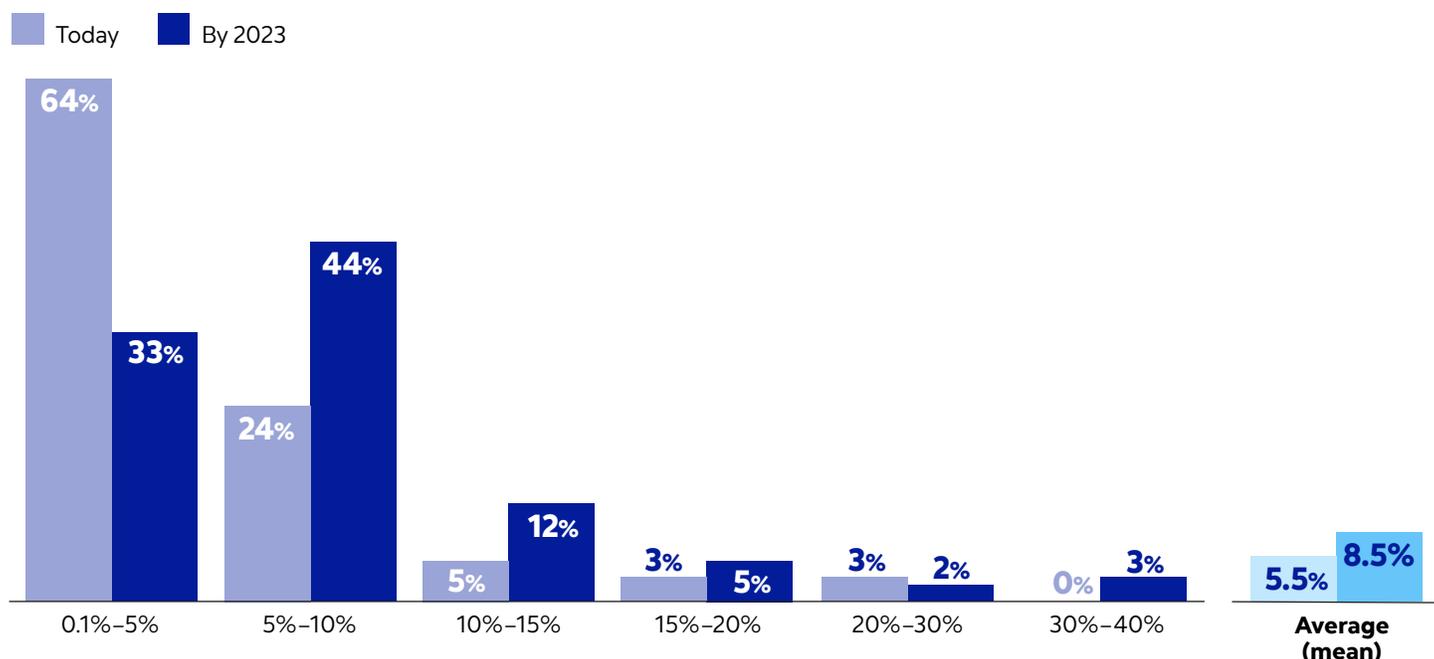
This spending gap isn't surprising. Given the structure of the European economy and its reliance on manufacturing (particularly in Germany and Eastern Europe), these manufacturers are attempting to enhance an expensive, highly skilled technical workforce with automation. The latest manufacturing plants in Europe are technologically sophisticated and highly automated, leveraging 5G, AI, augmented reality, IoT and robotics to enable rapid development of high value-added activities.

For example, Procter and Gamble's plant in the Czech Republic now enables new levels of agility, where a quick swipe on a production dashboard instantly changes the product being manufactured, reducing costs by 20% and increasing output by 160%.³

The dynamics surrounding tech investment at U.S. manufacturers, however, are a little more complex. When we asked respondents to predict how they would compare with their competitors by 2023, over one-third of U.S. executives (35%) said their technology investments would transform business models, make production processes more efficient, and put them ahead of their peers in that timeframe. Achieving these goals will require a leap in technology investment beyond current and predicted levels, in not only R&D but also supply and distribution functions. The rhetoric fails to match the reality, and there is a danger that U.S. manufacturers could fall behind the rest of the world, for good (see Quick Take, next page).

Technology investment lags

Respondents were asked how much they plan to spend on technology, now and in 2023. (Percent of revenues spent on technology)



Response base: 285 senior-level manufacturing executives

Source: Cognizant Center for the Future of Work

Figure 2


Quick Take

Policy makers strive to master global manufacturing

Even before the virus, the subtext of ongoing U.S./China trade discussions put political pressure on Western companies (and policy makers) to re-examine the structure of supply and production networks. And at the intersection of the emergence of new technologies and international competition lies a desperate need for more active industrial policy.

Several signs point to Western manufacturers beginning to adjust to a new reality, predicated on technology mastery and a return to onshore investments. Intel recently committed to building two new semiconductor factories in the U.S. (Arizona), with a price tag of \$20 billion, citing fierce competition from Asian manufacturers.⁴ What was once a battle to strip out costs by outsourcing in the East is now turning into a battle for technology superiority as onshoring strategies proliferate.

The European Commission recently published a vision for Industry 5.0 (going beyond 4.0), with sustainability and circularity concepts now part of the new mix.⁵ The burden of sustainability could create a trillion-dollar market as manufacturers drastically redesign product development and sourcing and distribution models. Policymakers have launched strategies for human centricity and the importance of highly skilled roles to ensure the development of people and technology in tandem.

The U.S. government published its industrial policy three years ago, and while the framework examined AI and IoT, it lacked a strategy for the dichotomy between human and machine work.⁶ Meanwhile, China will invest an eye-popping \$1.4 trillion in digital infrastructure over the coming years through its “Made in China 2025” program.⁷ Battlelines are being drawn, geopolitical competition is heating up, and global manufacturing is the hinge.

Manufacturers have another reason to boost their technology investments. The industry has long been urged to better integrate its information technology (IT) and operational technology (OT). Now, however, the industry must also integrate product technology (PT) into the IT/OT mix to meet customer demand for personalization. Take Tesla: The carmaker’s software-defined features, such as battery life enhancement (via an over-the-air update), are an example of the convergence between IT, OT and PT. While not every company can be a Tesla, every manufacturer can prioritize data and then use the insight to drive intelligence across the value chain.

The factory of the future, with rapidly converging IT, OT and PT, needs an IT investment level north of at least 11% of revenue. Unlocking the transformative power of a digitized manufacturing process, or a product that yields insights to customers, will kickstart a revolution in how goods and services are created.

Going beyond IoT to reconfigure operations

Investments lag in implementing process automation tools and AI technologies to complement and extend IoT. These technologies are needed to do the heavy lifting on consuming and acting on the huge volumes of process data now flowing from production workflow environments, plant machinery and manufactured products themselves.

One area where manufacturers are currently outperforming other industries in terms of tech investment is IoT (see Figure 3). Nearly one-quarter of manufacturing respondents report widespread IoT implementation (well above the cross-industry average of 16%), and over half report being at some level of IoT implementation. Of course, the challenge lies in scaling these IoT deployments.

It's likely that respondents expect IoT to trigger more data-oriented technology investments in the future as these sensors generate ever growing amounts of information. Physical products can now be covered in sensors, feeding information on pressure, temperature and viscosity, while advanced analytics tools can analyze continuous process flows and complement process-control systems.

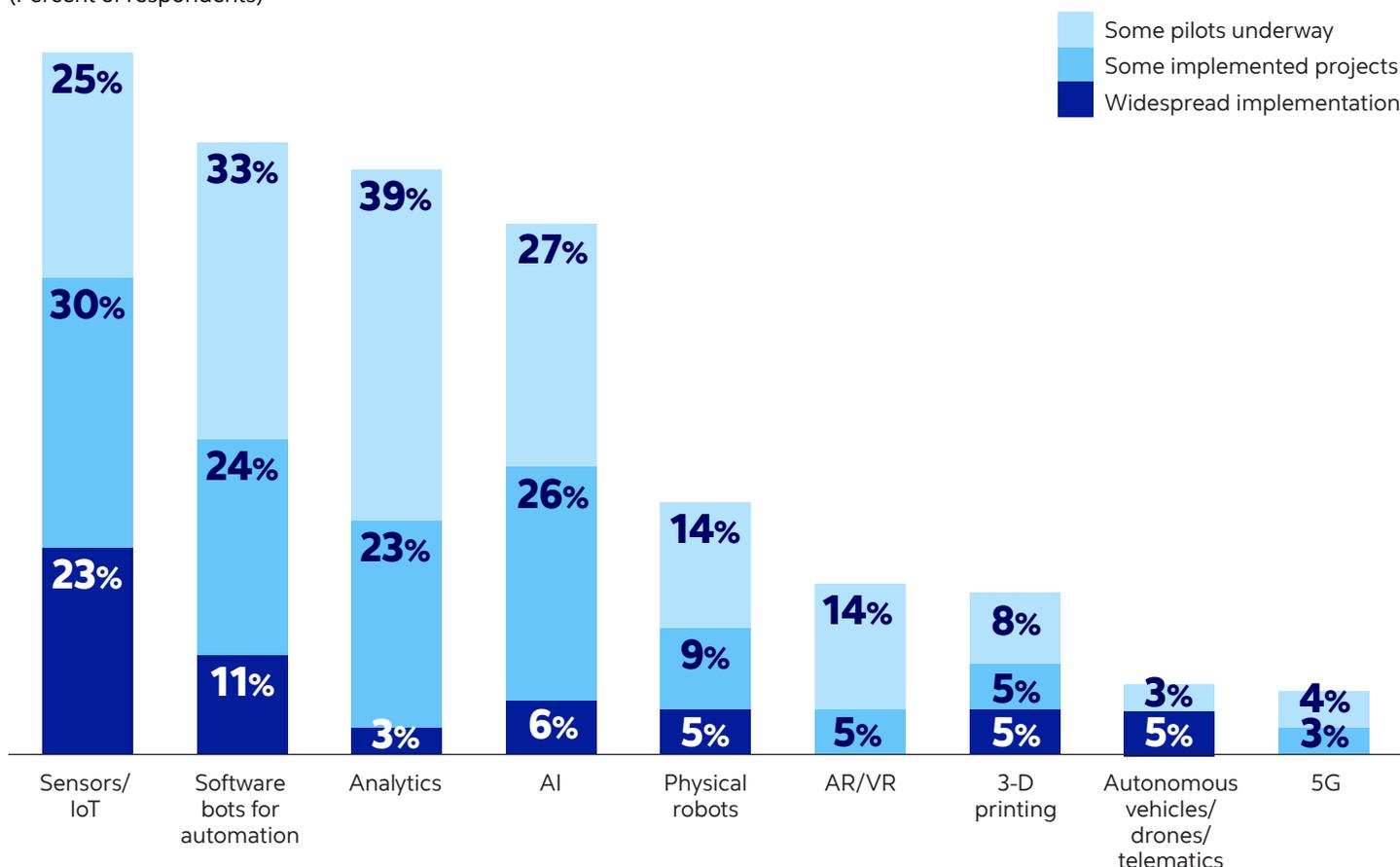
In fact, the data trails generated by advanced sensors and analyzed for meaning enable manufacturers to gauge operational performance with real-time precision. For example, Johnson & Johnson's orthopaedic manufacturing plant

established in Ireland over 20 years ago uses IoT to enable its legacy equipment to communicate with each other. J&J's new process-driven digital twins have resulted in a 10% reduction in operating costs and a 5% reduction in machine downtime.⁸

Investments lag, however, in implementing process automation tools and AI technologies like machine learning software to complement and extend IoT, according to our study. These technologies are needed to do the heavy lifting on consuming and acting on the huge volumes of process data now flowing from production workflow environments, plant machinery and manufactured products themselves.

IoT is the bedrock for modern manufacturing

Respondents were asked about the progress made in implementing the following technologies to augment processes. (Percent of respondents)



Response base: 285 senior-level manufacturing executives
 Source: Cognizant Center for the Future of Work
 Figure 3

The continuously growing deluge of operational and product data needs sifting, organizing and analysis to convey meaning. Machine learning, data analytics and process automation tools working in tandem with IoT would enable manufacturers to “see” process flows in new ways. In our study, a European manufacturing COO said his company expected to save up to 10,000 person hours per month using AI and machine learning tools to optimize core production processes.

Emerging manufacturing technologies

Our findings also point to technologies that are not, as yet, seeing high levels of implementation but are being widely explored. This next round of technology adoption will likely include augmented and virtual reality technologies (AR/VR), 5G and an expansion in 3-D printing. The technologies set to transform the next few years of manufacturing will focus on improving efficiencies for those on the factory floor, providing support for massive amounts of data and ensuring sustainability.

I AR/VR: With 19% of respondents either piloting or implementing AR/VR — and an additional 26% exploring or planning an investment — this technology is pegged to become an indispensable tool for manufacturers to see things differently. Many tasks in a live production environment require workers to continually refer to documentation to guide their work. To speed up work, some manufacturers are using AR devices to enable workers to keep their eyes on their work and the documentation at the same time, without needing to look away. Annotated guides and instructional videos can appear and hover exactly above where they’re needed and can be voice-controlled or dismissed with a swift motion or gesture.

Moreover, part-assembled products can have graphics overlaid on them as employees move between workstations, showing an operator exactly where to place bolts, route and solder a wire or connect a critical component. When AR is combined with IoT, real-time sensor data can be shown on machines, highlighting operational issues that occur outside normal servicing schedules. Because issues can be addressed before problems occur, this capability can improve efficiency, safety and worker effectiveness.

AR/VR and IoT can also be used to enhance the use of digital twins. By viewing these objects at full scale, either in the user’s physical space or within a digital representation of any conceivable environment, and feeding them data from their real-life counterparts via IoT sensors, manufacturers can enable workers to easily access a real-time dynamic blueprint of the factory as needed.

I 5G: Although it’s still at an early stage of adoption (only 7% of respondents have a 5G pilot or implementation underway), over time the “mesh of machines” created by IoT and 5G will serve as the foundation for new levels of functionality and possibility. For example, Worcester Bosch, a UK manufacturer of domestic boilers, has launched the UK’s first 5G factory with ultra-low latency that makes it easier to implement smarter manufacturing techniques on the fly. The company can deploy AI and machine learning techniques and insights quickly, without disrupting the production line or supply chain through complex infrastructure changes. The factory has already optimized machine performance and increased output by 2%.⁹

I 3-D printing: Our research also identified a growing interest in 3-D printing/additive manufacturing techniques, with 18% of respondents citing pilots or implementations, and an additional 32% exploring or planning investments. With 3-D printing, manufacturers can rapidly prototype products, as well as print replacement parts. For example, in medical manufacturing, 3-D printers routinely produce dental crowns and bridges, hearing aid shells, hip replacement joints, jawbones and prosthetics, all configured precisely to the patients’ requirements.

The long-term implications are profound because the ability to transport parts across the world digitally could radically transform entire value chains and reduce environmental impacts. Further, innovative technology partnerships reveal what could be around the corner: U.S. logistics heavyweight UPS and 3-D printing/data analytics startup Fast Radius jointly set up a facility in Chicago, designed to meet the growing demand for rapid customized product shipments. The facility is part of a global network of 3-D printing hubs operated by UPS, completely transforming how goods are produced, transported and sold.¹⁰

A graphic consisting of a white rectangular frame with rounded corners, partially filled with a light blue color. The text "Quick Take" is written in a bold, blue, sans-serif font across the middle of the frame.

Quick Take

Are you on track to remove 50% of carbon in the next 10 years?

Scientists and activists have worried about climate change for decades, but a marked change in global sentiment means policymakers are intensifying scrutiny of carbon emissions, and by turn, global manufacturing. Countries are legislating for net-zero emissions typically by 2050, but some are talking as early as 2035. Some are going even further, with Germany's Supreme Court pressuring policy makers to protect future generations and mandate stronger legislation now.¹¹

Some calculations cite manufacturing as one of the major sources of greenhouse gasses of any sector worldwide, which means any legislation demands fast action.¹² The critical question is how to transition production processes from a mantra of cost reduction to one of low carbon.

Moreover, sustainability will not just be a matter of meeting legislative targets. Customers today are demanding their products be sustainably produced from the first step in the process to the last, and this will only increase going forward. Making manufacturing green is now simply a matter of good business. For more on this topic, see our report "[Green Rush: The Economic Imperative for Sustainability.](#)"

Forward-looking companies are preparing by adopting the concept of low-carbon manufacturing (LCM) across operations. LCM provides a lodestar, with clear goals to reduce carbon intensity across processes. LCM mechanisms frame material innovation and guide product development, R&D activities, sourcing decisions and technology investments to reduce, reuse and recycle materials.

It's good for business as well as future-proofing against change. For example, consumer pressure about plastic pollution has led to biodegradable polymers replacing traditional petroleum-based plastics, without the need for legislation.

The concept of "remanufacturing" in the automotive industry, reusing durable and alloy steel in engines and steering systems, spreads the practice of circularity to other industries before legislation forces the issue. In addition, additive manufacturing is starting to replace the traditional manufacturing techniques of moulding and forming, reducing waste and carbon.

In the not-too-distant future, sourcing decisions could spur the use of material innovations, even green steel. The world's first large-scale fossil-free steel plant is scheduled to open in 2024, with a planned production capacity of five million tons of high-quality net-zero hot-rolled, cold-rolled and galvanized steel (not enough to feed an entire global industry but a good start).¹³

New tasks prime a workforce makeover

Given license to think, act and do — in effect, to be empowered — the augmented workforce in manufacturing could become a source of value creation, applying digital insights to technical work and raising corporate performance as a result.



Workers newly armed with the ability to exploit data, analytics or machine learning can be equipped to add value in new and innovative ways, using human insight and judgment to master sophisticated technical process work with skill, dexterity and flair.

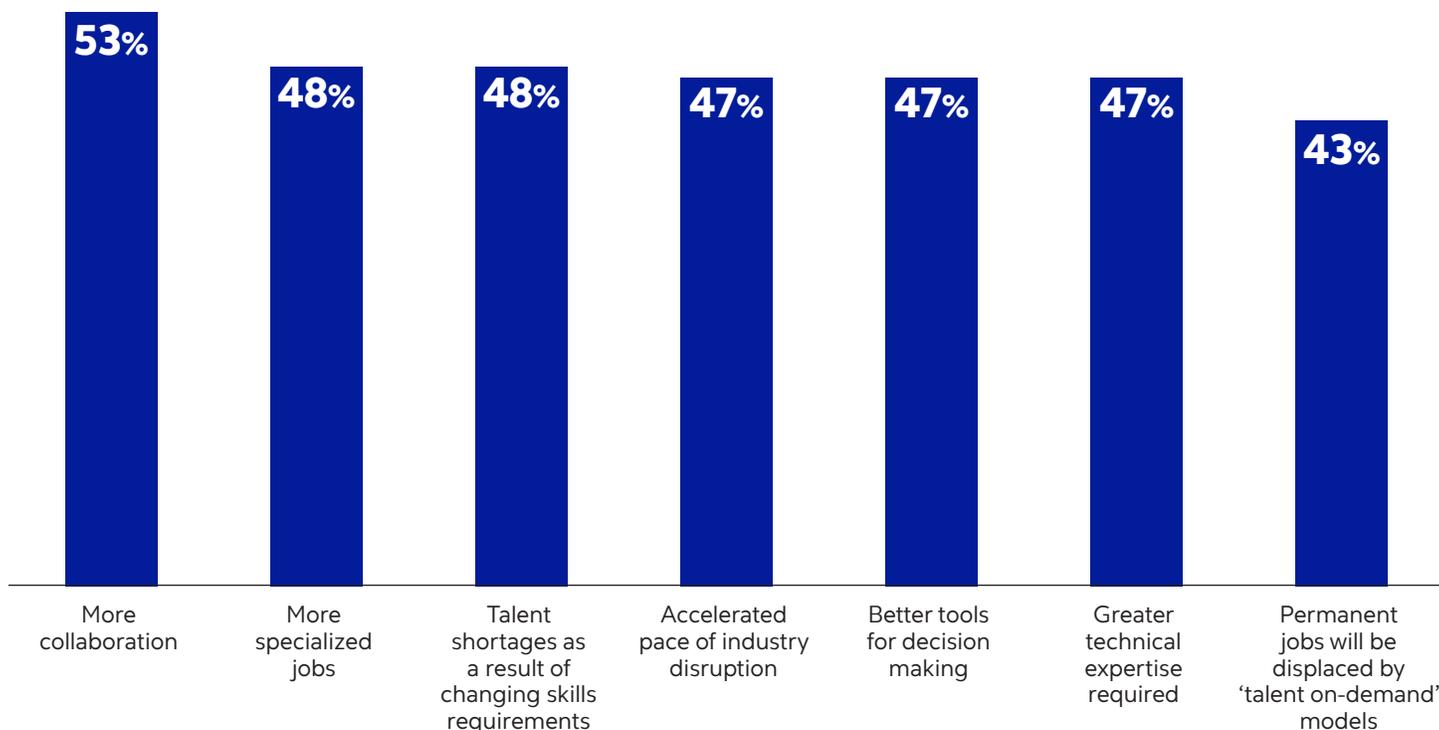
To gain more insight into this dynamic, we subdivided manufacturing respondents into a subset of 60 executives, or one-fifth of the sample, who identified themselves as heads of innovation, senior vice presidents of R&D and senior directors of product development functions. These roles best exemplify where changing ways of work in manufacturing will be early and most pronounced.

These executives revealed the significant changes they foresee in how people will work, including more specialized tasks (48%) and greater levels of collaboration across teams (53%). A near majority significantly agrees that process flows will accelerate as technology and data transform the work people do.

Given license to think, act and do — in effect, to be empowered — the augmented workforce in manufacturing could become a source of value creation, applying digital insights to technical work and raising corporate performance as a result (see Quick Take, next page). For example, the head of production at a mining processing company in our study said he fully expects the productivity of his company’s machine operators to increase as digitization accelerates. As better insights emerge between the technical tweaks applied during the mining process and the bank of machinery knowledge, the company expects better productivity by minimizing extraction errors and miscalculations.

New tasks prime a workforce makeover

A subsets of respondents with roles in innovation, R&D and product development were asked how work would change between now and 2023. (Percent of respondents who said ‘to a significant extent’)



Response base: 60 senior-level executives in innovation, R&D and product development roles

Source: Cognizant Center for the Future of Work

Figure 4

Quick Take Mercedes-Benz sees human-to-machine tasks proliferate

As more and more manufacturing work becomes knowledge-intensive, digital-oriented and non-routine, the workforce will be empowered to deliver higher rates of flexibility and speed. Human-machine integrated tasks will allow the right mix between flexibility and decision making, coupled with reliability and safety.

For example, Mercedes-Benz executives found that their inflexible processes presented a growing challenge: Its most profitable customers increasingly wanted individualized S-class sedans, but the automaker's assembly systems couldn't deliver on those customization demands.¹⁴

To meet these needs, the carmaker replaced some of its “dumb” robots with AI-enabled co-bots and redesigned its processes around human-machine collaboration. At the company's plant near Stuttgart in Germany, human workers guide co-bot arms to pick up and place heavy parts, becoming an extension of the worker's body. This system puts the worker in control of the build of each car, requiring less manual labor and more “piloting” of the robot. The company's human-machine teams can adapt to changes on the fly.

We can now start to predict how the interplay between people and machines could start to look in a fast moving, collaborative environment. As robots evolve into smart, context-aware co-bots working on the production line, a co-bot arm might, for example, handle repetitive actions that require heavy lifting, while a person performs complementary tasks that require dexterity and human judgment, such as assembling a hard-to-reach substructure or production part, without risk to the people doing it.

In many cases, co-bot programming can be done by a line operator. For example, in the same Mercedes plant, the co-bots can be reprogrammed easily with a tablet, allowing them to handle different tasks depending on changes in the workflow. Such agility has enabled the manufacturer to achieve unprecedented levels of customization. Mercedes can individualize vehicle production according to the real-time choices consumers make at dealerships, from the vehicle's dashboard components to the seat leather to the tire valve caps. As a result, no two cars rolling off the assembly line at the Stuttgart plant are the same.

Skills renaissance needed

As manufacturing digitizes, people clearly need a different set of skills to excel. Employers need their workforce to be flexible, agile and digitally literate. Data literacy, analytical insight, machine learning, machine-handling techniques and co-working with robots will be crucial skills in the work ahead, according to manufacturing respondents.

This will change how leaders find talent and put their best people to work. As our study shows, skills in decision making, strategic thinking, fabrication and learning are at the forefront in the minds of respondents (see Figure 5, next page).

The future workforce demands new skills

Respondents were asked to rate which skills had become more important than previously and which would become more important by 2023.

2020	IMPORTANCE	2023
Innovation	1	Decision making
Decision making	2	Strategic thinking
Analytical	3	Fabrication
Leadership	4	Learning
Strategic thinking	5	Leadership
Selling	6	Analytical
Fabrication	7	Interpersonal
Interpersonal	8	Communication
Communication	9	Global operating skills
Learning	10	Customer care

Response base: 285 manufacturing senior leaders
 Source: Cognizant Center for the Future of Work
 Figure 5

The skills sought from the workforce cluster around digital literacy and traditional production skills. For example, a supervisor at a Swedish industrial products maker in our study foresees the need for skilled machine operators, as well as more technical roles on the production floor, such as data scientists, software developers and even e-commerce specialists.

The ability to operate and manage computerized and automated technologies that dominate the production environment today demand new levels of digital literacy; our study reveals the heightened focus on using data to make better decisions, reaching the top required skill by 2023. Fabrication skills (building metal structures in auto manufacturing for example, by cutting, machining, welding, stamping, etc.) are predicted to rise in importance as well, revealing the challenge manufacturers face finding and putting their best people to work (see Quick Take, next page).

Undoubtedly, higher levels of automation and greater use of precision machinery requires better problem-solving skills from the people who use them; for example, while automation relieves some direct tasks, it can't deal with errors or variations. Human workers will be required to troubleshoot errors on production lines and provide the flexibility and customization that machines cannot.

Grippers provided by Robotiq are a great example of where humans and machines can work in tandem. While Robotiq's machines can run autonomously, workers can customize tasks on the fly if they have the right programming skills, cutting the time required from days to minutes.¹⁵

A graphic consisting of two white brackets, one above and one below the text "Quick Take".

Quick Take

Four steps to accelerating workforce transformation

Employees who traditionally were responsible for executing only physical tasks will transition toward engaging in more cerebral activities. As a result, the industry needs a digitally literate workforce, fully equipped with technical insight to perform specific tasks.

It will be essential for manufacturers to institutionalize knowledge capture across the organization and drive career development strategies to train, retain and cultivate employees to be future value generators. (For more on this topic, see our report [“The Renaissance of Blue-Collar Work.”](#))

Here are four ways to get started on an upskilling strategy:

- I Evolve performance metrics to drive the right behaviors.** Rather than focus reward systems solely on production volume and production margin, plan to align pay with improvements in customer satisfaction ratings (i.e., net promoter scores), work speed (i.e., process throughput) and supply chain efficiencies (i.e., KPIs on inventory cycles and carbon use).
- I Turn your best people into knowledge brokers.** Provide substantial learning opportunities so that workers can quickly move, if needed, to a different position or be redeployed into another team that can use their skills. Turn your best workers into knowledge brokers, having conversations across the organization to know who’s working on what at any given time. Brokers can then use this insight to share best practices across the organization, and benefit from the reputation they develop for their new skills and know-how.
- I Reform recruitment strategies.** Change recruitment practices to attract workers considered to be future “value generators.” Consider developing apprenticeship schemes to attract less experienced workers into the organization or co-developing outreach programs with employer/industry associations and partnering with schools and educational institutions to increase awareness of what a fulfilling and purposeful career in manufacturing could be.
- I Rethink the career model.** Longer-term career planning and different routes toward career progression are needed. Manufacturers will need to reconstruct career models to provide continuous development opportunities and foster a growth mindset among employees. Career routes need to be constructed into higher skilled, more senior roles for staff, which means providing the workforce with the digital skills to learn continuously, and the ability to improve on the job.

Modernizing manufacturing

Collaboration between humans and machines finds a natural home in manufacturing. To capitalize on this symbiosis however, the traditional risk-averse approach needs to be swept aside.



Manufacturers have a window of opportunity to take aggressive steps to modernize their business and operating models, their processes and the roles and tasks that people do, all with an eye on how manufacturing will evolve in the next stage of the digital economy.

To successfully move into this new world, manufacturers should consider the following bold steps to accelerate into the future:

I **Raise investment in technology above 11% of revenues.**

While European manufacturers are leading the way in terms of technology investments, tech spending in this sector still lags other industries, which seems misaligned for a sector reliant on its relationship with machines. To take advantage of the efficiencies and innovation technology can bring, manufacturers must look not only at their peers in other regions for their investment strategies, but also more widely across industry lines.

I **Double-down on upskilling people for the changes ahead.**

Manufacturing work is changing, and along with it, the skills necessary to succeed. Ensure that relevant training programs are in place. Build diverse and multifunctional teams with an open culture of collaboration and agile working practices to overcome competition and adapt to the shifting global manufacturing landscape.

I **Nurture local talent by focusing at the local level.**

Concerns of global talent shortages can be mitigated by working with local technical colleges and universities to evangelize and train students on careers in the manufacturing industry. Promotion of the Fourth Industrial Revolution and the digital skills required for it will not only allow manufacturers to grow and attract highly sought-after talent but also provide critical entry-level roles as the marketplace becomes more difficult to break into.

I **Keep perspective on global best practices.**

The trend toward more nationalistic industrial policies doesn't mean global collaboration needs to suffer. Global manufacturing bodies that espouse best practices such as the Global Lighthouse Network can be a source of innovation and inspiration at a time when isolation from competitors could lead to potential stagnation.¹⁶

I **Encourage pilots but adhere to a roadmap.**

Too much is spent on trying out technology vs. envisioning a critical path to change. Use your newly diverse, multifunctional and highly skilled workers to envision how new technologies and ways of working could be deployed to meet your goals. Through agile working practices, manufacturers can quickly set aside projects that don't show value and scale those that show value aligned with the strategic roadmap.

Natural partners in manufacturing: humans and machines

Collaboration between humans and machines finds a natural home in manufacturing. To capitalize on this symbiosis however, the traditional risk-averse approach needs to be swept aside. The prospect of receding into obsolescence for manufacturers that do not invest in not just cutting-edge but proven technology is very real.

Other industries have shown the havoc wreaked by new players that disrupt the market. Under-investment in the people and technologies that are driving the Fourth Industrial Revolution will open manufacturing to this shock not just from those that enter with new technologies, new ideas and human-centric policies but also those global competitors that understand the criticality of digitizing manufacturing processes to thrive in a post-pandemic world.

Manufacturers have a window of opportunity to take aggressive steps to modernize their business and operating models, their processes and the roles and tasks that people do, all with an eye on how manufacturing will evolve in the next stage of the digital economy.

Methodology

Cognizant commissioned Oxford Economics to design and conduct a study of 4,000 C-suite and senior executives, including 285 from the manufacturing industry. The survey was conducted between June 2020 and August 2020 via computer-assisted telephone interviewing (CATI). Approximately one-third of the questions were identical to those included in the 2016 Work Ahead study, allowing us to compare responses and track shifting attitudes toward technology and the future of work.

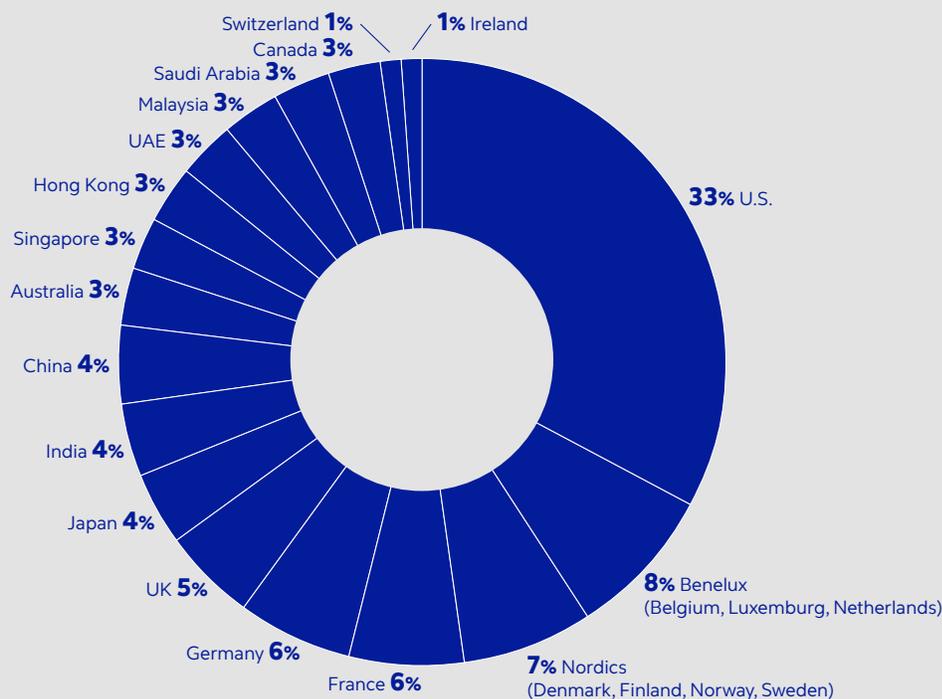
Respondents were from the U.S., Canada, UK, Ireland, France, Germany, Switzerland, Benelux (Belgium, Luxemburg, Netherlands), Nordics (Denmark, Finland, Norway, Sweden), Singapore, Australia, Malaysia, Japan, China, Hong Kong, India, Saudi Arabia and UAE. They represent 14 industries, evenly distributed across banking, consumer goods, education, healthcare (including both payers and providers), information services, insurance, life sciences, manufacturing, media and entertainment, oil and gas, retail, transportation and logistics, travel and hospitality, and utilities. All respondents come from organizations with over \$250 million in revenue; one-third are

from organizations with between \$250 million and \$499 million in revenue, one-third from organizations with between \$500 million and \$999 million in revenue, and one-third with \$1 billion or more in revenue.

In addition to the quantitative survey, Oxford Economics conducted 30 in-depth interviews with executives across the countries and industries surveyed. Interviewees who responded to the survey have a track record of using emerging technology to augment business processes. The conversations covered the major themes in this report, providing real-life case studies on the challenges faced by businesses and the actions they are taking, at a time when the coronavirus pandemic was spreading around the world and companies were formulating their strategic responses. The resulting insights offer a variety of perspectives on the changing future of work.

The following figures represent the demographics of the 4,000 respondents from the full global study.

Respondents by geography



(Percentages may not equal 100% due to rounding)

Respondents by role

- 13%** Vice President
- 13%** Chief Operating Officer
- 13%** Director reporting to senior executive
- 13%** Senior Vice President
- 12%** President
- 12%** Chief Executive Officer
- 12%** Chief Financial Officer
- 12%** Other C-suite Officer

About the authors



Euan Davis
Associate Vice President, Cognizant's Center for the Future of Work, EMEA

Euan Davis leads Cognizant's Center for the Future of Work in EMEA. A respected speaker and thinker, Euan has guided many Fortune 500 companies into the future of work with his thought-provoking research and advisory skills. Within Cognizant's Center for the Future of Work, he helps ensure that the unit's original research and analysis jibes with emerging business-technology trends and dynamics in Europe, and collaborates with a wide range of leading thinkers to understand how the future of work will look. Previously, Euan held senior analyst, advisory and leadership positions at Forrester Research, IDC and CEB.

Euan can be reached at Euan.Davis@cognizant.com

LinkedIn: [linkedin.com/in/euandavis/](https://www.linkedin.com/in/euandavis/)

Twitter: [@euandavis](https://twitter.com/euandavis)



Manoj Mathew
Vice President, Industry, Cognizant Digital Business & Technology

Manoj Mathew is a Cognizant Digital Business & Technology VP who focuses on the product, manufacturing, service and logistics space and leads advisory engagements in the Industry 4.0 space across EME and APAC markets. He has over 20 years of experience defining and delivering connected product solutions for mission-critical applications such as deep-water drilling, connected car solutions, gas turbine monitoring, autonomous agriculture and building-monitoring solutions.

Manoj's current focus is on smart products and smarter businesses — helping manufacturers transform their processes to leverage ever-increasing pools of sensor data and live telemetry.

Manoj earned his degree in electrical engineering and is based in the Netherlands.

He can be reached at m.mathew@cognizant.com

LinkedIn: www.linkedin.com/in/simplymanoj/



Duncan Roberts
Manager, Cognizant Center for the Future of Work

Duncan Roberts is a Manager at the Cognizant Center for the Future of Work. He joined the company in 2019, working as a digital strategy and transformation consultant in industries ranging from satellite communications to educational assessment and has advised clients on how to best utilize technology to meet strategic objectives while also turning around projects that had been in danger of failure.

Prior to Cognizant, he developed applications for emerging virtual and augmented reality hardware, leading to working directly with large companies on experiences for their launches. He also advised small startups on using blockchain solutions for advertising within VR and AR. Duncan brings his passion for technology and experience in industry to researching the impact of virtual space on the workplace.

Prior to Cognizant, Duncan worked for one of the largest publishing houses in Europe, playing a leading role in the publishing digital revolution, helping to transform the company's operations end-to-end and launching innovative products. He holds a master's degree in philosophy and classics from the University of St. Andrews.

Duncan can be reached at Duncan.Roberts@cognizant.com

LinkedIn: www.linkedin.com/in/duncan-roberts-16586022/?originalSubdomain=uk

Twitter: [@dgrobertscfow](https://twitter.com/dgrobertscfow)

Endnotes

- 1 “Superfeed to Provide 30,000 Respirator Masks for Local Healthcare Workers and Hospitals,” Cision, March 31, 2020, www.prnewswire.com/news-releases/superfeed-to-produce-30-000-respirator-masks-for-local-healthcare-workers-and-hospitals-301032559.html
- 2 Rob Davies, “Dyson and Airbus Expect Green Light to Start Making Ventilators,” *The Guardian*, March 25, 2020, www.theguardian.com/world/2020/mar/25/airbus-dyson-firms-waiting-uk-green-light-produce-ventilators-coronavirus
- 3 Jennifer Schenker, “Meet the World’s Most Advanced Factories: Five Are in Europe, Three in China and One in the US,” *The Innovator*, Sept. 14, 2018, <https://innovator.news/meet-the-worlds-most-advanced-factories-801a1e4567f3>.
- 4 Kif Leswing, “Intel Is Spending \$20 Billion to Build Two New Chip Plants in Arizona,” *CNBC*, March 23, 2021, www.cnbc.com/2021/03/23/intel-is-spending-20-billion-to-build-two-new-chip-plants-in-arizona.html.
- 5 “Industry 5.0,” European Commission, https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/industry-50_en.
- 6 “Strategy for American Leadership in Advanced Manufacturing,” National Science & Technology Council, October 2018, <https://trumpwhitehouse.archives.gov/wp-content/uploads/2018/10/Advanced-Manufacturing-Strategic-Plan-2018.pdf>.
- 7 “China Has New US\$1.4 Trillion Plan to Seize the World’s Tech Crown from the US,” *South China Morning Post*, May 2020, www.scmp.com/tech/policy/article/3085362/china-has-new-us14-trillion-plan-seize-worlds-tech-crown-us.
- 8 Charlie Taylor, “Cork Hip Joint Factory Among World’s Best Due to Internet of Things,” *The Irish Times*, Sept. 5, 2018, www.irishtimes.com/business/technology/cork-hip-joint-factory-among-world-s-best-due-to-internet-of-things-1.3618490.
- 9 “The 5G Factory of the Future,” Ericsson, www.ericsson.com/en/cases/2020/the-5g-factory-of-the-future.
- 10 Tia Vialva, “Fast Radius Raises \$48M to Accelerate Industrial AM in Series B Led by UPS,” *3D Printing Industry*, April 4, 2019, <https://3dprintingindustry.com/news/interview-fast-radius-raises-48m-to-accelerate-industrial-am-in-series-b-led-by-ups-152653/>.
- 11 Kate Connolly, “‘Historic’ German Ruling Says Climate Goals Not Tough Enough,” *The Guardian*, April 29, 2021, www.theguardian.com/world/2021/apr/29/historic-german-ruling-says-climate-goals-not-tough-enough.
- 12 “What Contributes to Carbon Footprint in Manufacturing?” Larry Burton, July 2, 2021, <https://resource.temarry.com/blog/what-contributes-to-carbon-footprint-in-manufacturing>.
- 13 “Accelerating the Decarbonisation of Steel Production,” H2Green Steel, www.h2greensteel.com/.
- 14 H. James Wilson and Paul R. Daugherty, “Collaborative Intelligence: Humans and AI Are Joining Forces,” *Harvard Business Review*, July-August 2018, <https://hbr.org/2018/07/collaborative-intelligence-humans-and-ai-are-joining-forces>.
- 15 Robotiq website: <https://robotiq.com/>.
- 16 The World Economic Forum’s Global Lighthouse Network website: www.weforum.org/projects/global_lighthouse_network.



See the full Work Ahead study series: www.cognizant.com/theworkahead



Center for
The Future of Work

About the Center for the Future of Work

Cognizant's Center for the Future of Work™ is chartered to examine how work is changing, and will change, in response to the emergence of new technologies, new business practices and new workers. The Center provides original research and analysis of work trends and dynamics, and collaborates with a wide range of business, technology and academic thinkers about what the future of work will look like as technology changes so many aspects of our working lives. For more information, visit Cognizant.com/futureofwork, or contact Ben Pring, Cognizant VP and Director of the Center for the Future of Work, at Benjamin.Pring@cognizant.com.

About Cognizant

Cognizant (Nasdaq-100: CTSH) is one of the world's leading professional services companies, transforming clients' business, operating and technology models for the digital era. Our unique industry-based, consultative approach helps clients envision, build and run more innovative and efficient businesses. Headquartered in the U.S., Cognizant is ranked 185 on the Fortune 500 and is consistently listed among the most admired companies in the world. Learn how Cognizant helps clients lead with digital at www.cognizant.com or follow us [@Cognizant](https://twitter.com/Cognizant).

Cognizant

World Headquarters

300 Frank W. Burr Blvd., Suite 600
Teaneck, NJ 07666 USA
Phone: +1 201 801 0233
Fax: +1 201 801 0243
Toll Free: +1 888 937 3277

European Headquarters

1 Kingdom Street
Paddington Central
London W2 6BD England
Phone: +44 (0) 20 7297 7600
Fax: +44 (0) 20 7121 0102

India Operations Headquarters

#5/535 Old Mahabalipuram Road
Okkiyam Pettai, Thoraipakkam
Chennai, 600 096 India
Phone: +91 (0) 44 4209 6000
Fax: +91 (0) 44 4209 6060

APAC Headquarters

1 Changi Business Park Crescent,
Plaza 8@CBP # 07-04/05/06,
Tower A, Singapore 486025
Phone: + 65 6812 4051
Fax: + 65 6324 4051