The Work Ahead is a research series providing insight and guidance on how businesses - and jobs - will evolve in the digital economy.

Whether you’re a producer of consumer durables or industrial goods, the future of manufacturing isn’t just about using new technologies to design and make physical products. It’s about leveraging the power of digital to create more connected and personalized experiences for customers. Our latest study shows the way forward to the future of work for manufacturers.

In this installment, we look at the new digital economics of manufacturing, as well as the ways in which new digital skills and technologies - from analytics and automation through artificial intelligence (AI) - will enable manufacturers to innovate new work (and work processes).
THE WORK AHEAD IN MANUFACTURING

Traditional manufacturing has always focused on getting products and parts crafted, fabricated, stored, moved and distributed to the right place at the right time. And because no manufacturer is an island, these steps have had to be intensively coordinated among partners — suppliers, production shops, shippers, distributors, retailers and, yes, customers.

Yet everywhere you turn, there are seemingly new competitive moves — everything from Amazon’s private-label diapers dropped digitally at your door,1 to John Deere’s “Farm Forward” crop management ecosystem,2 or GE’s digital jet engines that are instrumented down to the individual fan blade3 — that make past approaches suddenly seem old, creaky and unresponsive.

Even the simple act of making pizza can now involve prep and delivery with high-tech equipment: Zume Pizza in Palo Alto, Calif., for example, is using a robot to expedite the experience of deliciousness. This is not science fiction — it’s happening, now.4 Far more serious and sophisticated global digital changes in manufacturing are also occurring, as customers demand more than “better stuff” and gimmicks — and seek experiences that inform, inspire and bring meaning to their lives.

Just as Detroit’s assembly lines changed the very nature of work in auto manufacturing, new digital technologies herald massive change in the work ahead for the entire manufacturing sector. One driver of change is 3-D printing and its ability to allow some manufacturers to create new jobs onshore, or bring back old ones from abroad. This technology is also spurring the emergent trend of so-called “maker-artisanal” in diverse locales worldwide, presaging a near-term future of “what you want, when you want it” manufacturing. Imagine goods produced by local, bulk 3-D printing capabilities and a collective of skilled “finishers” that apply a final-polish, small-batch or artisanal stamp to the goods, to add a unique, personal touch.
The combination of localized production and customer-centered design will also likely alter the historic arm’s-length relationships between producers and distributors/dealers. If you can “make” something at the same site from which it is sold, why would you need a downstream intermediary? Legacy industrial models will need to be strategically re-thought or blended with new, digitally-driven approaches. For example, imagine a post-petroleum world, in which gas stations merge with quick-printing chains like Kinko’s to form local manufacturing sites, producing 3-D printing designs at scale and recycling waste materials back out through the supply chain.5

Already, embedded sensors and the Internet of Things (IoT) are breaking down barriers between products, customers, retailers, wholesale partners and suppliers. In response, manufacturers have a massive opportunity to make products that push the envelope of game-changing innovation or new levels of efficiency.

With digital innovation, the days of top-down, “you’ll-get-what-we-give-you” mass production are giving way to co-creation processes that deploy crowdsourcing techniques to improve products via open collaboration platforms that encourage innovation and yield highly personalized products built for markets of one.

The work ahead for all participants in the physical and digital manufacturing realms will be to strengthen, cultivate and coordinate the ecosystem of partners in an interconnected world of intelligent embedded systems that produce meaningful products, services and experiences for customers.

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**Key Insights**

To understand what the future holds for manufacturing, Cognizant’s Center for the Future of Work surveyed 2,000 executives globally, including 500 senior executives from the consumer and industrial products spaces (see Methodology, page 20). From their input, we learned:

- **Manufacturers haven’t saved money using digital, but their investments are reaping new revenues.** So far, respondents think digital initiatives have increased manufacturing costs by 1% during the last year, but they’ve also improved revenues by 5.4%.

- **Digital will become a money-making assembly line over the next few years.** By 2018, respondents expect to boost revenues by 9.0%. Extrapolated to the entire global manufacturing industry, digital will drive almost 25% additional growth.

- **To reap the rewards, tune in to the digital channel.** Today, only 30% of respondents believe more than 20% of their revenues currently originate from digital channels. By 2020, however, that percentage leaps to 78%.

- **Analytics and AI are transforming global “making” processes.** Roughly 70% of respondents think digital change is boosting the need for innovation skills today and will continue to do so through 2018. Meanwhile, the percentage of respondents who believe AI will have a significant impact on manufacturing by 2025 vs. today jumps nearly 400%. Getting ahead of these systems of intelligence is essential and will likely trigger a surge in analytics skills needed by 2020.
• Forget “oil spills” – manufacturers are worried about “data spills.” Universal concern about oversharred personal data abounds among manufacturers, with 90% of respondents citing this as a moderate or significant concern.

• Digital change makes manufacturing more meaningful in the work ahead. Consumer demand is evolving – fast – from a desire for “stuff” to more meaningful experiences, and manufacturers will need to adapt their skills accordingly. Their employees increasingly want to work on things that will improve other people’s lives. As such, over 50% of respondents believe that digital technology will allow them to “contribute more meaningfully.”

Digital forces – including 3-D printing, IoT/sensors, drone delivery and manufacturing robots – are converging to transform manufacturing and the entire value chain, and it’s increasingly being done by smart machines and code to augment human workers and customers.

Whether your company is a manufacturer of consumer or industrial products, the time to act is now. Leaders need to make critical choices regarding initiatives that will quickly allow the benefits of digital to help their businesses succeed. The scale of the opportunity is massive – and eminently achievable.
But Gains Achieved Digitally Double by 2018

After years of developing cost-saving programs to drive lean manufacturing, companies now want to propel outsized results on the top line through digital injection. Digital initiatives have increased manufacturing costs by 1% but have simultaneously improved revenues by 5.4% (see Figure 1, next page). By 2018, cost reductions remain marginal – while costs do decrease, it’s only by a mere 0.7% (with the exception of retail, this is the least impact measured in any industry we studied).

The strategy to “give” on costs to “get” outsized revenues will continue through 2018. As a result, many manufacturers will be doubling-down on digital, knowing they need to spend money to make money, causing revenues to soar 9.0% by 2018. That’s nearly a 10% top- and bottom-line improvement. If we extrapolate beyond our respondents to the entire global manufacturing industry, we estimate that digital will drive 24.7% additional growth in the $13 trillion manufacturing sector worldwide between now and 2018.6 That’s a massive amount of money.

Getting down into the weeds of these new, complex technologies might seem like the hard part, but in fact the really hard part is vision, imagining the future and thinking big – in other words, avoiding incrementalism. This requires a major mindset shift, and then animating and bringing the technology vision to life.
Manufacturers have moved beyond “knowing something needs to happen” to “making something happen;” we’re already seeing examples of tailored and customized versions of everything from stylish wardrobes, self-driving cars and shipping options to house-paint colors. By linking the purchase of discrete goods to continuous lifestyle choices, products can become services.

For example, Asian Paints (the largest paint company in India) has used the combination of industrialized sensors, automation and social media analytics to catalyze both internal operations and customer-driven product development and marketing outreach. By developing smarter “products-as-a-service” and more agile demand-driven supply chains, manufacturers like Asian Paints hope to generate growth rates far and above what they would have enjoyed in the “pre-digital” era.

Digital's Cost & Revenue Impact in Manufacturing: Present vs. 2018

Senior executives think digital increased costs by 1% in 2015, but simultaneously improved revenues by 5.4%. By 2018, respondents expect digital to boost revenues by 9.0%.

*Response base: 500 senior manufacturing executives

* 2015 Potential Impact represents the outcome respondents think they could gain were they to fully implement all digital best practices available to them.

Source: Cognizant Center for the Future of Work
MAKERS FIND NEW DIGITAL ROUTES TO MARKET

It’s clear that manufacturers expect increased revenue growth from digital channels between now and 2018. While only one-third of our respondents believe that 20%-plus of their revenues currently originate from digital channels (see Figure 2, next page), that percentage more than doubles to 78% by 2020.

The implications of this shift are huge. With the growing recognition that the days of making mass-produced things and selling them at a profit are becoming obsolete, manufacturers realize they need to adopt a broader transformation strategy that will affect their customers, suppliers, products, markets and employees.

A look at other industries can also be instructive. For example, imagine if Uber were a manufacturer: It might consider variables such as access to on-demand machine time, long-term or micro-leasing of equipment and driving higher machine utilization rates. As other industries continue to morph, age-old notions of what’s “core” vs. “non-core” in manufacturing need to be revisited (and revisited again and again several times over the next decade as digital disruptions continue). Whether it’s Levi’s shifting from being “just a jeans company” to a branding juggernaut, Ford Motor Co. rethinking the future of cars as “mobile communications platforms,” or GE’s existential relaunch as a “digital industrial company,” the signs of manufacturers’ metamorphoses are everywhere, and we’ll see even more signals in the coming years.
The Huge Shift to Digital as a Revenue Channel in Manufacturing

Only about 30% of manufacturers think more than 20% of their revenues were obtained through digital channels in 2015. By 2020, 78% think it will be 20% or more.

Source: Cognizant Center for the Future of Work

Figure 2

Source: Cognizant Center for the Future of Work
Response base: 500 senior manufacturing executives
When manufacturing executives look at the top-five impacts of digital that are set to transform work between now and 2020 (see Figure 3, next page), they agree that as more tasks are automated, work will become more strategic. That is, there will be less emphasis on discrete manufacturing equipment installation, and more focus on whether the gear will—or won’t—enhance new digital business approaches.

At the same time, our data also shows that digital will cause work to require greater technical expertise. Manufacturers need increasingly sophisticated ways of seeing the bigger picture of their business, in order to adapt and respond to demand volatility. Simultaneously, these changes will play out against a backdrop of skills shortages in the U.S. manufacturing industry of at least two million by 2025. Respondents also believe that digital will help them work faster, without having to necessarily work longer hours, or harder. Given the incipient skills shortages, further automation will be a critical remedy. Manufacturers—quickly—need to launch active programs around systems of intelligence that lead to more human-robotic collaboration.
Manufacturers – quickly – need to launch active programs around systems of intelligence that lead to more human-robotic collaboration.

Digital Forces Transforming the Work Ahead in Manufacturing

Senior executives believe as future tasks become more automated, work becomes faster and more strategic. Greater technical expertise will be required, and skills undergo significant change, but interpersonal relationships will be more valuable.

![Percentage of senior executives who believe the following will have a moderate or strong impact on work.](image)

Response base: 500 senior manufacturing executives

Source: Cognizant Center for the Future of Work

Fabricating the Future: Analytics Skills to Unlock Innovation

New automated systems, in concert with manned systems, create new outcomes by better integrating all participants – suppliers, partners, materials scientists, machinists and heads of safety – through digital approaches. Robots and other autonomic systems are working alongside humans on modern manufacturing floors rather than being contained in “just designed for robots” floors. A great example is the Airbus factory, in which robots are strapped to the side of fuselages, riveting thousands of holes, with operators “piloting” the robots.

To personalize this even further, consider the views of Greg Morris, Additive Technologies Leader at GE Aviation, regarding 3-D printing: “You’re going to have higher-skilled positions, both on the technician level, and the engineering and design level ... You’ll get complex parts that a machinist will have to work with vs. starting with a block of material. So you’re not replacing machinists, you’re just asking them to learn a little different skill set of what they start with and work with.”


As Figure 4 reveals, innovation is the most important skill for manufacturers today (cited by 70% of respondents), and by 2020, its importance increases (80%), as does the need for global operating skills (80%). Furthermore, intelligent automation and AI will reforge the links in manufacturers’ physical value chains as they digitize – releasing a flood of process feedback and analytics instantly. Consider the impact on workplace safety and productivity as well, as sensors provide interconnectivity between the shop floor and the managerial “top floor,” reducing the human intervention required to address issues or deviations. Sensors can also continually measure operating parameters, such as temperature, pressure, alignment or thickness at a process level, and send this data to a remote controller for real-time adjustments and analysis.

Skills that Will Grow More Important in the Future

Innovation is the most important skill, and by 2020, it grows in importance as a leading capability, also joined by global operating skills. Analytical skills also surge by 2020.

What that means for manufacturers is: Use advanced digital technologies to not only cut costs, but to also get smart. The instrumentation of smart factories will also spur a surge in the need for analytics skills by 2020 (from 57% today to 75%). More than just “doing digital” or “doing big data,” those with analytics skills will bring premium assets to manufacturers in multiple ways, such as supply chain optimization, product quality and asset optimization. As manufacturers ramp up their IoT initiatives on the shop floor, an explosion of analytics-driven optimization is just around the corner.
The creation and release of data through smart machines is ripe for analytics and meaning-making. When products become services, transactions give way to real-time, continuous engagement, leading to breakthroughs that introduce the “next cool experience” — the next Tesla or must-have product with augmented reality, etc. — that people want to buy. (Beyond being tangible “things,” connected cars like Tesla, loaded as they are with sensors and infotainment options, can be likened to “smartphones on wheels.”) For example, Jabil (the second-largest contract manufacturer in the world, after iPhone-maker Foxconn) is accelerating innovation and speed-to-market by making major investments in digital prototyping, building-on-demand and intelligent digital supply chains. These investments are strategic growth levers for Jabil; while the company is still hiring much-needed employees to fill skills gaps, new digital investments allow productivity improvements that are two to three times beyond what employees could achieve using “old” mechanized manufacturing approaches. All of this results in a digital enterprise where integrated machines, data and people with acute analytics skills create synergies, and something more powerful than the sum of their parts.

Lastly, our respondents anticipate dynamic growth in demand for design skills (whose importance burgeons to 70% by 2020), as well as fabrication skills (71% by 2020, as well). These trends underscore the coming impact of 3-D printing and additive manufacturing and the redoubled attention to the “maker culture” we’re already seeing in the future of work and work processes.

We expect to see this at the industrial level of manufacturing, too. Motorsport technology designer Prodrive uses 3-D printing to manufacture parts on-demand; similarly, Ford has started using 3-D printing to create the prototype engine parts for its automobile testing. From a product lifecycle management (PLM) perspective, the new Maserati Ghibli is manufactured using a state-of-the-art process on a production line created specifically for it — right from the stage where components are drafted digitally and tested virtually before they are manufactured.
More Data Equals More Security Concerns

With so much data swirling around the shop floor between suppliers and partners, and additional data being generated by smart products and their users, survey respondents voice palpable concern about the security and privacy risks of all that information getting into the wrong hands. While “oil spills” are bad, the anxiety about “data spills” among manufacturers is terrible.

On the one hand, given its massive growth potential, digital change is a blessing for both industrial products and consumer goods manufacturers. On the other hand, there’s the responsibility – or at least a heavy burden – of ensuring the safety and security of information as cyber threats continue to increase at the global, local and individual level. Already we’ve seen significant hacks of seemingly benign IoT devices like children’s toys and webcams, with the intent of “weaponizing” them to clog the wider Internet. (If the idea of having to upgrade the firmware on your IoT porch light seems ludicrous, thousands of consumers agree.) As a result, big data and cybersecurity – and related digital technologies like mobile and sensors/IoT – are having the biggest impact on manufacturers today (see Figure 5, next page).

By 2025, sensors and IoT stand as the pre-eminent digital technologies affecting the manufacturing sector. By then, we’ll likely see the instrumentation of every product, and more smart products means more data. Add to that a variety of autonomous and semi-autonomous systems, from 3-D printing to sensors and robots, converging to become an integral part of enterprise business architecture.
While industrial robots have a decades-long heritage in manufacturing, there is still major runway ahead for further depth, breadth and reach of automation in manufacturing over the next 10 years. Our data bears this out. The percentage of respondents who say software “robots” for process automation will have a significant impact on work grows 336% by 2025, while the significance of robots that manipulate physical things will rise 357%. AI beats all digital technologies in expected impact, growing a whopping 395%.

We think the aforementioned impending skill gaps in manufacturing will drive higher degrees of automation and adoption of the next wave of robotics. At the same time, we expect that further automation adoption by manufacturers will propel limited experiments with AI and robotics that are in line with projections on the most critical skills shortages.

The Digital Technologies Whose Impact Is Expected to Grow the Most in Manufacturing

Between now and 2025, digital technologies focused on the Internet of Things – as well as big data/analytics, cybersecurity and collaboration – are projected to have maximum impact on manufacturing companies.

Response base: 500 senior manufacturing executives

Figure 5 Source: Cognizant Center for the Future of Work

Percentage of respondents who say the technology category will have high or very high impact
Data Security Remains a Major Concern

In addition to data security having a high technological impact on the business of manufacturing, industry executives are also greatly concerned about security from a personal perspective, as well.

As shown in Figure 6, in an instrumented “world of things,” nearly all executives – 90% – are concerned about personal data getting into the wrong hands. When sensors become embedded in all products, this could perhaps fuel fears of a “Big Brother” world, in which personal data becomes ever more the target of hacks and exploitation.

This finding also ties in with “digital terrorism” as the biggest significant concern (38%, when we strip out those who felt it was only a "moderate" concern). No matter how one views the future work ahead in manufacturing, there is a connected, over-arching issue here between data, data protection, theft and outright terrorism.

Regardless of the products made, every manufacturer needs an absolutely robust data security strategy and infrastructure, as well as the creation of a separate function focused on overall digital security.

Data Security Is a Major Concern

Manufacturing executives’ concerns around the move to a more digital world fixates on data security: everything from personal information being overshared, to data theft and fraud and – significantly – digital terrorism.

Response base: 500 senior manufacturing executives

Source: Cognizant Center for the Future of Work
Is it possible that we are witnessing a manufacturing renaissance in the making? Perhaps – but a big part of the equation is to “make manufacturing meaningful.” Will it break the mold, or lead to “creative destruction?”

At the end of the day, manufacturing is about “making.” Analytical thinking, collaboration, communication, creative problem-solving – undertakings that fuel the imaginations of the largest global industrial producers and consumer goods companies to small-batch “maker movements” the world over – will become even more essential than ever before.

In the case of 3-D printing, the manufacturing industry is likely to be substantially impacted. Company structures will evolve rapidly, leading to new business, new innovation and new jobs that are more localized, skilled and craft-oriented – and more human in scale. Whether it’s cosmetics companies testing new products on 3-D printed skin rather than animals, or precision-finishing of 3-D printed aerospace parts, or craft breweries that refine their creativity and scale by using automated production processes, there is a sea change occurring in the ways many manufacturers think about the work ahead.
Figure 7 reveals the changing work attitudes. The response “contribute more meaningfully” (73%) tops the list of responses from those surveyed. There’s also a widespread sense of optimism that digital will help executives excel in their careers by providing additional opportunities for advancement (61%), as well as better communication with colleagues (57%).

The generations about to enter the workforce are bringing a powerful, innovative and inventive “maker” ethos with them. They will also require more systems-level thinking and convergence of disciplines. These are the skills that will foster innovation. All of these attributes echo the growth seen in design skills and collaboration skills, as seen in Figure 4.

The work ahead will require manufacturers to apply digital to making manufacturing more meaningful. To stay relevant in the digital economy, manufacturers will need to double down on activities where they currently have an advantage over silicon - and will continue to do so. In the words of Professor Leslie Willcocks of the London School of Economics, “It’s time to take the robot out of the human.”

How Digital Will Change Attitudes About Work

Manufacturing respondents think digital will result in more meaningful contributions, as well as more opportunities for advancement. Everything from better communication with colleagues to job commitment, engagement and satisfaction was also cited by a majority of respondents.

![Pie chart showing the responses to how digital will change attitudes about work](image)

- Ability to contribute more meaningfully: 73%
- Opportunity for advancement: 61%
- Communication with colleagues: 57%
- Job commitment and engagement: 55%
- Work satisfaction: 50%
- Job recognition: 48%
- Personal interactions and relationships: 46%
- Urge to get ahead: 46%
- Empathy and support among colleagues: 37%

Response base: 500 senior manufacturing executives

Source: Cognizant Center for the Future of Work
Our new research points to the onset of a new thinking in manufacturing – one that shuns the abundance of “cost-plus” offerings and heralds the coming of an “experience-centered” strategy. Clearly, the investment landscape is preparing to take more creative risks and opportunities – all made possible by the digital revolution.

Our new research points to the onset of a new thinking in manufacturing – one that shuns the abundance of “cost-plus” offerings and heralds the coming of an “experience-centered” strategy for customers.

So what should the manufacturing industry be focusing on? Some critical factors include:

- **Accelerate change across the organization.** Anticipating the needs of new digitally-driven customers has never been more urgent. The growth of a creative thinking mindset needs to percolate throughout the organizational hierarchy.

- **Design a learning organization.** Your sales teams will be familiar with the motto “always be closing” – but what about “always be learning”? The race to bridge the divide between traditional manufacturing organizational skills and consumer wants and needs requires industry leaders to create a culture of continuous learning to foster innovation in the digital age.

- **Create a lab as a “play-space” to facilitate breakthrough thinking.** What can be learned from other industries? (“What if manufacturing was done by Uber? What if an automaker had invented Pokemon GO?”) Curiosity and questioning will help inspire digital production innovation, collaboration and ongoing experimentation for new approaches and services that can be brought to new markets.

- **Cultivate your ecosystem of partnerships.** As noted above, no manufacturer is an island. Tap into the creativity and capabilities of your partnership ecosystem; successfully exploiting this nexus of participants will be the difference between winning and losing at the digital shift point.

- **Evolve from products to “themes.”** This can’t be one-size-fits-all, though. Leading manufacturers will need to repurpose product development strategies from a single-product focus to theme-oriented offerings that address multiple personas and constituents.

In a world of experience, data coupled to design is crucial, going beyond aesthetics to encompass “digits” in, around and beyond the “widget.” Manufacturers will likely need to harness innovation from other partners and alliances vs. advancing market innovation by relying solely on their own efforts.

It won’t be easy for manufacturers to cultivate broader visions of the possibilities of digital transformation. Yet, it’s essential to ensure relevance at a time when manufacturing is being reshaped by new cultural and economic forces, unleashing a critical digital shift in the future of work.
Methodology

We conducted a worldwide survey between December 15, 2015, and January 28, 2016, with 2,000 executives across industries. 500 executives from the consumer and industrial products industries participated in the survey. The executive survey was run in 18 countries in English, Arabic, French, German, Japanese and Chinese. We used telephone interviews for executives. The study was conducted with research and economic support from Roubini ThoughtLab, an independent thought leadership consultancy.

Footnotes


6 Economists from Roubini ThoughtLab extrapolated our study results across the manufacturing industry - which currently generates roughly $13 trillion - to arrive at the finding that digital will drive nearly 25% of additional revenue growth between now and 2018.


Peggy Hollinger, “Meeting the Cobots: Humans and Robots Together on the Factory Floor,” *Financial Times*, May 5, 2016, [https://www.ft.com/content/6d5d609e-02e2-11e6-af1d-c47326021344](https://www.ft.com/content/6d5d609e-02e2-11e6-af1d-c47326021344).


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