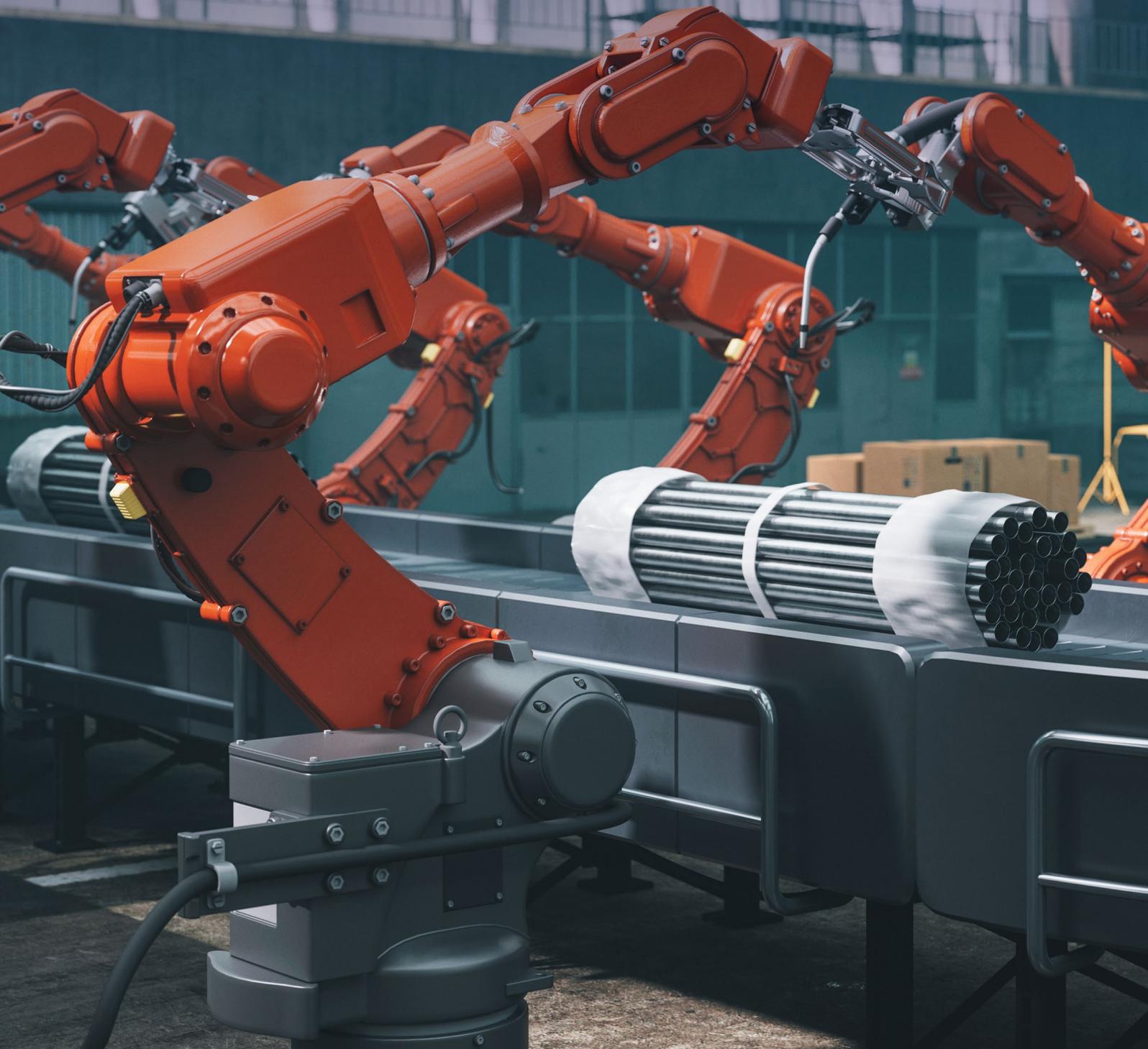


US
Center for
Advanced
Manufacturing

WORLD
ECONOMIC
FORUM

Unleashing Business Model Innovation in US Manufacturing

WHITE PAPER
NOVEMBER 2023



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Foreword



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Recent global developments, including the rapid evolution of artificial intelligence (AI), looming debt crises and resource scarcity concerns, are fundamentally reshaping and disrupting the business landscape. Given its position as one of the world's most significant economies, the United States is particularly vulnerable to major disruptions stemming from these developments. The US manufacturing sector, in particular, contributes a substantial 12% to the United States' GDP and \$2.91 trillion to the value-added output of the economy,¹ signifying that it can play a pivotal role in the current context.

Advancing innovation in the manufacturing sector is the linchpin of economic prosperity and global competitiveness in the US, as it is the world's largest spender on research and development (R&D), accounting for about 28% of global spending.² Over the years, substantial resources, from both the public and private sectors, have been dedicated to R&D that aims to push the boundaries for new patents and products. However, this journey has been fraught with challenges over the past decades. Now, more than ever, to remain competitive and address societal needs effectively in a rapidly changing global environment, US manufacturing must reconsider its approach to business model innovation.

As a result of this recognized opportunity, the US Center for Advanced Manufacturing (US Center) was launched in October 2022 in collaboration with the World Economic Forum as part of the Centre for the Fourth Industrial Revolution Network, a global

platform dedicated to helping leaders anticipate emerging technologies and accelerate their inclusive and sustainable integration. The establishment of the US Center marks a pivotal effort to advance innovation within the manufacturing sector. Its mission is to drive state, regional and national initiatives aimed at expediting and fortifying manufacturing in the US, while drawing on and contributing to the global agenda.

The US Center, in collaboration with its executive committee, has focused on three priority areas that are key to fostering a positive future within the US manufacturing community: workforce development, technology adoption and business model innovation.

This white paper is a product of the ongoing partnership between the World Economic Forum's Centre for Advanced Manufacturing and Supply Chains and the US Center. It aims to increase an understanding of innovation dynamics and drive industry transformation through the creation of new business models. The white paper underscores the critical need to identify innovative strategies specific to the US, enabling manufacturers to uncover and act upon their latent potential for innovation through new business models.

We trust this work will help manufacturing stakeholders evaluate their current capabilities and identify essential enablers to overcome challenges, embrace change and unlock new value through digital transformation.

Executive summary

This white paper introduces a new playbook for business model innovation in US manufacturing.

Industry headwinds – from material and component shortages to geopolitical tensions – have intensified over the past years and put further strain on supply chains already shaken by COVID-19. To remain competitive in this new environment and respond to the challenges posed by consumers and society at large, leading manufacturers are moving beyond productivity and efficiency improvements. They are making investments in innovation and technologies such as digital twins, robotics, connected workforce platforms and control towers to reinvent business models for greater economic, societal and environmental outcomes. However, several roadblocks lie in the way of uncovering their full opportunity.

Recognizing that manufacturing is the main engine of innovation in the US, responsible for 55% of all patents and 70% of all research and development spending,³ the US Center for Advanced Manufacturing has consulted with operations and technology executives, academics and policy leaders across the country. The aim was to shed light on these challenges and identify the best approaches to guide the industry as a whole on its business model innovation journey. The consultations revealed the eight most frequent barriers that arise when manufacturing firms adopt new models in their organizations:

- Lack of strategic planning
- Approach to scaling proven value
- Outdated infrastructure
- Resistance to change
- Organizational siloes
- Talent shortage
- Fragmented data systems
- Insufficient cross-sectoral collaboration

Building on the World Economic Forum's global approach and white paper *Unlocking Business Model Innovation through Advanced Manufacturing*, published in January 2022,⁴ and the conducted consultations, the US Center is set to introduce a new playbook designed to facilitate the adoption

of innovative business models in manufacturing, tailored to the US context. *The Playbook for Business Model Innovation in US Manufacturing* can be the starting point to a transformative journey for manufacturers, offering comprehensive solutions, real-world use cases and guiding questions to inform leaders on where to begin.

Designed to be accessible across various industries, the US Center's playbook caters to businesses, factory operations and principal executives, including chief executive officers, chief operating officers and plant managers. At its heart are seven strategies pivotal to business model innovation:

1. Understanding current business models to identify growth levers
2. Selecting technologies that fit future ambitions
3. Experimenting through proof of concepts to evaluate new business models
4. Scaling technologies to unlock new value through new business models
5. Addressing the industry challenge of talent and skill shortages
6. Building the right culture for change
7. Establishing strategic partnerships across the sector

This paper looks in more detail at the four strategies identified by the US Center community as the top priority areas to understand their implications and outlook: "Understanding current business models to identify growth levers", "Addressing the industry challenge of talent and skill shortages", "Building the right culture for change" and "Establishing strategic partnerships across the sector".

Moving forward, the US Center for Advanced Manufacturing, in collaboration with the World Economic Forum, will continue to work closely with regional and global manufacturing communities to support innovative thinking and the development of new business models to embrace change and foster economic and societal growth within the US manufacturing sector.

1

The innovation opportunity for US manufacturing

New technology trends present an opportunity for manufacturers to drive innovation and reinvent business models for economic and societal returns.

The manufacturing industry in the United States yields the most significant multiplier effect among all major sectors. Each dollar invested in manufacturing results in another \$1.81 being contributed to the economy. Moreover, for every individual employed in manufacturing, four more workers are hired in other sectors. Advancing innovation in the manufacturing sector is the linchpin of economic prosperity and global competitiveness in the US.⁵ This innovation encompasses the integration of cutting-edge technologies and material paired with the creation and application of new ideas and methodologies, resulting in the production of high-quality goods with greater precision and sustainability.

In a rapidly changing environment with evolving customer preferences and societal needs, adapting to trends and anticipating these changes is essential for the manufacturing sector. Without advances in how products are made and services delivered, there might be major impacts on both manufacturing itself and society. For instance, a severe global shortage of chips (semiconductors) threatens to disrupt the manufacturing of life-saving medical devices and systems, as demand for these chips is likely to double between 2021 and 2028.⁶ The current market is also proof that rapid innovation needs to be a priority. Consumer expectations are ever-evolving, the demand for

customization is constantly rising, sustainability is at the forefront of people's minds, and the competitive landscape is fierce; it will only become more difficult for companies to adapt if they do not take swift action.

Manufacturing leaders are faced with the choice of either innovating or deferring change: the decision to innovate now is a strategic move and a proactive response to the rapid pace of technological advance in society. Innovating in the manufacturing sector helps businesses to not only navigate and respond effectively to the ever-evolving landscape of trends, priorities and challenges but also to thrive in the transformative landscape ahead and ensure their continued relevance and competitiveness.

“ **Evolutionary change, not revolutionary change**
Industry leader

Fostering innovation relies on how well technologies are integrated into businesses: 92% of chief executive officers report that technology is a key element of competitiveness.⁷ This underlines the importance of understanding emerging technology trends, developing plans for effective implementation and merging the integration of new processes with legacy systems.

Harnessing emerging trends and technologies creates opportunities for economic and societal growth otherwise missing from many legacy manufacturing models. Through consultations with the US Center for Advanced Manufacturing's community of

manufacturing and supply-chain executives, as well as technology experts and academics, six major manufacturing-relevant technology trends that have the potential to transform, reinvent or generate new business models have been identified:

Factory digital twin for simulation-based decision-making:

A digital twin is a virtual replica of a physical object or system, created using real-time data from sensors and other sources. Digital twin technology enables businesses to simulate and optimize the behaviour of physical systems in a virtual environment, allowing them to identify and resolve potential problems before they occur. Digital twins are used to simulate manufacturing processes and optimize production efficiency, reduce waste and minimize downtime.



Mars, a global leader in food, pet-care and confectionery products, partnered with Accenture to test a digital twin that fed sensor data into a predictive analytics model. This solution enabled operators to monitor and adjust the process for filling packages in real time, resulting in a 50% reduction in waste. Mars is now using digital twin technology globally to develop an insights-driven "factory of the future".⁸

Intelligent asset management for improved asset health:

Intelligent asset management (IAM) uses a combination of internet of things (IoT) sensors, data and analytics to unlock trapped value from assets. Data is the bedrock of key enterprise initiatives, but successful adoption of IAM requires focus on the right data elements linked to prioritized use cases. Research shows that challenges in asset management underpin shortfalls in achieving growth targets in asset-intensive industries.



Augury, an artificial intelligence and software company, has developed technology that diagnoses malfunctions in machinery through vibrational analysis, industrial IoT, infra-red and more. The company has helped various organizations improve their manufacturing efficiency, such as Frito-Lay, which added 4,000 hours a year of manufacturing capacity.¹⁰

Connected workforce platform for workforce enablement:

A connected worker platform solution represents a transformative approach that integrates hardware, software tools and data to reshape how front-line operators perform their tasks. Through the amalgamation of wearables or mobile devices and software, these connected solutions help workers across diverse industries to improve their current productivity and safety by granting them access to crucial data in support of their work objectives.



By employing hands-free gadgets and cutting-edge technologies such as augmented reality, Honeywell Forge integrates intelligent wearables that blend a heads-up display and voice command alongside advanced workflow software and comprehensive assimilation of plant and process data. Collaborating with Wood, Honeywell aims to equip the energy sector's front-line workforce with immediate access to vital knowledge and information, thereby streamlining operations, guaranteeing uptime and fostering business continuity.⁹

Autonomous robotic systems to augment workforce capabilities:

Autonomous robotic systems (ARS) technology includes autonomous and remotely controlled robots and drones, associated equipment, software control and application software. ARS are used to gather, process, interpret and share data in a cost-effective, safe, quickly deployed, unobtrusive, low-footprint way across air, water and ground domains. Using data to get to autonomous operations requires an in-depth transformation supported by a tightly governed evolution of the operating model, from culture to architecture.



Since 2001, Japanese robotics company FANUC has operated a lights-out factory that uses automation and robotics to produce up to 50 robots per day. Robots perform all tasks, from welding and painting to assembly and packaging. A sophisticated computer system monitors and controls the robots, collects data on production output and quality, and uses it to improve the manufacturing process.¹¹

Blockchain and cryptographic anchors for supply-chain traceability: Blockchain is used for managing and recording data in a manner that permits numerous organizations and individuals to securely share real-time access to identical data, thereby addressing concerns related to security, privacy and control. Cryptographic anchors, in the form of immutable “digital fingerprints”, can be integrated into products or their components, enabling tangible goods to possess a traceable digital identity stored on a blockchain.¹²



TradeLens is a blockchain-enabled shipping solution that offers more efficient and secure global trade. It brings together various parties to support information-sharing and transparency, and ignite innovation throughout the industry. A 12-month trial found that TradeLens can identify and prevent delays due to documentation errors, information delays and other issues. In one example, TradeLens reduced the transit time of a shipment to a production line in the US by 40%, saving thousands of dollars.¹³

Plant control tower to break down the “silo-ed” view of a manufacturing plant:

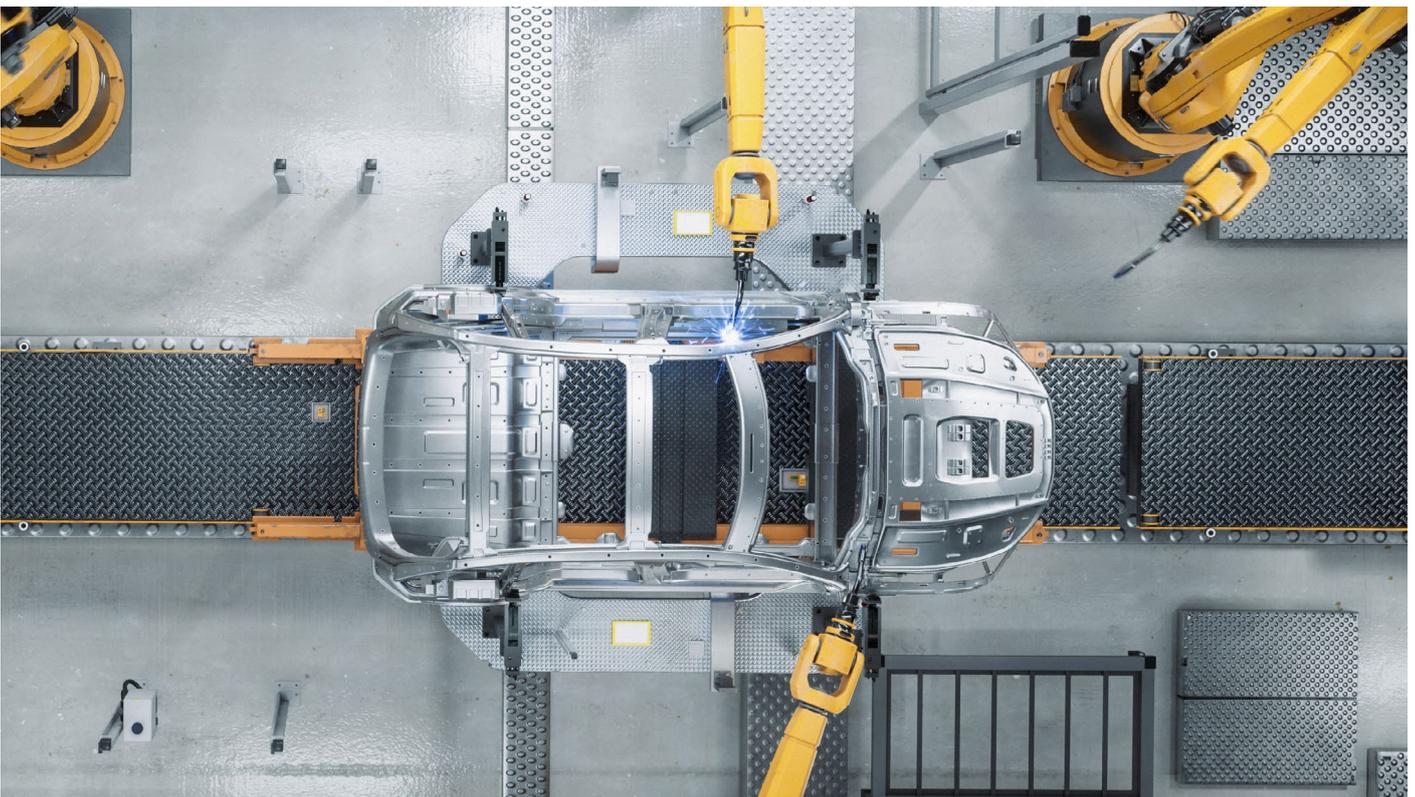
Plant control tower is an integrated plant performance management solution for monitoring, analysing and optimizing plant performance. Using the contextualized view enabled by a digital twin, it allows companies to break data silos, get real-time, end-to-end visibility of their process performance and equip production supervisors with the tools to drive problem resolution and operational improvements. Using a plant control tower, it becomes possible to rapidly identify issues in production, analyse root causes and collaborate with colleagues to resolve them, creating a virtual representation of the manufacturing or production process.



By establishing a control tower allowing visibility across the breadth and depth of its supply chain, Johnson & Johnson maintained an optimal flow of products to its customers and patients, while minimizing costs. The company proactively managed risk and opportunities by continuously sensing and reacting to events in the supply chain, building a strong digital capability to deliver real value.¹⁴

Collectively, these emerging trends and technologies offer a newfound wealth of readily accessible information that can strengthen manufacturers’ capabilities and empower them to establish new revenue models through, for instance, circular practices involving take-back and recycling, comprehensive supply-chain visibility and remanufacturing and repair initiatives.

Although the opportunity is ripe, leaders should first gain a deep understanding of their distinct internal innovation needs, the impact of these technologies on their existing processes and potential associated hurdles to make the right investments. Change is inevitable, but most important is how companies approach integrating such change into their business to generate new forms of revenue and create attractive outcomes for everyone.



2

Common barriers to creating new business models

Despite emerging technology trends and opportunities, barriers remain that hinder business model innovation in manufacturing.

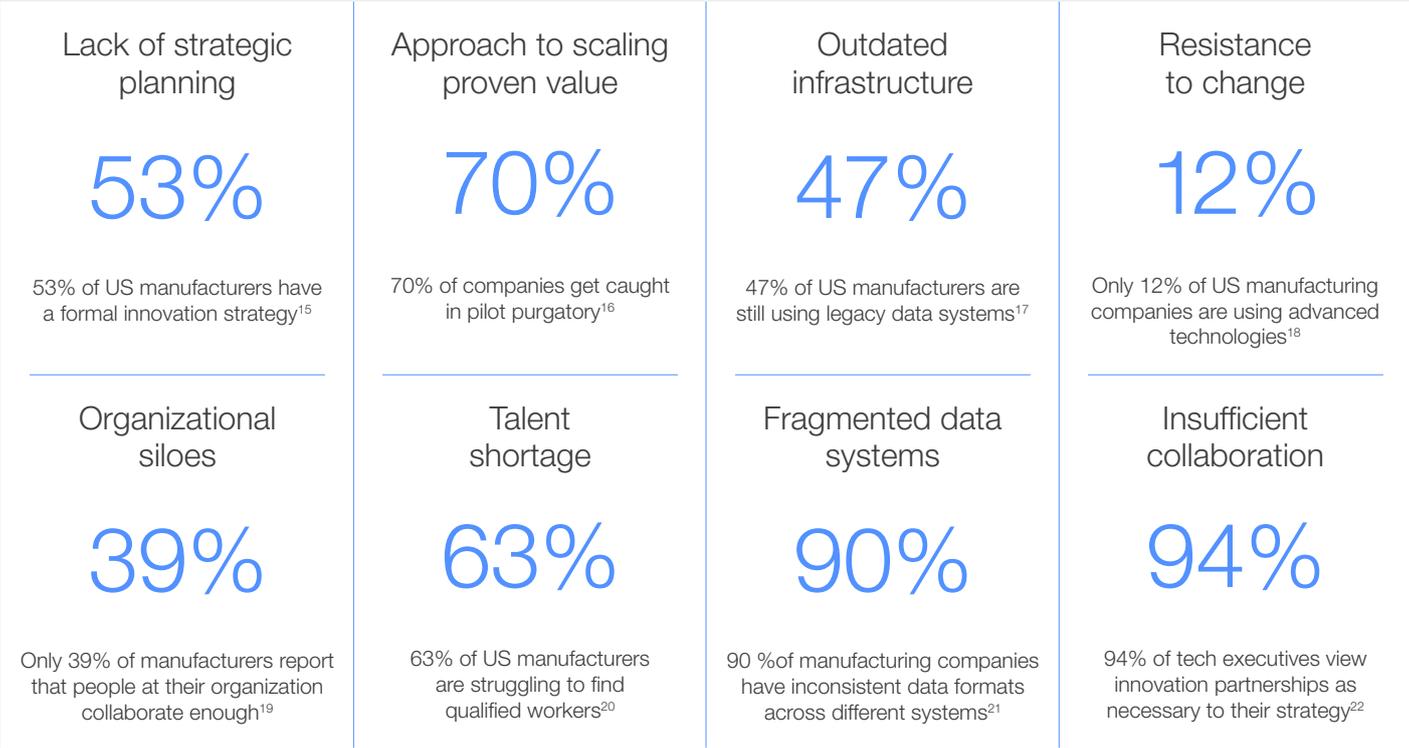
Many organizations have struggled to capture the full potential of innovations to unlock the next wave of value, despite the technological progress made in manufacturing and supply chains, specifically the technology trends identified in section 1. Understanding the barriers to creating new business models can open a new path to thinking through and deriving the right solutions to overcome them and implement new models that have a positive impact for companies, society and the environment.

Consultations with the more than 20 senior operations and strategy executives, technology

experts and academics led to the identification of eight key barriers that companies face when incorporating technology and innovation within their businesses (Figure 1).

These eight identified barriers serve as a valuable starting point for leaders to assess and pinpoint the specific challenges that resonate within their organizations. Keeping up to date and being educated about them equips leaders with the necessary insights to effectively employ the strategies outlined in the next section in order to surmount hurdles and drive innovation.

FIGURE 1 Barriers to business model innovation in manufacturing: where the US stands



Source: US Center for Advanced Manufacturing consultations



“ Strategic investments in research, technology and process optimization can lead to sustainable growth, increased efficiency and adaptability in a changing market.

Lack of strategic planning

Manufacturing organizations often prioritize short-term goals and immediate returns on investments. While these are necessary for daily operations and financial stability, they can sometimes overshadow the long-term benefits of strategic investments and innovative growth.

Balancing short-term objectives with a forward-thinking approach is crucial. Strategic investments in research, technology and process optimization can lead to sustainable growth, increased efficiency and adaptability in a changing market. A long-term perspective also helps organizations anticipate disruptions and market shifts, ensuring that they can thrive in a competitive landscape marked by rapid change.

Approach to scaling proven value

Introducing new technologies into manufacturing is a journey marked by a fair share of uncertainties. Initial success may be found during the pilot phase; however, when scaling up starts, additional challenges tend to emerge unexpectedly. Going from a controlled testing environment to full-scale adoption brings forth variables and intricacies that were not apparent in the beginning. These can range from infrastructure issues and integration hurdles to workforce readiness and operational complexities. To navigate this terrain effectively, a comprehensive and adaptable approach to technology implementation is essential. In this way, leaders can overcome these unknowns and ensure a smooth and successful transition to widespread deployment.

Outdated infrastructure

The inherent disparity between well-established infrastructure – or the long-standing and deeply ingrained systems, processes and technologies that have been a part of traditional manufacturing operations for a significant period of time and which serve as the foundation of conventional business models – and the need to seamlessly integrate advanced solutions from the Fourth Industrial Revolution poses a challenge. This disconnect presents significant obstacles for businesses striving to remain competitive and adaptable. To effectively address this challenge, a strategic reassessment of existing structures is imperative, accompanied by a willingness to embrace innovative methodologies. Bridging the gap between legacy frameworks and the transformative potential of contemporary solutions becomes a pivotal task in this rapidly evolving landscape.

Resistance to change

A key challenge faced by manufacturing leaders is the organization's reluctance to fully embrace digital transformation, which can impede the implementation of new business models that use emerging technologies. Organizations can face a disconnect between teams and leadership regarding expectations for change, which can result in change fatigue and elevated workplace stress levels. Establishing a culture of continuous improvement, where employees actively engage in pinpointing areas for enhancement, proposing innovative solutions and consistently reviewing and refining processes, demands significant effort.

Organizational siloes

A lack of cross-functional collaboration within an organization can lead to departmental divisions, communication breakdowns, inefficiencies, customers dissatisfaction and more. To mitigate these issues, a collaborative effort is needed among employees and teams from different segments of the same organization, facilitating interactions that bridge departmental boundaries.

The overarching aim of cross-functional collaboration is to enhance internal processes, communication and alignment. By breaking down organizational siloes, this approach strives to boost operational efficiency, elevate product quality and improve overall performance within the organization, ultimately contributing to success in the marketplace.

Talent shortage

The ageing demographic of the experienced manufacturing workforce and the simultaneous struggle to attract new talent is another issue. Compounding this challenge is the requirement for swift integration of new technologies, highlighting the pressing need for a well-structured learning strategy to enhance the skills of the existing workforce. Embracing these transformations necessitates an unwavering commitment to continuous skill enhancement, ensuring that employees remain proficient in harnessing cutting-edge technologies and preserving competitiveness in the ever-evolving industrial landscape.

Fragmented data systems

Inconsistent data formats and isolated information systems within organizations can disrupt the smooth flow of information along the manufacturing value chain. This fragmentation of data presents a significant obstacle for leaders striving to make data-driven decisions and respond promptly to market trends and opportunities.

To overcome this hurdle, organizations can prioritize data integration and standardization, encouraging collaboration between departments and systems. By doing so, they can establish a robust data infrastructure that empowers leaders with the insights needed to optimize processes and enhance competitiveness.

Insufficient cross-sectoral collaboration

Creating solutions within isolated siloes can impede progress towards achieving financial and sustainability goals within an organization. Overcoming these hurdles necessitates a shift towards collaboration and the forging of alliances to streamline efforts to reach shared objectives. Strategic partnerships become imperative, as they enable organizations across the manufacturing industry to pool resources, draw on expertise and foster creative thinking. Such collaborations are instrumental in navigating complex challenges more efficiently and accelerating the achievement of financial and sustainability targets. They serve as catalysts, propelling businesses towards heightened success and impact, not only in terms of financial outcomes but also in fulfilling environmental responsibilities.



Introduction to a playbook for business model innovation in US manufacturing

The new US Center playbook draws on industry best practices to present a common approach to capitalize on novel technologies and business model innovation.

Over the course of a nine-month study, the US Center for Advanced Manufacturing conducted extensive research on business model innovation in manufacturing. Gathering insights from manufacturing leaders across multiple industries, a playbook for business models in innovation in US manufacturing was constructed with an inside-out approach, beginning with internal factors before considering external ones. It was put together using the perspectives, successes and lessons learned by industry leaders driving innovation.

Holding executive roundtable discussions with manufacturing executives, the US Center dug into the emerging technologies that are influencing business model innovation, alongside the challenges plaguing the industry. Open and honest dialogue broke down barriers, allowing for conversation on industry taboos that need to be addressed if manufacturing leaders are to truly innovate. Leaning into these areas, manufacturing leaders can look to reposition their perspectives, apply appropriate organizational shifts and re-establish their foothold to generate new business value.

Alongside roundtable discussions, the US Center conducted a series of interviews with manufacturing leaders on technology, barriers to innovation, scaling success and adopting an organizational innovation culture. These one-on-one conversations provided key insights and an insider's perspective on the challenges, employee view and organizational journey to implementing new technologies and adapting to change.

In addition to using shop-floor experience, more than 50 emerging manufacturing trends and

technologies driving innovation were explored, reviewed and assessed. Combining this research with analysis from industry experts and leaders, the paper's authors identified select technologies with significant growth potential to spark business model innovation.

The latest technology trends and barriers to business model innovation derived from interviews with the US Center community emphasized the need to create a common language and understanding as well as to equip the manufacturing ecosystem with a structured resource to navigate these intricacies. Building on the Forum's global approach and white paper on *Unlocking Business Model Innovation through Advanced Manufacturing*, published in January 2022,²³ as well as on consultations, the US Center is set to introduce its new *Playbook for Business Model Innovation in US Manufacturing*. This is designed to facilitate the adoption of innovative business models in manufacturing, tailored to the US context.

The playbook offers a comprehensive guide for manufacturers to begin or enhance their innovation journey, with leading strategies for success and real-world examples of how other US manufacturers have overcome the challenges identified.

The playbook structure is framed to provide industry leaders with a systematic and comprehensive approach to embracing innovation in new business models. For ease of comprehension and implementation, it is organized into three sections, designed to guide the reader from the key concepts to the leading strategies to actionable next steps:

Section 1: Introduction and context

The playbook begins with definitions of innovation, business models and business model innovation, to ensure a common understanding and set the stage for a deeper exploration. It digs into the unique challenges faced by the manufacturing sector and emphasizes the need for innovative solutions. It then highlights transformative technologies driving manufacturing innovation and sheds light on potential barriers that organizations may encounter when implementing manufacturing innovation trends.

Section 2: Strategies for implementing innovative business models in manufacturing

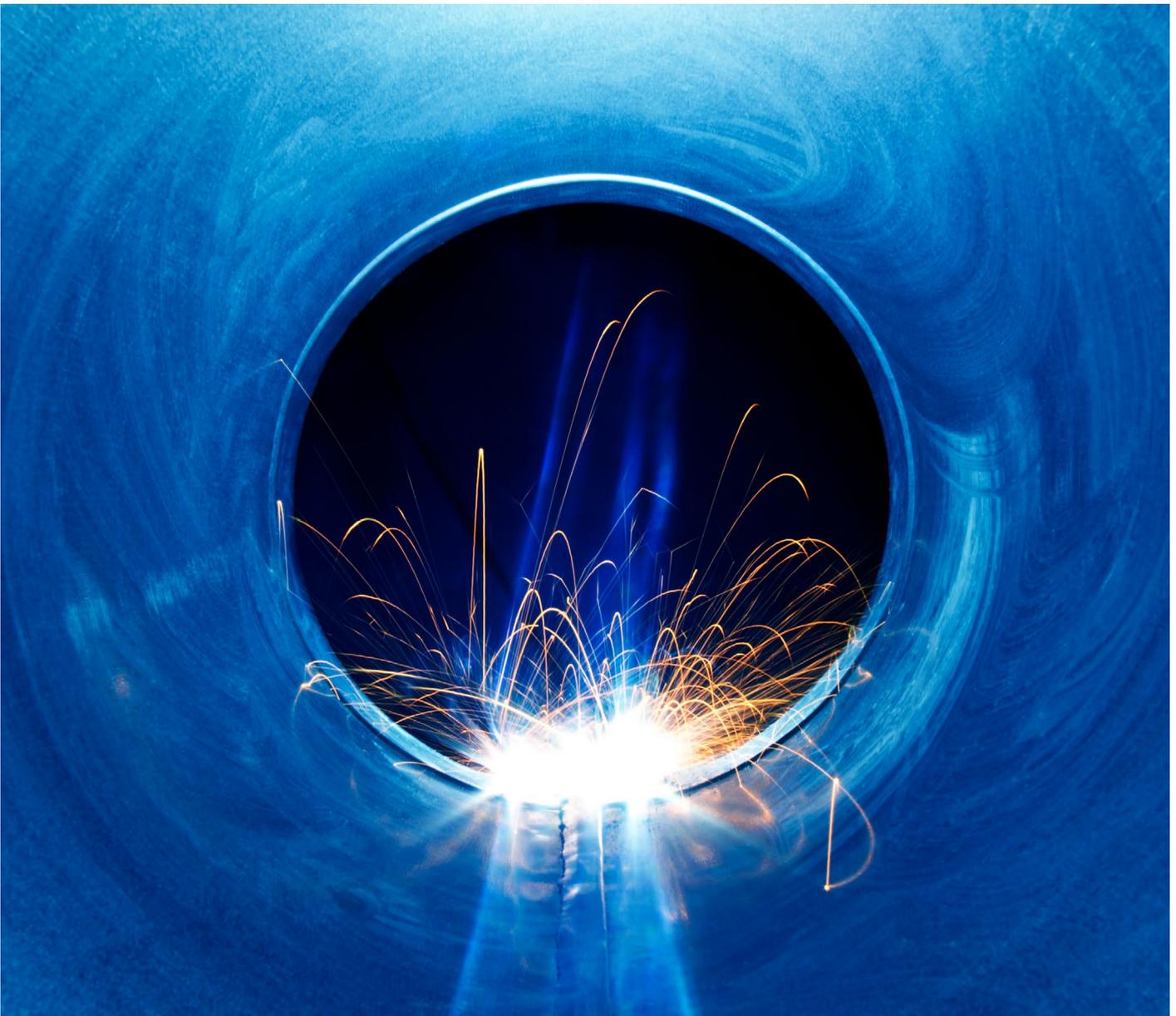
At the heart of the playbook are seven strategies (Figure 2) that have emerged as key for success and that manufacturing companies can apply to make meaningful progress on their innovation journey. These strategies encompass a wide range of approaches and actionable steps, from streamlining supply chains to promoting a culture

of continuous improvement, each backed up with case studies and insights from the community's experience of the topic.

Section 3: Conclusion and next steps

The key actions and strategies outlined come together to form a comprehensive roadmap for business model innovation. The last section of the playbook presents a well-defined set of actions and next steps that can be adopted to embark on or progress the innovation journey in manufacturing.

The playbook is designed to be dynamic and will be featured on the US Center's website, a strategic decision that enables continuous updates and refinements. Leaders can easily access the latest case studies, best practices and guiding questions on how to tackle these challenges within their organization. This adaptable approach ensures that the playbook remains up to date, effectively accommodating the rapid evolution of new business models and innovative solutions across various manufacturing industries.



4

Key strategies and outlook for success

The strategies identified in section 3 serve as a compass, guiding manufacturing leaders to rethink and reinvent their business models in the ever-evolving manufacturing sector.

These seven strategies are described in the playbook with case studies and key steps for leaders to take as they implement them. This section of the report takes a more detailed look at the four strategies that received the most attention and gained the highest priority among members of the US Center community.

Focus strategy 1: Understanding current business models to identify growth levers

At the heart of every successful organization lies the drive to innovate and solve problems, particularly in today's rapidly evolving technological landscape. However, the quest for solutions should not begin from the bustling market of technology offerings; instead, it should start internally, by comprehending an organization's current business model and the core issues at hand. This is where a well-structured problem statement emerges as an indispensable first step.²⁴

In the grand strategy of problem-solving for growth, it becomes crucial for leaders to identify all possible levers that influence the business's performance.²⁵ This matters because once a solution is implemented, predicting and forecasting its expected returns becomes more reasonable. Hence, it is essential to closely analyse productivity data, customer demographics, preferences, market trends, value-chain obstacles and the relationships with vendors and distributors to gauge their interests, priorities and potential for future involvement in the organization's pursuit of growth.



By adopting a data-backed approach to assess the health of the overall value chain, leaders can identify the most suitable areas for growth and investment.²⁶ This methodical approach ensures that the organization aligns its efforts towards well-informed decisions, ultimately driving the goal of business expansion.²⁷

Focus strategy 2: Addressing the industry challenge of talent and skill shortages

The manufacturing sector is undergoing digital transformation, a paradigm shift with profound implications for the workforce and one that has placed talent and skills at the top of the agenda for manufacturing leaders.²⁸ At the same time, the experienced manufacturing workforce is ageing. People aged 55 and older are the fastest-growing segment of the US workforce, with about 4 million workers in manufacturing alone being 55 or above in 2022, according to the US Bureau of Labor Statistics.²⁹

In this context, understanding the opportunity of workers' longevity and building infrastructure and systems to support and engage them could bring numerous benefits to the workplace. Additionally, partnering with universities and academia to build well-rounded manufacturing programmes that incorporate the latest technology could help prepare and attract more talent to the industry. Finally, companies that put in place talent progression, and reward and promotion processes and mechanisms have been more successful in retaining key business talent in their organizations.



With an ageing US population and an increase in the adoption of key technologies by those in the oldest age groups over the past decade,³⁰ organizations should focus on identifying the most relevant upskilling and training programmes they can offer to maximize workers' desire to learn and contribute. Both younger and older workers have much to contribute. Younger digital natives can bring their digital skills to the legacy workforce while members of the legacy workforce can share their knowledge and experience with the younger workers.



Partner with universities to develop tailored programmes and build specific curriculums by industry.

Industry leader

Focus strategy 3: Building the right culture for change

In a period of rapid digital shift, it is important for leaders not only to be conscious of the cultural impact these technologies will have on their organizations but also to know how to act as effective shepherds during this time of change,³¹ inspiring a culture of innovation and encouraging employees to take risks and experiment – essential for developing new products and services.

At the same time, leaders need to ensure that everyone in the organization is aware of the company's evolving goals and objectives and make an effort to support all staff in adapting to this new culture.³² This will help to ensure that all are working towards the same target and that there is no resistance to change.



The US is expected to have 2.1 million manufacturing jobs unfilled by 2030.³³ To meet this projected demand and attract new talent to the sector, creating an environment suited to this new digital age and a culture for embracing change will be critical. Commitment to innovation, communication and training will reward success but also help the country adapt to an ever-growing labour shortage and cyclical changes in technology.

Focus strategy 4: Establishing strategic partnerships across the sector

Being adept at recognizing and collaborating with partners can serve as a robust driver of competitive edge, especially in the realm of innovating new products, solutions and frameworks.³⁴ Collaborations can balance out research and development expenses, contribute expertise and adaptability, and facilitate the emergence of fresh markets. They can also expedite innovation and the process of making a product commercially available because achieving and commercializing significant advancements can otherwise be a multi-year process.³⁵

Maintaining an effective business environment by building strategic partnerships enables organizations to create value that no single company could have created. The advantages of these systems, commonly addressed through terms such as “platform leadership”, “keystone strategies”, “open innovation”, “value networks” and “hyperlinked organizations”, are tangible and broadly disseminated.³⁶

Some factors to consider before embarking on a partnership are the opportunity cost of not working together, finding a win-win scenario, growing the industry customer base and safeguarding a competitive edge.³⁷



To foster innovation and growth within the manufacturing sector, companies need to go beyond transactional relationships with their partners in the business environment. Strengthening existing partnerships and establishing new ones will enable companies to tap into fresh talent and skill sets, bridge capability gaps and gain new insights from various levels of operations, drawing on diverse multistakeholder experiences. Such connections and networks will also be the means of influence for manufacturers and their value chain on policy decisions.

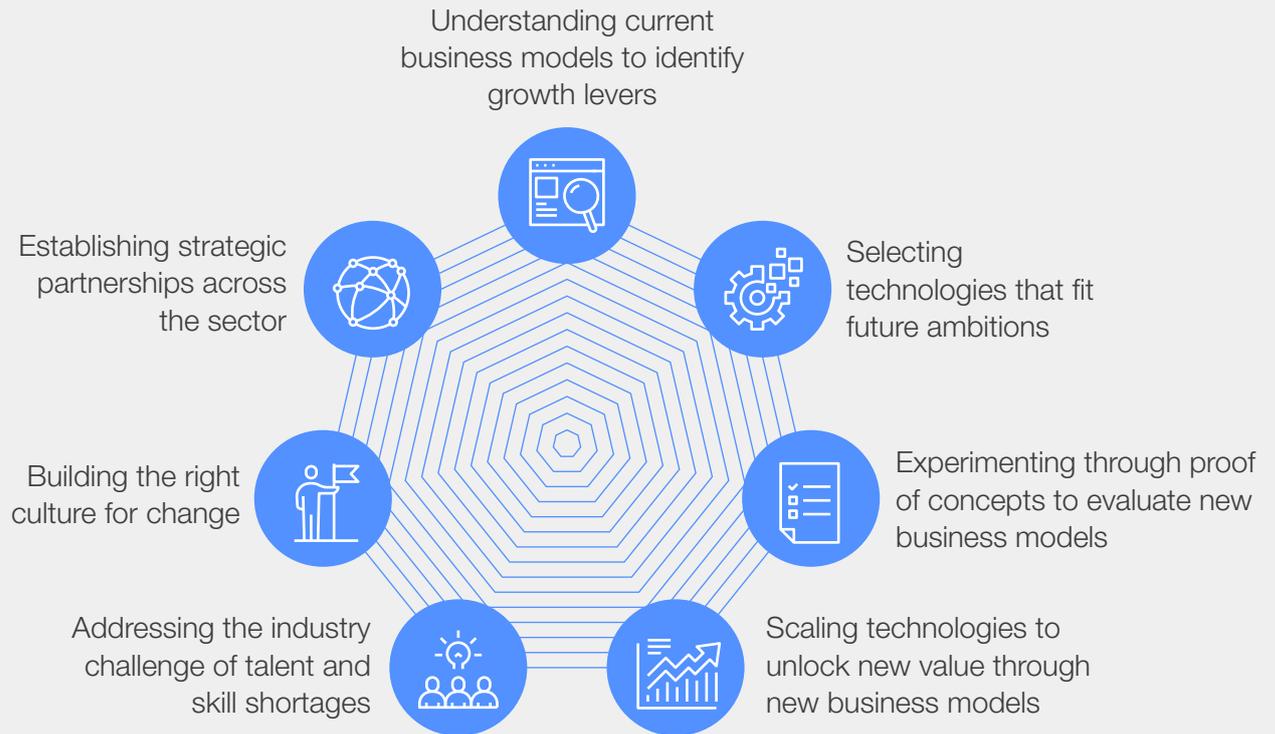
The US Center playbook examines all seven strategies (Figure 2), providing additional case studies and key actionable steps for leaders to address challenges and implement these strategies effectively. From understanding current business models and addressing talent shortages to building the right culture for change and establishing strategic partnerships, these strategies form a cohesive framework for success in manufacturing innovation. As leaders embark on their innovation journeys, these strategies and their future outlooks provide a roadmap for navigating the complex and dynamic manufacturing landscape, propelling organizations towards continuous improvement and operational excellence.



Create internship opportunities where young minds can experience what it's like working at a plant and be exposed to the emerging technology they would have the opportunity to work with in the manufacturing industry with industrial automation.

Industry leader

FIGURE 2 | Seven strategies for implementing innovative business models in manufacturing



Source: US Center for Advanced Manufacturing consultations



Conclusion

Incorporating insights from industry leaders across the manufacturing sector, this paper showcases a diverse tapestry of local US practices. These practices, derived from the automotive, semiconductor, apparel, additive manufacturing, construction, mining, software and computer services industries, reflect the innovative spirit driving the US manufacturing landscape. Such examples serve not only as sources of inspiration but also demonstrate the transformative potential of innovative business models in overcoming industry challenges and fostering sustainable growth.

The US Center for Advanced Manufacturing's playbook aims to act as a catalyst for business model innovation in the US, positioning innovation at the forefront of transformation in US manufacturing, providing manufacturers with accessible and pragmatic approaches to address the challenges that often loom large in business models and strategy. By collecting best practices in business model innovation, organizations can engage in deep learning and apply this newfound knowledge to advance their initiatives.

The innovation journey continues as a collective endeavour. Using the platform provided by the

US Center for Advanced Manufacturing, industry leaders are invited to:

- Share new insights and examples arising from the application of the playbook and its strategies within their organization at the US Center's next innovation roundtable
- Join a project-related event with senior operations and technology executives to exchange methodologies and incubate new collaborations around business model innovation in manufacturing, upskilling and reskilling the workforce or technology adoption

As industry leaders apply these strategies, they have the opportunity to embark on a transformative journey, fostered by a continuous learning community facilitated by the US Center. While it is rooted in the US, the playbook has an influence that transcends national boundaries, resonates with manufacturers worldwide and contributes to a global movement that is redefining the future of manufacturing through innovative business models and shared best practices, thus forging a path to a more interconnected and innovative future in the realm of global manufacturing.

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Cummins
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PTC
Qualcomm
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Stratasys
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Endnotes

1. National Association of Manufacturers, “Facts about Manufacturing”: <https://www.nam.org/facts-about-manufacturing/>.
2. National Science Board, “The State of US Science and Engineering Indicators 2022: Executive Summary”, National Science Foundation, 2022: <https://ncses.nsf.gov/pubs/nsb20221/executive-summary>.
3. Devon Bistarkey, “US Manufacturing Ecosystem Key to Economic Growth, Innovation, Competitiveness”, US Department of Defense, 14 October 2022: <https://www.defense.gov/News/News-Stories/Article/Article/3189049/us-manufacturing-ecosystem-key-to-economic-growth-innovation-competitiveness/#:~:text=%22America's%20manufacturing%20ecosystem%20has%20been,defense%20for%20acquisition%20and%20sustainment>.
4. World Economic Forum, *Unlocking Business Model Innovation through Advanced Manufacturing*, 13 January 2022: <https://www.weforum.org/whitepapers/unlocking-business-model-innovation-through-advanced-manufacturing/>.
5. Chad Moutray, “A Strong Manufacturing Sector Fuels Economic Growth”, Forbes, 27 September 2023: <https://www.forbes.com/sites/realspin/2016/11/21/a-strong-manufacturing-sector-fuels-economic-growth/>.
6. Frans Van Houten, “Global Chip Shortages Put Life-Saving Medical Devices at Risk”, World Economic Forum, Agenda, 4 May 2022: <https://www.weforum.org/agenda/2022/05/global-chip-shortages-put-life-saving-medical-devices-at-risk/>.
7. Accenture, “When Atoms Meet Bits Technology”, Vision 2023: <https://www.accenture.com/content/dam/accenture/final/accenture-com/a-com-custom-component/iconic/document/Accenture-Technology-Vision-2023-Executive-Summary.pdf>.
8. Business Wire, “Accenture Collaborates with Mars to Develop ‘Factory of the Future’ Using AI, Cloud, Edge and Digital Twins”, 5 October 2023: <https://www.businesswire.com/news/home/20221003005151/en/Accenture-Collaborates-with-Mars-to-Develop-“Factory-of-the-Future”-Using-AI-Cloud-Edge-and-Digital-Twins>.
9. Wood, “Wood Adopts Connected Worker Solution Enabled by Honeywell Forge for Business Continuity”: <https://www.woodplc.com/insights/spotlights/digital-and-technology/emerging-technologies/connected-worker/wood-adopts-connected-worker-solution-enabled-by-honeywell-forge-for-business-continuity>.
10. Angus Loten, “‘Predictive-Maintenance’ Tech Is Taking Off as Manufacturers Seek More Efficiency”, The Wall Street Journal, 7 September 2022: <https://www.wsj.com/articles/predictive-maintenance-tech-is-taking-off-as-manufacturers-seek-more-efficiency-11662543000>.
11. Gail McGraw, “Lights-Out Manufacturing”, AMT Online, 6 May 2021: <https://www.amtonline.org/article/lights-out-manufacturing>.
12. Peter Lacy, Jessica Long and Wesley Spindler, “Disruptive Technologies”, in *The Circular Economy Handbook*, Palgrave Macmillan, London, 2012: https://link.springer.com/chapter/10.1057/978-1-349-95968-6_3.
13. Container News, “Maersk and IBM Introduce TradeLens Blockchain Shipping Solution”, 5 October 2023: <https://container-news.com/maersk-ibm-introduce-tradelens/#:~:text=TradeLens%20is%20the%20result%20of%20a%20collaboration%20agreement,information%20sharing%20and%20transparency,%20and%20spur%20industry-wide%20innovation>.
14. Christian Titze, “Case Study: E2E Supply Chain Control Tower to Orchestrate and Optimize Across the Value Chain”, 27 October 2022: <https://www.gartner.com/document/4020512?ref=solrAll&refval=379487723&>.
15. National Association of Manufacturers, “NAM Manufacturer’s Outlook Survey Second Quarter 2022”, 15 June 2022: <https://www.nam.org/2022-2nd-quarter-manufacturers-outlook-survey/>.
16. Elsie Boskamp, “35+ Compelling Workplace Collaboration Statistics [2023]: The Importance of Teamwork”, Zippia, 6 July 2023: <https://www.zippia.com/advice/workplace-collaboration-statistics/>.
17. Deloitte, *2022 Manufacturing Industry Outlook*, March 2022: <https://www2.deloitte.com/content/dam/Deloitte/us/Documents/energy-resources/us-2022-manufacturing-industry-outlook.pdf>.
18. Sree Ramaswamy et al., “Making It in America: Revitalizing US Manufacturing”, McKinsey and Company, 13 November 2017: <https://www.mckinsey.com/featured-insights/americas/making-it-in-america-revitalizing-us-manufacturing>.
19. World Economic Forum, *Global Lighthouse Network: Shaping the Next Chapter of the Fourth Industrial Revolution*, January 2023: <https://www.weforum.org/whitepapers/global-lighthouse-network-shaping-the-next-chapter-of-the-fourth-industrial-revolution/>.
20. National Association of Manufacturers, “NAM Manufacturer’s Outlook Survey: Second Quarter 2022”, 15 June 2022: <https://www.nam.org/2022-2nd-quarter-manufacturers-outlook-survey/>.
21. McKinsey and Company, “Transforming Advanced Manufacturing through Industry 4.0”, 27 January 2022: <https://www.mckinsey.com/capabilities/operations/our-insights/transforming-advanced-manufacturing-through-industry-4-0/#>.
22. Paola Cecchi-Dimeglio, Taha Masood and Andy Ouder Kirk, “What Makes Innovation Partnerships Succeed”, Harvard Business Review, 14 July 2022: <https://hbr.org/2022/07/what-makes-innovation-partnerships-succeed>.
23. World Economic Forum, *Unlocking Business Model Innovation through Advanced Manufacturing*, 13 January 2022: <https://www.weforum.org/whitepapers/unlocking-business-model-innovation-through-advanced-manufacturing/>.
24. MSN, “3 Excellent Problem Statement Examples”: <https://www.msn.com/en-us/money/smallbusiness/3-excellent-problem-statement-examples/ar-AA1bXkO2>.

25. Daniel Markovitz, "How to Avoid Rushing to Solutions When Problem-Solving", Harvard Business Review, 27 November 2022: <https://hbr.org/2020/11/how-to-avoid-rushing-to-solutions-when-problem-solving>.
26. Warren Berger, "The Secret Phrase Top Innovators Use", Harvard Business Review, 17 September 2012: <https://hbr.org/2012/09/the-secret-phrase-top-innovato?autocomplete=true>.
27. Tim Stobierski, "What Is a Value Chain Analysis? 3 Steps", Harvard Business Review, 3 December 2020: <https://online.hbs.edu/blog/post/what-is-value-chain-analysis>.
28. Ling Li, "Reskilling and Upskilling the Future-Ready Workforce for Industry 4 and Beyond", Information Systems Frontiers, 13 July 2022: <https://link.springer.com/article/10.1007/s10796-022-10308-y>.
29. US Bureau of Labor Statistics, "Labor Force Statistics from the Current Population Survey", 25 January 2023: <https://www.bls.gov/cps/cpsaat18b.htm>.
30. Andy Patrizio, "Think Older Workers Struggle with Technology? Think Again", CIO, 3 August 2016: <https://www.cio.com/article/238789/think-older-workers-struggle-with-technology-think-again.html#:~:text=Just%20one%2Dquarter%20of%20the,tech%20in%20the%20workplace%20stressful>.
31. John Kotter, "Leading Change: Why Transformation Efforts Fail", Harvard Business Review, May–June 1995: <https://hbr.org/1995/05/leading-change-why-transformation-efforts-fail-2>.
32. David Lancefield, "How to Communicate Your Company's Strategy Effectively", Harvard Business Review, 29 November 2022: <https://hbr.org/2022/11/how-to-communicate-your-companys-strategy-effectively>.
33. Deloitte Insights, "Creating Pathways for Tomorrow's Workforce Today": <https://www2.deloitte.com/us/en/insights/industry/manufacturing/manufacturing-industry-diversity.html>.
34. Andrew Shipilov, Nathan Furr and Tobias Studer Andersson, "Looking to Boost Innovation? Partner with a Startup", Harvard Business Review, 27 May 2020: <https://hbr.org/2020/05/looking-to-boost-innovation-partner-with-a-startup>.
35. Paola Cecchi-Dimeglio, Taha Masood and Andy Ouderkirk, "What Makes Innovation Partnerships Succeed", Harvard Business Review, 14 July 2022: <https://hbr.org/2022/07/what-makes-innovation-partnerships-succeed>.
36. Arho Suominen, "Innovation Studies and Ecosystems" [Slide 9], Slideshare, 14 August 2013: <https://www.slideshare.net/ArhoSuominen/innovation-studies-and-ecosystems>.
37. Michael Schrage, "The Right Way for an Established Firm to Do an Innovation Pilot with a Startup", Harvard Business Review, 30 May 2018: <https://hbr.org/2018/05/the-right-way-for-an-established-firm-to-do-an-innovation-pilot-with-a-startup>.



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