

Options for a National Plan for Smart Manufacturing

Data Management and Infrastructure

Smart manufacturing utilizes next-generation technologies such as advanced sensing and computing technologies to improve the productivity, precision, efficiency, and sustainability of the workforce, factories, and supply chains. Smart manufacturing relies on data to control, manage, and optimize production at the scale of enterprises ranging from factory operations to supply chains and industry ecosystems. This requires an overlay of computing and data analytics on top of the traditional manufacturing capabilities. The United States needs to advance its capacity to manage and share data and expertise across government agencies and companies engaged in smart manufacturing to successfully encourage widespread adoption, maximize industry innovation, and be globally competitive.

At the request of Congress and the Department of Energy (DOE), the National Academies of Sciences, Engineering, and Medicine conducted a study to evaluate options for a national plan to promote and support smart manufacturing. *Options for a National Plan for Smart Manufacturing* explores promising technologies transforming the manufacturing sector and identifies research and resources needed to adopt and accelerate smart manufacturing while establishing the United States as a global leader in the field. Learn more and download the full report at <https://nap.nationalacademies.org/catalog/27260>.

TODAY'S SMART MANUFACTURING

Smart manufacturing's potential lies in the efficiency, cost, and environmental benefits that are possible when the required data are available in facilitative formats in order to apply the best machine or human action to make the best product with the fewest resources. Through the sensing, contextualization, and modeling of data to produce actionable information, smart manufacturing enables manufacturers to visualize “what” is going on; develop insights into “why” an operation is behaving a certain way; use predictive modeling to forecast “when” to expect certain behaviors; and determine “how” to control and optimize the manufacturing process.

While there is a rich base of data for many small, medium, and large smart manufacturers in the United States, the data currently reside in distributed and compartmentalized operational and business structures and are not categorized, discoverable, or accessible. The smart manufacturing sector currently lacks the technical infrastructure or common mechanisms to securely exchange data and analytics and communicate best practices across the industry. This lack of curated data hampers development of the industry and limits the capacity of new and existing manufacturers, especially small- and medium-sized companies, to adopt and benefit from smart manufacturing technologies.

DEVELOPING A CYBER INTERSTATE

The ability to readily and securely access, utilize, and update manufacturing data across the industry is a fundamental necessity for smart manufacturing. Expanding manufacturers’ access to data is necessary to increase the pace of smart manufacturing adoption throughout the industry as well as improve efficiency, productivity, resilience, and precision.

Bold thinking and ambitious efforts are required to ensure that the nation’s technical infrastructure can support this effort. **A national plan for smart manufacturing should urgently support the establishment of national transformative data infrastructure, tools, and mechanisms to assist with cultivating, selectively sharing, and securing the use of data in real time and at scale and sharing best practices to promote industry-wide technical data standards. Such infrastructure, developed as a national capability, could take the form of a secure digital network that facilitates the flow of data with controlled and credentialed access, such as a Cyber Interstate. It should be planned and coordinated with companies, government agencies, associations and consortia, and academic stakeholders.**

The Cyber Interstate would serve as an important infrastructure asset and a technical framework to enable smart manufacturing and further inspire the standards; coordination; and new organizational structures, system integration, and workforce development that drive and accelerate industry innovation and global leadership.

Fully realizing the potential of the Cyber Interstate would require the adoption of new business structures and cybersecurity practices to allow companies to take advantage of being networked and interconnected while mitigating potential risks. The Cyber Interstate must simultaneously address scaling, integration, and industry adoption in order to help firms navigate that business and market disruption. None of this is possible without providing support for workforce development to ensure that smart manufacturing workers can operate at many different levels to generate, consume, and analyze data with confidence.

DATA MANAGEMENT

While most manufacturers are invested in digital technologies to some degree, small- and medium-sized manufacturers typically have limited cybersecurity skills, staff, and resources, which can prevent them from taking full advantage of the smart manufacturing technologies. Manufacturers need better assurance that their data will be protected when they are shared and aggregated.

The report recommends DOE, in partnership with the National Institute of Standards and Technology, the Department of Defense, and federal manufacturing institutes, should establish manufacturing CASE (Calibration, Autonomy, Security, Evaluation) Data Banks for the next generation of secure manufacturing architectures.

These data banks could house rigorously validated and thoroughly curated data contributed by the

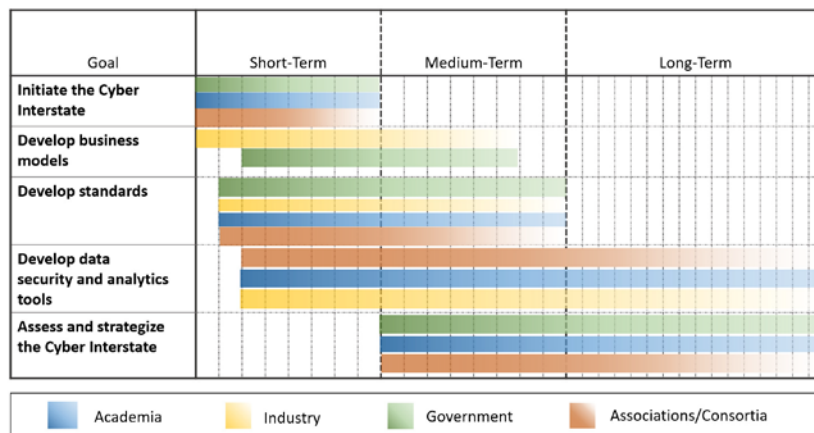


FIGURE 1 Timeline for the Cyber Interstate.

manufacturing community (across industry, academia, and government) with the goal of securely and selectively sharing the state-of-the-art process information related to manufacturing products and operations throughout

the supply chain. This will further enable cybersecure collaboration and facilitate various levels of autonomy within manufacturing and supply chain operations.

FOR MORE INFORMATION

This Consensus Study Report Issue Brief was prepared by the National Academies' National Materials and Manufacturing Board based on the report *Options for a National Plan for Smart Manufacturing* (2024).

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To read the full report, visit <https://nap.nationalacademies.org/catalog/27260>.

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