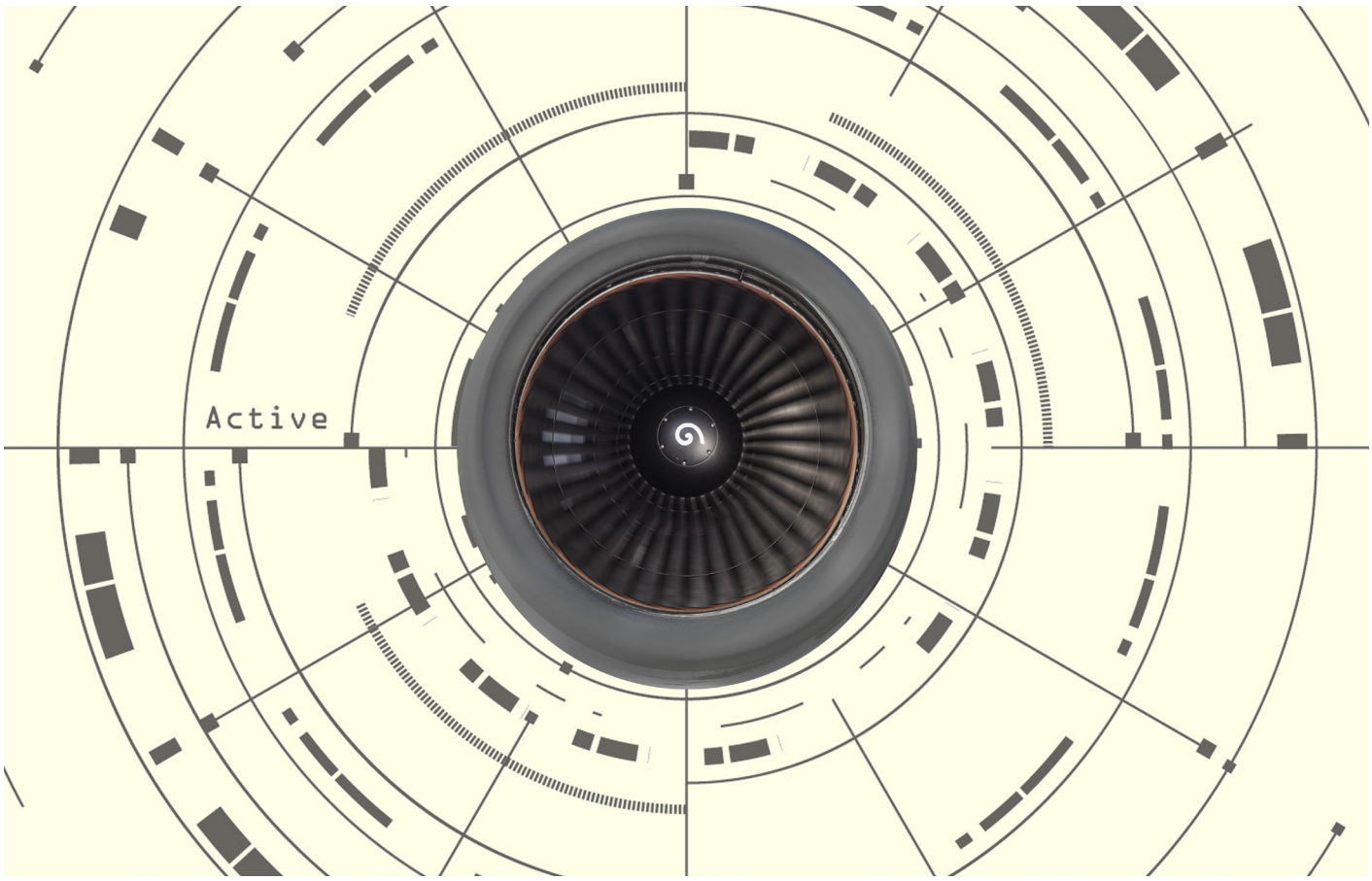
Deloitte.
Insights



FEATURE

Using the network effect

Driving advanced manufacturing in aerospace and defense

Michael Schlotterbeck, Scott Bishop, and Brenna Sniderman

THE DELOITTE CENTER FOR INTEGRATED RESEARCH

Industry leaders cite data-sharing, smart technology investments, and industrywide ecosystems as keys to smart manufacturing.

SMART MANUFACTURING IS on the rise, and for good reason. It can help manufacturers better weather future upheavals and adapt more quickly to changes in demand, the supply chain, and other parts of the value chain. According to Deloitte's 2021 Global Resilience study, today, 66% of leaders surveyed in manufacturing, industrial products, and construction believe that massive change, such as COVID-19, will be an occasional or regular experience from now on, suggesting that organizations need to be prepared for agility and resilience more or less continually in the future.[1]

Much has been explored about what's possible and how organizations can transform their processes and capabilities. But within *aerospace and defense (A&D)*, specifically, what's real? What is happening *now*? What technologies and capabilities are *actually* disruptive today? And perhaps most importantly, do companies have the right strategy in place to capitalize on the disruption?

To better understand these shifts and the specific considerations and opportunities that A&D industry leaders can leverage, Deloitte used industry-specific insights, interviews with industry executives, and primary research data gathered through our experience with smart factories to examine how A&D leaders have successfully implemented smart manufacturing capabilities.

We learned that sharing data across teams and partners can be key to advancing the industry, but it can come with risk. Another possible key to advancing the industry is technology: A&D engineers are seeing success with advanced manufacturing technologies that suggest where the highest-value investments lie. Most important, we learned that to pursue the full potential of data-sharing or technology, A&D leaders can explore industrywide ecosystems to drive transformative change.

The data life cycle provides an opportunity for growth

> "I think we'll begin to see more power available as more of it becomes digitized. As the connectivity in the airplanes improves, you'll be able to … have the capability to integrate into those systems and be thinking about fleet management, maintainability, customer management, revenue management from the initial design phase of those aircrafts."[2]
>
> — A&D industry executive

The data life cycle for A&D spans the full arc from engineering, to manufacturing, to the aftermarket, as well as the components included within—monitoring the design process, the digital supply chain, and health of systems when in use. A&D manufacturers and OEMs have a wealth of data at their virtual fingertips but can struggle with how to use it most effectively.

Data from throughout the manufacturing life cycle presents organizations with a significant opportunity to take information from the digital supply chain, smart factory, connected aircraft systems, and the aftermarket, and feed that data back into the manufacturing process to improve design, fabrication, and performance—a process known as the digital thread.[3] Data democratization, which allows all relevant stakeholders equal, unrestricted access to data, can enable ecosystem partners to use information from throughout the

data life cycle to inform their own processes, thus advancing the industry.

Many leaders agree that willingness to share data across teams and ecosystem partners can be critical to true innovation, transformation, and growth. Deloitte's recent Digital Transformation Executive Survey found that, prior to COVID-19, one half of industrial products and construction (IP&C) leaders surveyed said getting better insight about their business and market from data was a key driver of digital transformation initiatives; 61% of respondents said this priority had increased as a response to the pandemic.[4] Thirty-eight percent of IP&C leaders surveyed are in the process of building more transparency across their supply chains, and 28% plan to do so.[5] Further, 88% of IP&C executives asked agree or strongly agree that access to data-driven insights is making a significantly positive impact on their business.[6]

At the same time, however, organizations that wish to collaborate must find ways to share data safely. While connection can bring greater collaboration, deeper insights, and more intelligent decision-making, it can also create challenges for A&D companies, where intellectual property (IP), cybersecurity, customer privacy, and other concerns are paramount.[7] According to a 2020 MAPI-Deloitte study, 58% of participating manufacturers express concern about privacy, IP, and cyber risks created by smart factory manufacturing ecosystems,[8] while 67% of IP&C leaders surveyed say that cyber will play an important role in their digital transformation over the next 12 to 24 months, significantly higher than leaders in other industries.[9]

A&D leaders note that the question of data—specifically, data ownership—in the A&D industry is a sensitive one, as those who hold ownership over the data also have greater ownership over supply chains and pipelines.[10] Questions regarding who owns the data are further dwarfed by the question of who owns the front-end, user-facing application, which means owning the conduit to all the information.[11] Leaders also note that while shared data could unlock significant value for the end user, privacy and protection from external digital threats are critical concerns—both for customers and the aircraft itself.[12] Data-sharing policies can help with this challenge, including taking a contract-by-contract approach or creating an industry-federated data store for ecosystem members to use.

Which technology offers the most value?

> "If I think about the pure manufacturing side, definitely there's going to be a move towards automation. There has to be. It's happened in automotive. It's starting to happen in aviation."[13]
>
> — A&D industry executive

Smart investments in advanced technology can lead to outsize results: Those who take the leap could realize greater business value. For example, a 2019 MAPI-Deloitte study found a connection between investment in smart factory initiatives and business value, and those who implemented the most use cases saw twice as many gains in labor productivity as those who were still on their way.[14] A&D executives interviewed pointed toward markedly positive outcomes where they made informed investments with a clear view toward reducing costs, improving operations, and better serving customers.

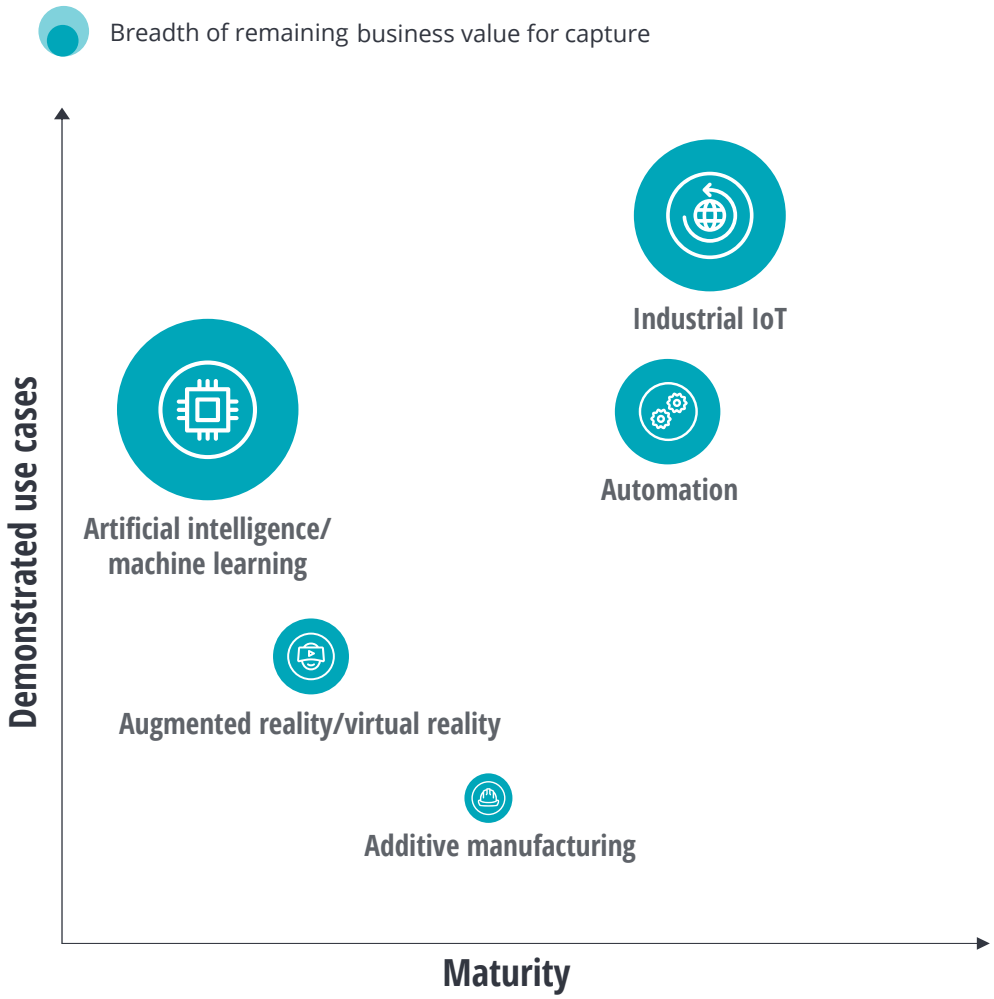
But what tech investments are worthwhile? It can be difficult to sort through what's hype and what has true promise, what's in use today and, beyond that, what's truly ready to deliver, and how broad of an impact these investments can make across the full value chain. Five noteworthy

technologies are seeing adoption across the industry. While each could be worthy of investment, some hold more potential value and promise than others (figure 1).

1. ***Industrial Internet of Things (IIoT):*** IIoT is perhaps the most mature and most widely used advanced technology in the industry across multiple applications and demonstrated use cases. It's the connective glue that binds the network together, generating and communicating flows of data. Sensors and connected devices generate more data to drive insights and actions at the edge than ever before. Predictive maintenance is a common example that illustrates the value of IIoT. It monitors machine performance indicators such as amperage draw, temperature, and speed. It also enables companies to optimize the use of workers, better allocate resources, and inform and predict when a part or equipment failure may occur by comparing real-time data to historical performance.

FIGURE 1

Industrial IOT and AI offer strong potential for future value



Source: Deloitte analysis.

Combining live machine status with RFID-tracked inventory can go one step further and serve as the baseline for dynamic routing algorithms. If production supervisors know when machine capacity is coming available, where critical material is physically located in real time, and what jobs are open, they can optimize machine utilization by proactively staging material where it can best be consumed.

2. ***AI and machine learning (AI/ML):*** While still in their relatively early days in the industry, the use of AI and ML appears to be increasing and they hold significant promise across the full scope of the value chain that could potentially rival IIoT. Massive data loads from connected, advanced manufacturing systems, along with more powerful algorithms, have made AI integral to the manufacturing process. In addition, it's also used in manufacturing processes such as computer vision, generative design, natural language processing, and autonomous decision-making. It's also used to generate insights from production data.

   Beyond the shop floor and further along the data life cycle, AI/ML is used by A&D companies to gather and analyze data about aircraft while in use for predictive maintenance and air traffic control, and to better understand air traffic patterns.[15] A&D executives have also pointed to the power of AI/ML for diagnosing potential problems while aircraft are in-flight, so repairs and turnaround can take place more quickly and efficiently between flights. The potential for use of ML algorithms in digital twins can help to drive greener, more energy efficient aircraft.[16] AI/ML applications also helped some aerospace companies better adapt and respond to COVID-19–driven fluctuations in 2020 and 2021. Given that AI/ML does not involve the manufacture of physical parts, it is also often easier to implement.

3. ***Automation.*** While the breadth of applications of automation across the full value chain is relatively lower, the breadth of potential value of this technology is significant. Within the supply chain, autonomous robots can drive value by lowering labor costs, increasing productivity, and augmenting the performance of human workers.[17] Within A&D, the use of autonomous technologies brings with it industry-specific considerations. Given the relatively smaller scale of production in A&D, the margin for error can be smaller and the business case for investment must be particularly strong. Senior A&D executives addressed the importance of scale: Rather than building hundreds of thousands of units each year, as in the automotive industry, an aerospace company might produce a few dozen aircraft annually. Therefore, using one robot for multiple processes or for multiple programs can spread costs and make a stronger case for investment.[18]

   According to one executive, experimenting with multiple uses for automation and starting with smaller-scale pilots can help make a compelling business case.[19] Executives reported employing dedicated tools, but also using flexible robots that can move between stations to do different jobs and employ multiple dedicated tools when needed.[20] Automation in A&D should maintain a degree of flexibility and portability in order to be successful in the job shop, based on operations that are frequent in the industry.

4. ***Augmented and virtual reality (AR/VR):*** The value of AR/VR is well-established; however, its scope of application may not be as broad as other technologies and is focused on

specific, discrete needs. It's been used extensively in training and maintenance tasks, as well as design. In this way, data from throughout the value chain can be consolidated to better visualize and understand the physical components of the aircraft, making it useful in the early stages of design and manufacturing.

Manufacturers are also using AR/VR to drive action with 3D models. Sales executives simulate aircraft designs for customers. Manufacturing engineers create 3D work instructions that enable mechanics to work more quickly with higher quality. Design engineers can use models to collaborate with supply chain professionals to ensure manufacturability. Similarly, manufacturers are using AR to project logos and paint jobs onto fuselages, enabling customers to view and make changes to exterior designs while avoiding the costly need to repaint.

5. ***Additive manufacturing (AM):*** AM has long been part of the discussion in the A&D industry for concept modeling, prototyping, tooling, lightweighting, and fabrication of complex or low-volume parts.[21] These developments include the introduction of new metallic alloys, lower material costs, and faster production times.[22] Further, the use of AI and ML can enable OEMs to leverage information from throughout the digital thread for generative design and parts optimization.

   At the same time, however, while AM has long held promise, it represents a point solution with a scope that is largely limited to the shop floor and manufacturing processes, and it can be challenging to implement. The certification process for AM-produced parts can be onerous; as of this writing, AM is not used to produce primary aerostructures, due in large part to the ability to prove fatigue and damage tolerance thresholds and the need for FAA approval.

Scaling capabilities externally means building an industrywide ecosystem

"Some of the technologies have some real capabilities. Some are a long way off. What we're trying to understand is, how do we form a group of partners to go do something that's real, in a realistic timeframe, and make sure that we're out there setting realistic expectations? To enable that future, there's going to have to be some new technologies that come into manufacturing. How do you take those and scale them up so that they are more ready when that future comes?"[23]

— A&D industry executive

Any organization that has piloted a new capability knows that scaling can be difficult to achieve, but taking an ecosystem approach by leveraging collaborative connections throughout the industry can make it easier. It can also help organizations extract greater value from transformation initiatives, and leverage data from across the value chain to drive smarter decisions.

Whether in nature or in business, ecosystems comprise individual components that interact in an integrated, mutually reliant system. Ecosystems enable stakeholders to coordinate, collaborate, and partner to address mutual challenges, meet shared goals, and pursue new innovations, opportunities, and business models.[24] The power of ecosystems is derived from the "network effect," which describes a phenomenon in which the value of something increases or decreases depending on the number of stakeholders that use it.[25] Larger networks can correspond with greater results, as more data, insights, ideas, and resources can be shared and the benefits of advanced technologies can be amplified.

Manufacturing leaders understand how ecosystems maximize value; 85% of manufacturers interviewed believe that production ecosystems are either important or extremely important to maintaining competitiveness. They also appear to understand how critical ecosystems are to their future: Eighty-five percent believe that ecosystems will transform how they deliver value and will lead to greater productivity and revenue.[26]

Manufacturers appear to be noticing faster time to market and new channels and markets for their products through these production ecosystems. Research has shown that among the companies surveyed, those that worked with external partners to build capabilities saw results more quickly.[27] Further, 86% of IP&C leaders in Deloitte's Digital Transformation study agree or strongly agree that engagement with external partners *is* already making a significant positive impact on their business.[28]

At the same time, however, some A&D leaders interviewed suggest that the ecosystem ideal isn't quite coming to fruition, noting that the industry has not done enough to help accelerate digitization collectively as a whole.[29] Others point to challenges around data ownership, IP, regulatory concerns, and customer privacy as hurdles that are simply too high to enable a full, democratized ecosystem.

Industry collaboration to enable collective transformation, however, is not impossible. Leaders pointed repeatedly to the relatively small number of players in the A&D industry, noting that relatively fewer stakeholders could make it easier to bring enough organizations to the table to gain critical mass. Furthermore, it may be the key to true transformational change: the use of cohesive industry standards and ecosystemwide collaboration to drive success, greater adoption, and improved outcomes. The industry can work together and leverage the power of the network effect to drive these cohesive industry standards for the benefit of all, enabling the A&D industry to recognize true transformation in smart manufacturing.

Manufacturing leaders know that digital transformation—the enabler of smart manufacturing—is critically important to the industry. Seventy-nine percent of IP&C leaders in Deloitte's Digital Transformation study agree or strongly agree that within five years, all successful companies in the industry will have extensive digital capabilities compared with 67% of leaders in other industries.[30] Getting there, however, requires an understanding of the technologies and capabilities that are possible now, how to leverage them to maximize value, and, perhaps most important, the ability to harness data and insights from across the entire ecosystem to create a whole that is greater than the sum of its parts—and propel transformation across the industry.

> **"We don't transform for digital transformation's sake. Everything we've done has been in service to solving the big problems."[31]**
>
> — *Sheryl Bunton, SVP business technology and chief information officer at Gulfstream Aerospace*

MAKING TRANSFORMATIONS STICK: KEEPING THE HUMAN AND THE BUSINESS NEED FRONT AND CENTER

A capability is only successful if it's adopted. Once a new tool or process is implemented, organizations must make it stick. But how do they do so? Leaders suggest that it's not about the technology, but about the challenge it addresses and how easily stakeholders can use it and see its value.

Design with the human in mind. Whomever the end user is—whether an individual on the shop floor, a supplier, a customer, a regulator, or another stakeholder—they will be far likelier to adopt and use a new tool if they can see its benefit to their own needs. Beyond that, it should also be easy to use. Executives pointed to the form factor as critical to transformative change happening in smart manufacturing.[32] Include end users in functional requirement building and design stages of the process so that they become invested in the transformation from the beginning.

Be willing to change. Put simply, if a process isn't working, re-work it. Apply an agile mindset not only to the way work is done, but the workforce as well. This is an area where manufacturing organizations have their work cut out for them: Fifty-four percent of IP&C leaders interviewed said that hiring for flexibility and adaptability was the most critical workforce trait, followed by a general technological savvy at 39%.[33] At the same time, however, 48% of IP&C leaders interviewed did not think they excelled at embedding advanced technologies in core business processes to become more agile.[34]

Don't start with technology. Start with the business need and invest in the technology that will accomplish that need. Leaders we interviewed noted that digital transformation for its own sake doesn't work. It can also help not to refer to it as such; stakeholders may care less about "digital transformation" than they do about whether it *works*. Framing the conversation around the problem that needs solving or the goal to be achieved (for example, reducing cost or grappling with an upcoming surge in retirements) rather than taking a technology-first approach can help stakeholders not only understand the need, but also the overarching goal.[35]

Remember tech is not a panacea. Digital transformation should not be limited to just the technology; it should include the human and operational sides as well. Leaders emphasized that technology will not solve a problem on its own. Stakeholders must use it; it must be focused on solving a problem or improving a process, and perhaps most important, other nontech-related changes often need to happen elsewhere in the organization for true transformation to follow.

Take a bottom-up and top-down approach. To make change stick, it should be driven from both sides of the organization. Executives should set expectations that change will occur while championing the benefits of the change. At the same time, change agents from staff and working team levels can provide voice-of-the-customer feedback into the process while encouraging their peers to step out of their comfort zone in the short term in exchange for long-term benefits.

Endnotes

1. Punit Renjen, *Building the resilient organization: 2021 Deloitte Global Resilience Report*, Deloitte Insights, 2021.
2. Industry executive interview, May 6, 2021.
3. Ibid. May 11, 2021; Mark J. Cotteleer, Stuart Trouton, and Ed Dobner, *3D opportunity and the digital thread: Additive manufacturing ties it all together*, Deloitte Insights, March 6, 2016.
4. 2021 Digital Transformation survey data.
5. Renjen, *Building the resilient organization*.
6. 2021 Digital Transformation survey data.
7. Paul Wellener et al., *2019 Deloitte and MAPI smart factory study: Capturing value through the digital journey*, Deloitte Insights and MAPI, September 2019.
8. Paul Wellener et al., *Accelerating smart manufacturing: The value of an ecosystem approach*, Deloitte Insights, October 21, 2020.
9. 2021 Digital Transformation survey data.
10. Industry executive interview, May 11, 2021.
11. Ibid.
12. Ibid., May 6, 2021.
13. Ibid., May 11, 2021.
14. Wellener et al., *2019 Deloitte and MAPI smart factory study*.
15. Kelsey Reichmann, "How is the aviation industry enabling innovation with artificial intelligence?," Aviation Today, December 14, 2020.
16. Industry executive interview, May 11, 2021.
17. Patrick Gallagher et al., *Supply unchained—Tech Trends 2021*, accessed July 21, 2021.
18. Industry executive interview, May 6, 2021.
19. Ibid.
20. Ibid.
21. Cotteleer, Trouton, and Dobner, *3D opportunity and the digital thread*.
22. Aerospace Manufacturing, "Machine learning making light work of AM aerospace alloys," January 19, 2021.
23. Industry executive interview, May 6, 2021.
24. Wellener et al., *Accelerating smart manufacturing*.
25. Tim Stobierski, "What are network effects?," Harvard Business School, November 12, 2020.
26. Deloitte, "Smart manufacturing ecosystems: A catalyst for digital transformation?," press release, October 21, 2020.

27. Wellener et al., *Accelerating smart manufacturing*.
28. 2021 Digital Transformation survey data.
29. Industry executive interview, May 11, 2021.
30. 2021 Digital Transformation survey data.
31. Industry executive interview, May 21, 2021.
32. Ibid.
33. Renjen, *Building the resilient organization*.
34. Ibid.
35. Industry executive interview, May 21, 2021.

Acknowledgments

The authors would like to thank **Andy Bayiates** of Deloitte Services LP for his contributions to this article.

About the authors

Michael Schlotterbeck | mschlotterbeck@deloitte.com

Michael Schlotterbeck is a senior manager in Deloitte Consulting's Manufacturing Strategy & Smart Operations practice and has 15 years of experience serving industrial products companies. He leads large-scale, shop floor–based digital transformations that combine both functional and technical competencies to improve throughput and reduce costs. He holds a BS in chemistry business from Wichita State University and an MBA from Columbia Business School.

Scott Bishop | scott.bishop@spiritaero.com

Scott Bishop is chief of staff to the CEO at Spirit AeroSystems, the world's largest supplier of aircraft structures. Before his current role, Bishop led Spirit's Process Verification, Advanced Research, and Portfolio Strategy and Collaborative Research teams, where he led the development and implementation of Spirit's technology strategy and road maps. Bishop holds a bachelor's degree in systems engineering from the United States Naval Academy, a master's degree in electrical engineering from the Naval Postgraduate School, and is currently part of MIT's Executive MBA program.

Brenna Sniderman | bsniderman@deloitte.com

Brenna Sniderman leads the Deloitte Center for Integrated Research. In this role, she drives cross-industry, cross-functional thought leadership, including climate change, trust, digital transformation, and the Future of Work. Her own research focuses on the intersection of digital and physical technologies and the ways in which they transform the supply network, operations, business strategy, and the broader organization and its ecosystem. She works with other thought leaders to deliver insights into the strategic, organizational, and human implications of these technological changes.

Contact us

Our insights can help you take advantage of change. If you're looking for fresh ideas to address your challenges, we should talk.

Industry leadership

Louis Librandi
Principal | Supply Chain & Manufacturing Operations | Deloitte Consulting LLP
+1 215 446 4367 | llibrandi@deloitte.com

Louis Librandi is a principal in Deloitte Consulting LLP focused on the manufacturing sector and a leader in the firm's Supply Chain and Network Operations practice.

Michael Schlotterbeck
Senior manager | Deloitte Consulting LLP
+1 412 338 7546 | mschlotterbeck@deloitte.com

Michael Schlotterbeck is a senior manager in Deloitte Consulting LLP's Manufacturing Strategy and Smart Operations practice.

The Deloitte Center for Integrated Research

Brenna Sniderman
Managing director | Deloitte Center for Integrated Research
+1 215 789 2715 | bsniderman@deloitte.com

Brenna Sniderman leads the Deloitte Center for Integrated Research.

About the Deloitte Center for Integrated Research

The Deloitte Center for Integrated Research focuses on developing fresh perspectives on critical business issues that cut across industries and functions, from the rapid change of emerging technologies to the consistent factor of human behavior. We look at transformative topics in new ways, delivering new thinking in a variety of formats, such as research articles, short videos, in-person workshops, and online courses.

Connect

To learn more about the vision of the Deloitte Center for Integrated Research, its solutions, thought leadership, and events, please visit www.deloitte.com/us/cir.

Deloitte's Supply Chain & Manufacturing Operations practice helps global manufacturers translate their business strategy into practical operational plans through an effective manufacturing strategy. We help companies implement their strategy by finding ways to improve operational performance across complex value chains. This includes assessing manufacturing capacity, core versus noncore products, where products are made, core capabilities versus those that can be outsourced, where manufacturing plants are located and their supporting supply base, and even advanced manufacturing technologies.

Sign up for Deloitte Insights updates at www.deloitte.com/insights.

Follow @DeloitteInsight

Deloitte Insights contributors

Editorial: Andy Bayiates, Rupesh Bhat, and Emma Downey

Creative: Adamya Manshiva and Sanaa Saifi

Audience development: Nikita Garia

Cover artwork: Adamya Manshiva

About Deloitte Insights

Deloitte Insights publishes original articles, reports and periodicals that provide insights for businesses, the public sector and NGOs. Our goal is to draw upon research and experience from throughout our professional services organization, and that of coauthors in academia and business, to advance the conversation on a broad spectrum of topics of interest to executives and government leaders.

Deloitte Insights is an imprint of Deloitte Development LLC.

About this publication

This publication contains general information only, and none of Deloitte Touche Tohmatsu Limited, its member firms, or its and their affiliates are, by means of this publication, rendering accounting, business, financial, investment, legal, tax, or other professional advice or services. This publication is not a substitute for such professional advice or services, nor should it be used as a basis for any decision or action that may affect your finances or your business. Before making any decision or taking any action that may affect your finances or your business, you should consult a qualified professional adviser.

None of Deloitte Touche Tohmatsu Limited, its member firms, or its and their respective affiliates shall be responsible for any loss whatsoever sustained by any person who relies on this publication.

About Deloitte

Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited, a UK private company limited by guarantee ("DTTL"), its network of member firms, and their related entities. DTTL and each of its member firms are legally separate and independent entities. DTTL (also referred to as "Deloitte Global") does not provide services to clients. In the United States, Deloitte refers to one or more of the US member firms of DTTL, their related entities that operate using the "Deloitte" name in the United States and their respective affiliates. Certain services may not be available to attest clients under the rules and regulations of public accounting. Please see www.deloitte.com/about to learn more about our global network of member firms.

Copyright © 2021 Deloitte Development LLC. All rights reserved.
Member of Deloitte Touche Tohmatsu Limited