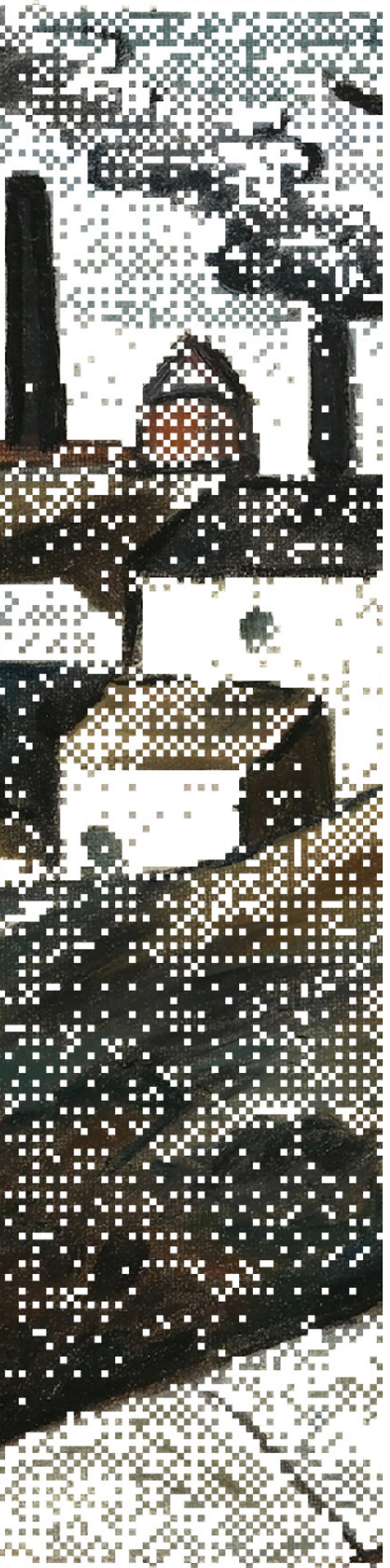

■ Industrial Power

Reforming the Advanced Manufacturing Institutes

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SUMMARY

The 17 US Manufacturing Institutes are public-private partnerships that bring together key actors in industry, universities, and government to accelerate domestic advanced manufacturing innovation. The Institutes have had significant success, but the model needs enhancements to achieve its stated vision of promoting "US global leadership in advanced manufacturing through the development and transition of innovative technologies into scalable, cost-effective, and high-performing domestic manufacturing capabilities." This requires networking the Institutes for better technology integration and improved private-sector take up, better linking the Institutes to the Manufacturing Extension Partnership programs in each state, improving the workforce education offerings, and supporting stronger scale-up capabilities. This proposal will outline how.

PROBLEM

The US Lacks Manufacturing-Led Innovation

The manufacturing productivity rate in the US has been stagnant or declining for 15 years, a signal of our failure to innovate and compete in production. By the end of World War II, the US innovated mass production and was the clear global leader in manufacturing. But after the war, the US failed to prioritize manufacturing in its innovation system. American research and development (R&D) agencies such as the National Science Foundation (NSF), the Department of Energy's Office of Science, the National Institutes of Health (NIH), national labs, and military research centers have made important discoveries and innovated new technologies, but with few exceptions (such as DARPA's support of Sematech) these agencies have not developed R&D portfolios around manufacturing technologies and processes. The assumption was that basic R&D would lead to new critical general purpose technologies, and that those might evolve into manufacturing improvements, but there was no organized effort to undertake this translation.

Industry did not fill the gap, focusing on development rather than longer-term research where the risks are too long-term and advances difficult for the originating firm to appropriate. The financial sector, demanding quarterly returns, pushed firms into a "core competency" model, requiring them to go "asset light," divesting, outsourcing, and offshoring manufacturing. These have been major disincentives for industry investment in manufacturing R&D.

By contrast, other countries such as Germany, Japan, Korea, and now China have developed "Manufacturing-Led" innovation strategies focused on manufacturing technologies. Japan invented its quality production model in the 1970s and 1980s and the technologies and processes behind it; the US had to play catch up, losing leadership in auto and consumer electronics sectors as a result. China has developed a rapid production scale-up approach using connections across regional firms that has allowed it to develop dominance of production in numerous sectors; the US has not. The US is 7th in the world in adopting industrial robotics, far behind Germany, Korea, and China. Too often a technology invented in America is scaled in other countries more focused on production. Lithium ion batteries, drones and solar panels were invented in the US, but production is now dominated by China.

Apart from R&D and product development, the US also faces a problem with adoption of new production technologies. Small- and medium-sized manufacturers (SMMs) struggle to adopt new technologies and processes, owing to the high cost and risk of implementing new technologies, low R&D capability, lack of technology expertise, and lack of qualified workers, among other challenges. Foreign counterparts outpace them. There is a pyramid of manufacturing firms beneath critical technology firms: every high-end product produced in the US requires dozens (sometimes hundreds) of critical tier 2 and 3 components and products. Making sure those suppliers can compete is essential for critical technology leadership.

The Manufacturing Institutes

To help tackle this challenge, starting in 2012 the US formed 17 advanced manufacturing institutes (called "Manufacturing USA") funded initially at around $50 million each from the Commerce, Defense and Energy Departments for a term of five years. Each focuses on a particular technology, from 3D printing to digital production and robotics. These are industry-led, public-private partnerships for late-stage development of advanced manufacturing technologies. The Institutes were formed to help close the gap between R&D innovation and production innovation, and involve the critical actors required for developing advanced manufacturing technologies: industry, universities, community colleges, and federal, state, and local government. They match federal funding with industry and state and local government investments, in order to:

- Connect small and large firms in collaborative innovation to restore the thinned-out manufacturing ecosystem;
- Relink innovation and production through collaborations between firms and universities;
- Pursue advanced manufacturing technologies and processes that improve manufacturing efficiency and productivity;
- Provide shared facilities to support scale-up of promising technologies; and
- Train a skilled workforce to use advanced manufacturing technologies

In 2023, the 17 institutes had 2,500 reported members, including 1,177 small manufacturers; undertook over 400 applied R&D projects with 85 percent meeting key project goals; and enjoyed federal funding matched by industry and state funding at a ratio of 2.6 to 1. Nevertheless, US manufacturing has not been implementing advanced manufacturing at the scale required. China, for example, has a much larger network of over 40 comparable institutes and hubs, with much larger funding. This is a meaningful part of its rise from 5.7 percent of world manufacturing output in 2000 to 31 percent in 2024.

SOLUTION

The Manufacturing Institutes need to be enhanced to meet these long-term challenges. There are steps the administration can take.

The Departments of Commerce, Defense and Energy: Network the 17 Manufacturing USA Institutes

- The Manufacturing Institutes are organized around particular technologies, but manufacturers need integrated packages of fully coordinated new technologies to achieve maximum production efficiencies. New robots should be integrated with digital production technologies and 3D printing systems, for example. Integrating varied new technologies requires a mechanism to achieve it; there is no such mechanism now. The Manufacturing USA program describes itself as a

"network" but has never been funded to integrate across these technologies. They should be incentivized to pursue joint development among a group of institutes and provide packages of technologies that can be readily introduced by industry—particularly for small and mid-sized manufacturers that face the greatest productivity challenges. Groups of institutes should compete for a separate fund to undertake this networking and receive additional funding for packaging their various technologies together.

- Manufacturing Institute federal funding levels should be restored to at least the levels of their initial five-year terms to enable greater small firm participation and workforce education programs, and to support networking. Successful institutes meeting their technology adoption roadmaps should receive this additional funding. Manufacturing is a $2.3 trillion sector; to transform it requires additional investment. This will require smarter executive branch budgeting; if additional Congressional appropriations are required, agencies must take the lead in requesting these funds.

The Commerce Department: Tie the Manufacturing Extension Partnership (MEP) and the Manufacturing Institutes Together

- MEP has programs in every state, funded by the states with federal seed funding, to bring the best manufacturing processes to SMMs. Each MEP program has teams of engineers and experts with substantial manufacturing experience that work with SMMs to adopt new processes. The program's overall success has been validated in National Academies reports.
- MEP was created to help bring the quality manufacturing models developed in Japan to American firms (a process known as LEAN manufacturing in the US). But manufacturing technologies have evolved. The technologies resulting from the Institutes' work, as well as best practices in technology areas like robotics and digital production, need to get onto SMM factory floors.
- A much closer alliance with MEP is required. Institute funds (or alternatively National Institute of Standards and Technology funds) should back joint collaborations between MEPs and Institutes to help SMMs achieve a measurable increase in productivity and profitability by adopting Institute-supported technologies. (For more on how to improve the MEP, see "Upgrading the Manufacturing Extension Partnership to Be an Engine of Reindustrialization.")
- Part of this funding should be used for Institutes to enable SMM access to technology demonstration centers where they can test and learn new technologies with Institute help and expertise. Once new technologies are validated, MEP staff should be trained on them so they can help spread best technologies and practices to additional SMMs.
- MEPs also support workforce education programs for small manufacturers, which are most in need of them. Institute funds can support bringing advanced manufacturing skills from Institute programs to SMMs through MEPs, in addition to expanding the Institutes' own workforce efforts. (Both the Institutes

and SMMs generally will also benefit from broader workforce development improvements; see "Building a Techno-Industrial Workforce" for an example of such a proposal.)

The Departments of Defense, Commerce, and Energy: Support Scale Up of Technologies Emerging from the Manufacturing Institutes

- Manufacturing Institutes were designed to operate at Technology Readiness Levels 4–7, that is, from development through prototyping stages. However, moving the technologies they prototype into the follow-on stages of testing, demonstration, technology validation and initial production design (Technology Readiness Levels 8–9) remains a major challenge.
- Many companies, particularly SMMs, are not equipped to take prototypes and move them through these next stages themselves. While a number of Institutes have basic demonstration facilities, building these out so that the Institutes can carry out full demonstrations and technology validations is becoming increasingly important to achieve their mission. Lacking that, new technologies will too often not be adopted, particularly by smaller firms. The three agencies supporting the Institutes should direct that part of the Institutes' federal funding be directed to these later stages of technology readiness. Institutes could compete for this funding, with awards going to the best Institute proposals for scale up facilities. The Institutes could also collaborate with national labs so that their facilities could assist in the technology validation process.

JUSTIFICATION

The great majority of US manufacturing sector firms are small and mid-sized that, despite producing some 46 percent of US output, perform little in-house R&D and often have difficulty accessing the production innovation they need to compete. The Institutes can address these challenges and needs by acting as test beds, providing a range of industries and firms with opportunities to collaborate on, test, and prove prototypes for advanced production technologies and processes. The Institutes also help fill manufacturing talent gaps, training technical workers to use advanced technologies and to develop processes and routines for introducing advanced technologies into established production systems.

Many nations have been contending with these issues for the past three decades. There are ample case studies from Germany (the Fraunhofer institutes and manufacturing competence centers), the Netherlands (Smart Industry Labs), Israel (the Advanced Manufacturing Institute and Resource Efficiency Center), China (its advanced manufacturing institutes), and the UK (Catapult Centre) that show that other nations are finding value in an institute approach.

The UK's Catapult Centre, for example, rather than farming out its R&D projects to companies and universities (as the American Institutes must do), has created substantial expertise in-house. As of 2023 the Catapult has reached over 5,000 SMMs in

its over 2,800 commercialization projects. The Fraunhofer Institute system (with over 70 institutes) takes advantage of the respected Fraunhofer Laboratory to undertake full technology performance evaluations and certifications for technology prototypes emerging from the Institutes. The US has not used its labs in this way. A study of German firms with Fraunhofer engagements suggests after a year they experienced a nearly 10 percent increase in sales and a corresponding 7 percent increase in employment. China adopted and built on the US institute model; its 45 centers and hubs are operating at much larger scale, have much deeper funding, and are located in regional manufacturing ecosystems so that their technologies can move more quickly onto factory floors with substantial government assistance. The US Manufacturing Institutes must catch up. ■

FURTHER RESOURCES

- Michael Szczupak, "Lessons from Israel's Advanced Manufacturing Institute," *American Affairs*, 2024
- David Adler and William B. Bonvillian, "America's Advanced Manufacturing Problem—and How to Fix It," *American Affairs*, 2023
- David Adler, "Why 'Economic Security' Became Magic Words in Japan," *Foreign Policy*, 2023

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