

December 11, 2025

The Honorable Michael Kratsios
Director
Office of Science and Technology Policy
The White House
1650 Pennsylvania Avenue, NW
Washington, DC 20501

Re: Request for Information (RFI) – National Strategic Plan for Advanced Manufacturing

Dear Director Kratsios,

On behalf of IEEE-USA, we are pleased to submit the attached response regarding the critical trajectory of advanced manufacturing in the United States. As the global landscape shifts toward digitization and sustainability, the United States stands at a pivotal juncture. The input provided herein outlines a strategic roadmap to ensure the nation not only maintains its competitive edge but redefines the boundaries of industrial innovation.

Our submission details how emerging technologies, specifically Artificial Intelligence (AI), Biomanufacturing, and Nanotechnology, will serve as the bedrock for the next generation of production. However, technological superiority cannot be sustained in a vacuum. Our response emphasizes that successful integration requires a holistic approach that addresses the "Valley of Death" in funding, the widening workforce skills gap, and the urgent need for supply chain resilience regarding critical minerals.

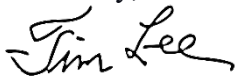
Key recommendations within this response include:

- **Revitalizing Public-Private Partnerships:** Moving beyond traditional funding to create "lab-to-fab" ecosystems ensuring that small and medium-sized enterprises (SMEs) have access to shared-use facilities and "tech playgrounds."
- **Securing the Supply Chain:** Reducing reliance on foreign sources through the adoption of additive manufacturing, urban mining, and the strategic stockpiling of critical materials.
- **Workforce Transformation:** Implementing national occupational frameworks and expanding registered apprenticeships to rebrand manufacturing as a high-tech career path.
- **Intellectual Property Protection:** Establishing a patent system that protects American innovation from anti-competitive foreign acquisition and ensures that SMEs are not priced out of protecting their own inventions.

We agree that the goals of the 2022-2026 National Strategy for Advanced Manufacturing remain relevant, but we argue that they must be accelerated through policy coherence and a renewed focus on implementation standards.

IEEE-USA appreciates the opportunity to provide these comments for consideration in the development of the National Strategic Plan for Advanced Manufacturing. We welcome any further dialogue on these crucial points. Please direct any questions to Ryan Cunius at (202) 530-8339 or r.cunius@ieee.org.

Sincerely,

A handwritten signature in black ink that reads "Tim Lee". The signature is written in a cursive, flowing style.

Tim Lee

2025 IEEE-USA President

1. a. Which emerging science and technology areas (e.g., artificial intelligence) will be key to the next generation of innovative advanced manufacturing technologies, and how will they impact advanced manufacturing?

Emerging technologies critical to the next generation of advanced manufacturing include:

- **Artificial Intelligence (AI) and Machine Learning:** AI will enable self-optimizing production lines, predictive maintenance through the analysis of real-time sensor data, and advanced quality control capable of detecting subtle deviations. Examples of future applications include digital twins, generative design, rapid prototyping, and the optimization of supply chain logistics and inventory management.
- **Biotechnology and Biomanufacturing:** This area holds the potential to create new materials, chemicals, and products through biological processes, shifting production away from traditional, energy-intensive methods. It can lead to more sustainable and novel materials.
- **Nanotechnology:** The precise, intentional bottom-up engineering of matter at the atomic and molecular scale. It will create new abundance in material properties that do not currently exist on a larger scale. It will create new materials and devices from the bottom up to achieve specific, unique functions.
- **Quantum Technologies:** Although still in its early stages, quantum computing and sensing have the potential to revolutionize material design and optimization, enabling the simulation of complex molecular interactions and the creation of materials that are currently impossible to model.
- **Autonomous Systems and Robotics:** AI-powered robots and collaborative robots (cobots) will take automation to the next level, optimizing workflows, increasing efficiency, and working in tandem with human operators. It will improve safety and productivity.
- **Advanced Materials:** The development of novel materials, from composites and alloys to innovative materials and metamaterials, is crucial for creating lighter, stronger, and more functional products.
- **Next-Generation Communications Networks (e.g., 6G):** These networks will enable the massive data transfer required for a fully connected "smart factory," supporting real-time communication between machines, systems, and supply chain partners.

These technologies will fundamentally change manufacturing by increasing efficiency, reducing waste, enhancing product quality, enabling mass customization, and creating more resilient and adaptable production systems.

b. What are the primary challenges and barriers that need to be addressed to ensure the successful integration and widespread adoption of emerging technology in manufacturing?

The primary challenges and barriers include:

- **Cost and Investment:** The high initial investment required for new equipment, software, and infrastructure is a significant barrier, particularly for small and medium-sized enterprises (SMEs).
- **Workforce Skills Gap:** There is a critical shortage of workers with the technical, digital, and data analysis skills necessary to operate, maintain, and innovate with these advanced technologies.
- **Integration and Compatibility Issues:** Integrating new technologies, such as AI and IoT sensors, with legacy equipment and existing IT infrastructure can be complex, leading to compatibility problems and operational disruptions.
- **Data Security and Cybersecurity:** Increased connectivity and automation expose manufacturing systems to new cybersecurity threats, making data protection a critical concern.
- **Regulatory and Policy Frameworks:** Evolving regulatory requirements, particularly concerning environmental sustainability, data privacy, and intellectual property, can create uncertainty and hinder adoption.
- **Organizational and Cultural Resistance:** Many manufacturers resist adopting new technologies due to a lack of innovative culture within their own organizations. This stems from the lack of incentives for creating new and innovative manufacturing ideas that can help propel the US sector forward.
- **Public Acceptance:** Many citizens have legitimate concerns about employment losses, malicious artificial intelligence, reduced privacy, and economic inequality. Many of these concerns are justified and must be addressed in a forthright manner.

- **Analytical Assessment Tools and Methodology:** The sector struggles with the lack of open-architecture data sets and operates on outdated systems. This leads to issues within quality control due to inconsistent methods, human error, and a lack of real-time data to help monitor progress. Additionally, industry-led standards are not created promptly, resulting in significant barriers to the sector.
- **Anti-Competitive Technology Acquisition:** Some large organizations may purchase and monopolize the rights to advanced manufacturing technologies and IP.

2. a. **Which disruptive manufacturing technologies (e.g., additive, nanotechnology, biotechnology) hold the potential to eliminate reliance on foreign sources for critical minerals and materials, and how will they do that?**

Disruptive manufacturing technologies that can reduce reliance on foreign critical minerals and materials include:

- **Additive and Digital Manufacturing (3D Printing):** Additive manufacturing can reduce the demand for critical materials by optimizing part design to be lighter and use less material. It also enables the use of domestically sourced powders and filaments and can be used to repair or refurbish parts, extending their lifespan and reducing the need for new materials.
- **Bio-manufacturing:** This technology can create bio-based alternatives for materials that currently rely on critical minerals—for example, microbes engineered to produce rare-earth-free magnets or biological materials that can replace mineral-based catalysts.
- **Advanced Recycling and Urban Mining:** New technologies, such as plasma gasification and novel chemical processes, can efficiently extract critical minerals from electronic waste, batteries, and industrial slag, making material recovery more effective. This "urban mining" creates a domestic supply from existing waste streams.
- **Materials Substitution and Design:** Advances in materials science allow the creation of new alloys, composites, and polymers that can serve as direct replacements for materials that require critical minerals. This includes developing high-performance magnets and battery components that do not use rare earth elements.

b. What are the technical challenges and barriers associated with implementing these technologies at an industrial scale, and how can they be addressed?

- **Cost, Speed, and Scalability:** Scaling up processes such as additive manufacturing and biomanufacturing from a laboratory setting to industrial production presents a significant technical and economic challenge. The cost of materials, equipment, energy, and water for these processes at scale can be prohibitive. Addressing this requires R&D focused on process optimization and the development of more efficient, larger-scale machinery. Supply chain management is another aspect that involves limited and costly raw materials, as well as fragile and geographically concentrated sources.
- **Quality Control and Certification:** Ensuring consistent quality, performance, and reliability of products made with new materials or processes is a significant hurdle. This is particularly crucial in industries such as aerospace and defense. Federal agencies and industry can work together to establish new standards, metrics, and certification processes for these technologies.
- **Technical Knowledge and Workforce:** A lack of expertise in these novel fields, from material scientists to technicians, hinders implementation. Strengthening academic and vocational training programs, along with supporting on-the-job training, will build the technical workforce.
- **Technological Leadership:** The appointment of technical experts within the government is vital to advancing advanced manufacturing in the country. Appointing unqualified individuals will create knowledge gaps and undermine the federal government's credibility.
- **Collaboration with the Broader Ecosystem:** Effective innovation within the advanced manufacturing space requires continuous and meaningful partnerships with all sectors of the industry. Industry, standards development organizations (SDOs), and small businesses need the federal government to create a strong, collaborative relationship to help advance the sector. We need to think of innovative ways to integrate manufacturing into academia and universities, and explore methods to understand regional needs across the nation.
- **Hybridization of Technologies:** Promise has been shown, but many technical issues remain that need to be addressed to move this forward. This includes data integration from two separate processes, which causes problems with software and control systems in real-time. Material compatibility between two different materials can also lead to serious issues.

3. a. What should be the near-term and long-term technology R&D priorities for advanced manufacturing, reasons for those priorities, key objectives based on those priorities, the timeframe for achieving goals, and the metrics for assessing progress toward the objectives?

- **Near-term Priorities: (1-5 years)** The immediate R&D priority should be focusing on integrating AI and robotics into advanced manufacturing techniques and datasets. This will help the sector by enabling reliable, real-time data on operational effectiveness and quality control. The focus should be on developing and deploying new software platforms that can serve as the foundation for digital twins infrastructure, optimizing these advanced manufacturing processes. Building this infrastructure will enable the implementation of new intelligent automation technologies into manufacturing processes, streamlining operations for technicians and engineers. All of these advances need to be based on reliable data sets to help move these systems forward. We should develop open-architecture software platforms and implement successful pilot programs in industrial environments within the next one to five years. We can define our progress on these challenges by focusing on quantitative data such as a decrease in mean time to repair (MTTR), improvement in process energy and water efficiency, and an increase in Overall Equipment Effectiveness (OEE) within pilot program facilities. We can also track progress within the broader manufacturing ecosystem by tracking the number of new patents and the successful adoption of these new software platforms by SMEs.

- **Long-term Priorities (5+ years):** In the long term, the strategic focus of R&D should be on advancements within the Advanced Materials and Biomanufacturing spaces. This is driven by the focus on creating and securing a sustainable domestic supply chain of critical materials needed to advance the manufacturing space, as well as creating new manufacturing methods to move innovation forward. The primary objective in Advanced Materials will be to design and synthesize new, novel materials with tailored properties (e.g., lightweight, high-strength composites). For Biomanufacturing, the focus will be on developing scalable biomanufacturing processes. As with all fundamental science, timelines cannot be defined because it takes long periods to find innovations and validate them. The focus should be on committing to funding basic science projects within these fields for the long term. We can assess progress within these spaces by examining how many basic research projects in advanced materials and biomanufacturing transition into applied research and ultimately toward commercialization.

b. What are the major technical challenges to achieving the priorities identified in response to 3a, and how can they be mitigated to ensure timely progress?

Some significant technical challenges and possible solutions include:

- **Data Quality, Interoperability, and System Integration:** This can be mitigated by developing and deploying technology-agnostic middleware platforms that act as translators between disparate systems, allowing them to communicate without requiring a single set of shared standards.
- **Capital Investment for Facilities:** The focus should be on establishing federally funded, shared-use facilities for small and medium-sized enterprises (SMEs). It should also focus on expanding the use of government loan guarantee programs to help invest in infrastructure, while also implementing a more expansive R&D tax credit for SMEs, specifically targeting facility and infrastructure investments.

- **Scaling and Commercializing Research:** A possible solution includes creating a “lab-to-fab” scaling ecosystem. Public-private partnerships can provide a structured environment for applied research, technology validation, and de-risking new processes before they are fully commercialized. These partnerships are crucial for validating new technologies and mitigating risks associated with innovative processes before they are ready for commercialization. We must also ensure that the designs can be manufactured using these new technologies, allowing us to create efficient outputs.

4. a. What are examples of U.S. manufacturing-related technological, market, or business challenges that may best be addressed by public-private partnerships and are likely to attract both participation and primary funding from industry?

- Public-private partnerships (PPPs) are a powerful, multifaceted tool for addressing some of the most pressing challenges in the manufacturing sector. They span various sectors, offering a collaborative model to overcome obstacles that are too large or too risky for any single entity to tackle alone.
- A strength of PPPs is their ability to tackle technology challenges by fostering a collaborative environment for pre-competitive R&D. This includes creating new manufacturing processes for advanced materials like high-performance composites or next-generation semiconductors. They also encourage further private investment due to the federal government's commitment to the industries in which they are investing. However, this model must evolve to address past issues, particularly concerning intellectual property (IP) leakage, by establishing clear and transparent frameworks that protect proprietary information while still enabling shared access to federal R&D resources and national laboratories that make these partnerships so attractive to industry.

- Beyond technology, PPPs are essential for addressing significant market challenges. By pooling resources, they can establish new, resilient domestic supply chains for critical products—a task too capital-intensive and risky for a single company. The most effective place for these partnerships is within the manufacturing infrastructure itself, where investments in shared-use facilities and regional hubs provide access to cutting-edge equipment and technology. This aligns with public infrastructure investment and partnerships in strategic areas nationwide, fostering localized ecosystems of innovation that support not only the factory floor but also the surrounding community. This includes examining public investment in electrical infrastructure needed to support these innovative areas, given the current state of our aging infrastructure.
- Finally, PPPs are critical for overcoming workforce development challenges. They can address the widening skills gap by creating industry-led training and credentialing programs. Through these partnerships, the industry can directly shape the curriculum to meet its needs, ensuring that educational programs are aligned with the demands of modern manufacturing. This includes developing shared standards for cybersecurity, a critical concern for every firm, and establishing a unified approach to workforce training that benefits all participants. For industry, the allure of PPPs lies in this blend of shared risk, access to vital resources, and the opportunity to collectively shape the future of manufacturing—from technology and supply chains to the skilled workforce that drives it.

b. How can public-private partnerships be structured to overcome potential hurdles and foster successful collaboration?

- **Transparent Governance and IP Policies:** Partnerships must have clear and transparent governance structures that define roles and responsibilities effectively. Intellectual property (IP) policies should strike a balance between the need for commercialization and the public interest, allowing for both private ownership and shared access to pre-competitive research results.
- **Industry Leadership and Co-Funding:** To ensure relevance and attract private capital, partnerships should be industry-led, with a governance model that gives the private sector a strong voice in setting research priorities and project selection. The government must provide credible assurances that it will not attempt to change the terms of partnerships in progress.

- **Comprehensive Membership:** Structure partnerships to include a wide range of stakeholders, including large corporations, SMEs, universities, federal laboratories, and workforce development organizations.

5. a. How can Federal agencies and federally funded R&D centers supporting advanced manufacturing R&D facilitate the transfer of research results, intellectual property, and technology scale-up into commercialization and manufacturing to benefit all Americans and ensure economic and national security?

- Overcoming the hurdles in advanced manufacturing requires a strategic, multi-pronged approach that leverages public-private partnerships and targeted federal policies, while also fostering state-level initiatives.
- A key component of this strategy is not just to rely on a single federal program, but to expand and refine the entire industry. Creating a multi-prong approach to new shared-use facilities and manufacturing hubs, with federal support, enables companies, especially SMEs, to mitigate the risks of adopting new technologies and fosters a collaborative environment for innovation within the manufacturing sector.
- The federal government needs to develop more innovative ideas to encourage the advanced manufacturing sector. New ideas for federal programs should be explored to support the direct scaling of manufacturing. This could include targeted grant programs for specific sectors, or federal matching funds to incentivize states to launch their own manufacturing support programs.
- The Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) programs have been crucial in pushing innovation throughout the decades. We should consider enhancing this program to more effectively bridge the “valley of death” between R&D and commercialization, particularly in the manufacturing sector. This could involve increasing the funding caps for manufacturing-focused projects or creating a dedicated track within the programs to support the scaling of production from a prototype to a commercial product.
- Another significant move the federal government can make is to enhance Technology Transfer Offices (TTOs) within federal labs and universities. By providing these offices with additional resources and incentives, they can be staffed with professionals who possess both scientific and business acumen, enabling them to identify and market commercially viable research more effectively.

- Finally, federal agencies can play a critical role by utilizing procurement policies to act as anchor customers for new, domestically manufactured technologies. By providing a guaranteed market for innovative products, the government can help de-risk investments for private industry, allowing companies to scale up their production capabilities and reduce reliance on foreign supply chains.

b. What are the key challenges in translating research findings into commercially viable manufacturing processes and products, and how can they be overcome?

Key challenges include:

- **The "Valley of Death":** This refers to the funding gap between fundamental research and commercial-scale production. Securing financing for the expensive and high-risk process of scaling up a technology from a lab prototype to a production line is a challenging task.
- **Lack of Manufacturing Expertise in Research:** Researchers in academia and federal labs often lack an understanding of the practicalities of manufacturing, such as production costs, supply chain logistics, and quality control at scale.
- **IP Licensing Hurdles:** Complex and protracted negotiations over intellectual property can stall or kill the commercialization process.
- **Regulatory Hurdles:** The lack of standards for new technologies creates long-term issues within the industry in applying these innovations.

Some possible solutions include:

- Creating dedicated federal funding streams and tax incentives for "scale-up" activities.
- Embedding manufacturing industry professionals within research teams at federal labs and universities.
- Streamlining IP licensing processes for government-funded research by creating standardized agreements.
- Encouraging manufacturers to support relevant university research.

6. a. What are the main challenges in attracting, training, and retaining a skilled workforce for advanced manufacturing, and how can they be addressed?

- Manufacturing often suffers from an outdated public image as a low-skill, dirty job, which makes it challenging to attract young talent. Addressing this requires a national marketing campaign to rebrand manufacturing as a high-tech, innovative, and well-paying career path. The necessary skills are also evolving faster than traditional education and training programs can keep pace with technological advances, creating a skills gap that is particularly acute in digital technologies, data analytics, and robotics. This can be addressed by developing agile, modular training programs that can be updated quickly to reflect new technologies. Finally, high turnover is a problem due to competition from other high-tech sectors and a lack of clear career pathways. Employers can address this by providing continuous learning opportunities, competitive salaries, and well-defined career advancement paths to improve employee retention.

b. How can Federal agencies and federally-funded R&D centers develop, align, and strengthen all levels of advanced manufacturing training, certification, registered apprenticeships, and credentialing programs?

- **Develop National Occupational Frameworks:** The Department of Labor and Commerce can collaborate to develop and promote national frameworks for advanced manufacturing occupations. This creates a common language and set of standards for skills and credentials.
- **Expand Registered Apprenticeships:** The federal government should increase funding and support for registered apprenticeships in advanced manufacturing, which offer on-the-job training with a direct link to employment opportunities. This model has a proven track record of success.
- **Expand Career Pathways:** Encourage the creation of "stackable" credentials and micro-certifications that allow workers to gain new skills incrementally and demonstrate their expertise without requiring a full degree.
- **Leverage Federally Funded Centers:** Utilize the NIST MEP centers as regional hubs for developing and disseminating best practices in workforce training. These centers can partner with community colleges and vocational schools to ensure that curricula are aligned with industry needs.

7. a. In what ways can the Federal government assist in the development of advanced manufacturing clusters and technology hubs nationwide, beyond funding needs?

- The federal government is uniquely positioned to foster the development of technology clusters. By leveraging its convening power, the government should bring together diverse local and regional stakeholders—including industry, universities, state and local governments, and non-profits—to establish a shared vision and strategy. Additionally, federal agencies can work to streamline and harmonize regulatory processes, thereby reducing administrative burdens for companies within a hub and accelerating innovation.
- Through clear federal government commitment, particularly via targeted procurement and long-term contracts from agencies like the Department of Defense, they can effectively encourage further private investment and promote the growth of these local technology hubs.
- Finally, federal assistance with the planning and development of critical physical and digital infrastructure—such as high-speed broadband and shared lab spaces—provides the essential foundation for these clusters to thrive.

b. Is there a need for new or expanded advanced manufacturing clusters or technology hubs for the competitiveness of U.S. manufacturers, and if so, in what sectors or technologies?

There is a clear need for new and expanded clusters to ensure U.S. competitiveness. The recent designation of 31 Regional Technology Hubs under the CHIPS and Science Act is a testament to this need. Key sectors and technologies for new or expanded hubs include:

- **Biomanufacturing:** Focused on pharmaceuticals, advanced materials, and food production, from producing food to creating drought-resistant crops.
- **Critical Minerals and Materials:** To develop processing and refining capabilities for minerals essential for batteries and high-tech components.
- **Advanced Composites:** For aerospace, defense, and automotive applications.
- **Quantum Information:** For computing, sensing, and communications
- **Next-Generation Communications:** Vital to widespread adoption of new communications technologies such as 6G and beyond to create a robust and secure infrastructure around the country.

c. Should Federal incentives prioritize industry-specific advanced manufacturing clusters or instead focus on technology hubs centered on advanced technologies, critical components, and materials? If so, why?

Federal incentives should prioritize technology hubs centered on advanced technologies, critical components, and materials. This approach is more effective for several reasons:

- **Cross-Cutting Impact:** A technology-focused hub (e.g., one centered on AI and robotics) can support a wide range of industries, from automotive to aerospace to medical devices. This promotes diversification and resilience.
- **Economies of Scale in R&D:** It is more efficient to concentrate research, development, and workforce training on core enabling technologies that have broad applicability.
- **Supply Chain Resilience:** Focusing on critical components and materials directly addresses the most significant vulnerabilities in U.S. supply chains.

8. a. What are the primary vulnerabilities and weaknesses within the current domestic supply chains?

- The U.S. faces significant supply chain vulnerabilities. An over-reliance on a few foreign sources for critical minerals, components (such as semiconductors), and finished goods leaves the United States vulnerable to geopolitical risks and disruptions. Additionally, many companies have adopted a "just-in-time" or "lean" approach, which is efficient but leaves little room for error. When one part of the supply chain breaks, everything grinds to a halt, a phenomenon that occurs across multiple industries.
- A critical technical barrier is the prevalent lack of real-time data sharing and interoperability among supply chain stakeholders. Information silos prevent the proactive detection and mitigation of disruptions, delaying our response to emerging threats. Outdated domestic manufacturing infrastructure, particularly among small and medium-sized enterprises (SMEs), further exacerbates these challenges, as older equipment and processes are less efficient and less resilient to change. These multifaceted issues underscore the need for a comprehensive, government-led strategy to enhance supply chain security and resilience.

b. What programs and policies need to be implemented to develop and re-shore a resilient domestic advanced manufacturing supply chain and industrial base?

To address the significant vulnerabilities in the U.S. supply chain, a multi-pronged approach is necessary.

- Establishing a strategic stockpile of critical minerals and materials, while providing grants and loan guarantees to companies to expand domestic production capacity, is crucial for mitigating over-reliance on foreign sources.
- By improving visibility and resilience, federal agencies can implement supply chain risk management programs to help companies, particularly SMEs, map their supply chains and develop robust strategies.
- To make domestic production more competitive, it is vital to incentivize automation and digitization through tax credits or grants, encouraging companies to invest in robotics and innovative manufacturing technologies.
- Working with its allies, the USA should take action to discourage mercantilist policies by countries that seek to monopolize key aspects of critical supply chains.

9. a. What are the biggest obstacles faced by small and medium-sized manufacturing companies in adopting advanced technologies to increase efficiency and productivity?

- Small and medium-sized enterprises (SMEs) face a difficult challenge in adopting new technology due to a mix of financial and operational barriers. The most significant hurdle is the substantial capital investment required for advanced systems, which is simply not available at scale for most smaller businesses. This financial constraint is often exacerbated by a lack of in-house expertise, leaving them unsure how to implement and manage these new systems.
- The risks are amplified when you consider the energy usage within the manufacturing space. Upgrading to new, more efficient technology can dramatically reduce long-term operational costs; however, the initial investment is a significant risk for an SME. This is where the fear of a failed implementation becomes a very real threat to the company's survival. Additionally, many SMEs are unaware of the benefits or government assistance programs that could help them overcome these barriers. Ultimately, this leads to a cycle of risk aversion, keeping them from investing in the very technologies that would make them more efficient and competitive.

b. How can Federal agencies assist these companies in adopting advanced technologies and participating in the establishment of robust and resilient domestic manufacturing supply chains?

Some federal agencies' assistance ideas to establish robust and resilient domestic manufacturing supply chains include:

- **Create Technology Adoption Grants:** Offer grants or subsidies specifically for SMEs to purchase and implement advanced technologies like robotics, cybersecurity software, and data analytics tools.
- **Facilitate Supply Chain Matching:** Utilize federal agencies as matchmakers, connecting large manufacturers with smaller domestic suppliers that can participate in reshored supply chains.
- **Provide Access to Shared Facilities:** Fund the creation of shared-use facilities, also known as "tech playgrounds," where SMEs can experiment with and learn about new technologies without incurring the high upfront costs associated with individual investments.

10. What are examples of public-private partnership models (at the international, national, state, and/or local level) that could be expanded to facilitate manufacturing technology development, technology transition to market, and workforce development?

Some examples include:

- **The SEMATECH Model:** The SEMATECH consortium, which helped revitalize the U.S. semiconductor industry in the 1980s, is a successful example of a partnership focused on pre-competitive research and development (R&D) and shared manufacturing capabilities.
- **Fraunhofer Gesellschaft Model:** A German model that created a technology development organization, with support from the German government. It focuses on pre-competitive research and already has a US branch to build upon.
- **DOE's ARPA-E Model:** The Advanced Research Projects Agency-Energy (ARPA-E) provides funding for high-risk, high-reward research projects. This model could be applied to advanced manufacturing to fast-track the development of truly transformative technologies.
- **State-Level Initiatives:** The states of Texas and Michigan have created a "triple helix" model, which brought together industry, government, and universities to develop advanced technologies, and is a scalable example of a public-private partnership that other states should consider.

11. The current 2022-2026 National Strategy for Advanced Manufacturing has three top-level goals, each with objectives and priorities: (1) Develop and implement advanced manufacturing technologies; (2) Grow the advanced manufacturing workforce; and (3) Build resilience into manufacturing supply chains and ecosystems.

a. Are these goals appropriate for the next 4-5 years? Why or why not?

The three goals of the 2022-2026 National Strategy for Advanced Manufacturing remain highly appropriate for the next four to five years. They are relevant because:

- **Technology is a continuous race:** The pace of innovation in AI, robotics, and materials science is accelerating, requiring a constant focus on developing and implementing new technologies to stay competitive.
- **The skills gap is persistent:** The workforce challenge is a long-standing issue that will not be solved in a single strategy period. As technology evolves, so too will the required skills, making continuous workforce development a necessity.
- **Supply chain vulnerabilities persist:** Recent global events have underscored that supply chain resilience is a matter of both economic and national security. The work of re-shoring and building redundancy is far from complete and will require sustained effort.

b. What emerging needs or opportunities might require the addition of new top-level goals, and why?

- A new goal of proactively protecting American intellectual property (IP) and combating unfair foreign trade practices is essential because external threats can undermine domestic technological advancements.
- This is particularly urgent given the financial disparity in the patent system. Big businesses enjoy significant advantages due to greater capital (\$), which they can use to file and maintain extensive patent portfolios, litigate IP infringement, and navigate complex international patent systems. In contrast, Small and Medium-sized Enterprises (SMEs), while often qualifying for reduced USPTO fees, still face prohibitive overall costs for legal counsel, global filing, and enforcement, leaving their innovations vulnerable to theft by well-funded domestic or foreign entities.

- Adding to this concern are potential shifts in U.S. patent policy, such as the change reportedly considered to replace the current flat-fee patent maintenance structure with a potentially radical percentage-based "property tax" on patent value. If implemented, such a value-based tax could disproportionately impact smaller innovators and startups by significantly raising the annual cost of maintaining high-value patents. This could potentially force them to abandon critical IP or rely more on trade secrets, which can hinder open innovation and collaboration. Therefore, a comprehensive strategy must not only combat foreign exploitation but also ensure a stable and equitable domestic patent system that supports all American innovators.

12. Is there any additional information related to advanced manufacturing in the United States, not requested above, that should be considered? If so, describe.

Yes, several crucial areas related to advanced manufacturing in the United States, not explicitly requested, warrant consideration for a comprehensive national strategy. These areas focus on standards and measurement, policy coherence, workforce immigration, and logistics and transportation.

- **Standardization and Measurement Systems: The Foundation for Interoperability and Scale**
 - A robust, industry-led system of standardized measurement and data protocols is fundamental to the widespread adoption and scaling of advanced manufacturing technologies. Without this common framework, the full potential of these technologies will be severely limited due to pervasive issues with interoperability and data fragmentation.
 - **Data and Interoperability Standards:** Establishing standard data formats, communication protocols, and semantic ontologies is necessary for seamless communication across different machines (e.g., CNC, additive systems), software platforms (e.g., MES, ERP), and supply chain partners. Organizations such as the National Institute of Standards and Technology (NIST) and private Standards Development Organizations (SDOs) must play a central role in this effort, defining the "language" of the modern factory.
 - **Cybersecurity Standards:** Standardized, verifiable frameworks for securing Industrial Control Systems (ICS) and operational technology (OT) networks are critical to protecting intellectual

property and maintaining operational continuity against escalating cyber threats.

- **Performance Metrics:** Agreed-upon, standardized metrics are needed to benchmark productivity, efficiency, and quality of manufacturing operations across the sector. This enables precise, data-driven comparisons and facilitates continuous process improvement.
- **Certification and Credentialing:** Standardized credentials ensure that the advanced manufacturing workforce possesses skills that are recognized and transferable across different companies and regional supply chains, reducing friction in labor mobility.
- **Policy Consistency and Coherence**
 - To provide the long-term stability required for significant capital investment and R&D cycles, the U.S. must ensure policy consistency, avoiding abrupt shifts that create market uncertainty.
 - **Technology Neutrality and Strategic Alignment:** The U.S. should avoid unilaterally withdrawing from promising areas of manufacturing growth, such as environmental sustainability and green manufacturing technologies, for purely ideological or short-term political reasons. Strategic alignment with global trends, particularly in areas like sustainable materials and energy efficiency, ensures future competitiveness and market access.
- **Immigration Reform for Talent Stabilization**
 - The nation's long-term competitive advantage hinges on securing and retaining the world's top talent in science, technology, engineering, and mathematics (STEM) fields. Current immigration policy often acts as a counterincentive.
 - **Prioritize Permanent Residency for High-Skilled Workers:** The policy should be reformed to actively encourage well-qualified individuals in research, development, manufacturing, and engineering fields to become permanent citizens. This anchors top talent to the U.S. economy, fosters long-term commitment, and contributes to national security.
 - **Re-evaluate Temporary Visa Programs (e.g., H-1B):** Simultaneously, the current structure of temporary work visas should be reviewed and curtailed where they demonstrably depress

wages or displace U.S. workers. Instead, the focus should be on programs that provide a direct, clear path to permanent residency for individuals with essential, high-demand skills.

- **Logistics and Advanced Transportation Systems (The "Last Mile" of Manufacturing)**
 - The efficiency of advanced manufacturing is fundamentally linked to the logistics infrastructure for material flow—both inbound (raw materials and components) and outbound (finished goods).
 - **Integrated Supply Chain Digitalization:** Focus must be placed on deploying digital thread technologies that extend beyond the factory floor into the transportation and supply chain network. This includes utilizing AI-driven logistics optimization and standardized IoT tracking to improve visibility, resilience, and just-in-time delivery for high-value, custom-manufactured goods.
 - **Infrastructure Modernization:** Investment in modernizing intermodal transportation hubs, enhancing freight rail capacity, and developing resilient regional distribution centers is necessary to support the faster, more flexible, and often customized material flows characteristic of advanced manufacturing (e.g., micro-factories and distributed production models).