



# Learning From the Past to Plan for the Future

## Restoring Manufacturing for National Security

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President Roosevelt on the eve of World War II reached out to industry and sought its advice on how to meet pending war production demands. The current administration has sought industry's advice on how to restore our competitive advantage—in peacetime and war—through public-private cooperative partnerships. The aim is to develop “ecosystems” that promote emerging technologies and deliver new capabilities to the warfighter. Based on the advice received, the Department of Defense (DoD) established the first of eight Manufacturing Innovation Institutes, or MIIs, in 2012.

Manufacturing dominance underpins technical dominance. Historically, the collocation of scientific invention with strong manufacturing and workforce competencies has allowed the United States to move promising technologies

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*Ratcliff has been director of the Department of Defense (DoD) Manufacturing Technology Program, since 2004. She has spearheaded establishment of the six DoD Manufacturing Innovation Institutes already set up and has launched the two currently under development. The author wishes to thank Leo Grassilli for turning her on to the book “Freedom’s Forge” by Arthur Herman, which captured and preserved the history of the heroic efforts of the U.S. defense industrial base during World War II. Herman has been a close advisor to the author on matters related to the U.S. industrial base.*



into mass production, catapulting America into its position as the world's leader for innovation. It also has given our nation a decided strategic advantage to prepare for and deter wars and, when necessary, to prosecute and win them.

Last year during the 70th anniversary of the end of World War II, we celebrated the Arsenal of Democracy with a flyover of more than 70 military aircraft from that era. It was testimony to both the fighting tenacity of the women and men of that generation and the contributions of an invigorated defense industrial base to our national security.

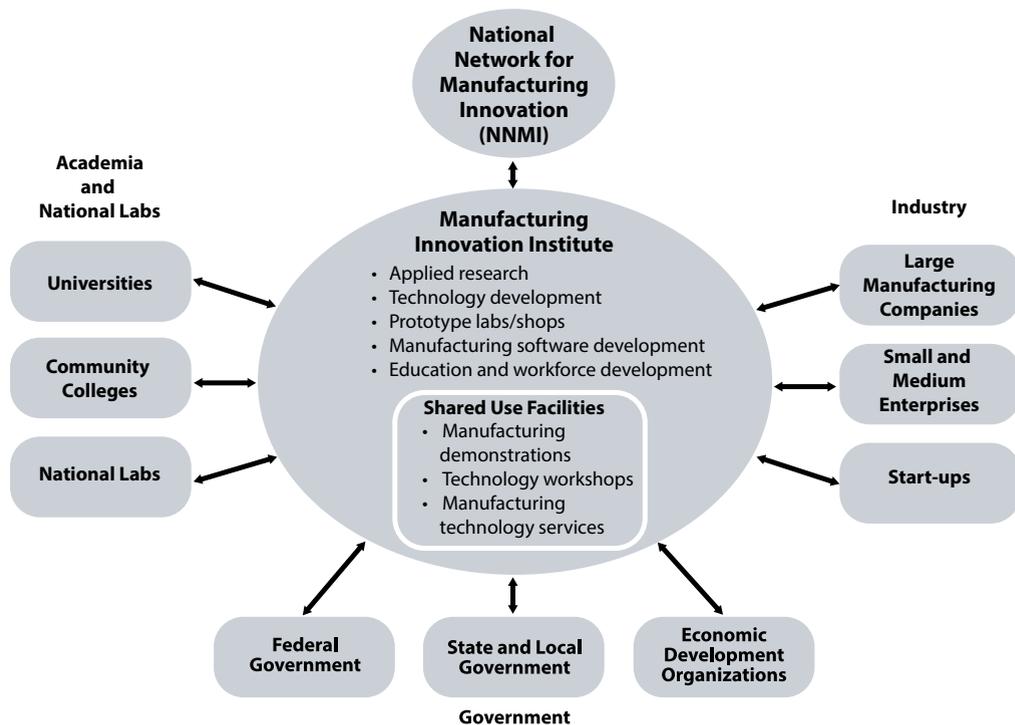
In retrospect, it wasn't easy getting there. In 1939, when Gen. George S. Patton took command of the 2nd Armored Brigade in Fort Benning, Georgia, he had a meager 325 World War I vintage tanks. At that time, the German army possessed nearly 2,000 modern Panzers. In fact, Patton had to use his own money to purchase nuts and bolts from Sears and Roebuck to equip the U.S. Army. The military aircraft situation was no better. Our defense industrial base could muster a mere 70 airplanes per month. Defense factories eventually would expand, producing thousands of airplanes every month to meet U.S. and Allied requirements.

**Competition has been shown to be useful up to a certain point and no further, but cooperation, which is the thing we must strive for today, begins where competition leaves off.**

**—Franklin D. Roosevelt**

In 2016, America is not in the same dismal war-readiness shape as it was on the eve of World War II. Nevertheless, the manufacturing base faces significant pressure as it works to support a new generation of technologically advanced war-fighting capabilities. In recent years, the Great Recession, the wars in Iraq and Afghanistan, and ongoing cutbacks in defense spending have distracted us from structural weaknesses in our defense manufacturing base. Fortunately, a countermovement is growing in government and industry to address these weaknesses and restore the critical linkage between manufacturing and defense. The building blocks for renewal are coming into place.

**Figure 1. Interconnections in the Network**



Today there is strategic promise for the DoD in new emerging technologies such as revolutionary fibers and textiles, integrated photonics, flexible hybrid electronics, and regenerative tissue. As technology becomes more complex, so have the corresponding manufacturing technologies and processes needed to convert research into products. In many cases, the developing manufacturing technologies are more challenging than the initial technology itself. While competition can drive innovation and reduce costs in mature technology areas, there is a need for cooperation to build manufacturing capabilities where complexity is beyond the ability of or risk taken by any single company to address and gaps are left in emerging areas.

The MIIs are a new frontier for manufacturing—public-private partnerships establishing rich healthy ecosystems focused on manufacturing shortfalls of new promising technologies. Along with Departments of Commerce (DoC) and Energy (DoE), the DoD-led MII program is a major component of the government-wide National Network for Manufacturing Innovation (NNMI). (See the *National Network for Manufacturing Innovation Program—Annual Report*, February 2016 [<http://www.manufacturing.gov/files/2016/02/2015-NNMI-Annual-Report.pdf>]).

### How an MII Works and Operates

The NNMI and agency-led MIIs are industry-driven public-private partnerships focused on advancing manufacturing for specific technology sectors. Within this broad rubric, the

DoD-sponsored MIIs focus on advancing manufacturing technologies and applications for both commercial and defense needs. Each MII creates the critical infrastructure necessary to provide a dynamic, highly collaborative environment spurring manufacturing technology innovations and technology transfer, leading to domestic production scale-up and commercialization. MIIs also provide the DoD with access to key enabling technologies that cost-effectively enhance the performance and capabilities of future defense systems. The DoD MIIs all share the following characteristics:

- They are regional hubs of manufacturing excellence with a national impact. They bring together industry, universities, community colleges, federal agencies and states to share infrastructure assets and knowledge to help U.S. companies gain access to cutting-edge advanced manufacturing capabilities and equipment.
- They are led by a nonprofit organization with the capacity to lead an industry-wide manufacturing technology, workforce development, and infrastructure agenda.
- They invest in applied research in industrially relevant manufacturing technologies with broad applications that accelerate innovation and bridge the gap between basic research and product development (in the Technology Readiness Level or Manufacturing Readiness Level 4-7 range).
- They educate and train students and workers in advanced manufacturing skills.
- They require a minimum of 1:1 nonfederal co-investment.
- They become self-sustaining after 5 years of core institute funding.



The Office of the Deputy Assistant Secretary of Defense for Manufacturing and Industrial Base Policy is responsible for managing the DoD MII program. Since 2012, six DoD institutes have been established, and two more are in competition:

**2012—America Makes.** Headquartered in Youngstown, Ohio, America Makes focuses on a wide spectrum of additive manufacturing technologies.

**2014—Digital Manufacturing and Design Innovation.** Headquartered in Chicago, this institution seeks to improve the utilization of data across the entire manufacturing process and

**2016—Advanced Tissue Biofabrication (ATB) Institute.**

This new center will bring together the diverse collection of industry practices across many disciplines (cell biology, bio-engineering, materials science, analytical chemistry, robotics and quality assurance) to realize the promises of advanced tissue biofabrication.

**2016-2017—Robots in the Manufacturing Environment.**

This new center is focused on machine-to-machine collaboration at the shop floor and human-to-machine interface. The same technology can be applied in commercial robots in medical procedures, space exploration, mines and earthmoving, and

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product life cycle. Design, production and assembly operations and the entire supply chain are optimized to reduce the cost and time involved in manufacturing.

**2014—Lightweight and Modern Metals Manufacturing Innovation** (now referred to as LIFT: Lightweight Innovations for Tomorrow). Headquartered in Detroit, LIFT focuses on accelerating the transfer of new lightweight metals and manufacturing technologies from the lab to the production floor.

**2015—American Institute for Manufacturing (AIM) Integrated Photonics-AIM Photonics.** Headquartered in Albany, New York, AIM focuses on developing an end-to-end integrated photonics ecosystem in the United States, including domestic foundry access, integrated design tools, automated packaging, assembly and test, and workforce development.

**2015—NextFlex.** Headquartered in San Jose, California, NextFlex is developing flexible hybrid electronics to support wearable electronics and new medical and sensor capabilities.

**2015—Advanced Functional Fabrics of America (AFFOA).** Headquartered in Boston, AFFOA will deliver revolutionary advances across the entire fabric supply chain enabling fiber to act as an electronic device. In addition, new multifunctional fibers and advanced nonwovens and yarn production will provide lightweight structural and protective capabilities.

Two additional DoD-led institutes are in competition:

service robots at home and in patient recuperation—especially for the aging population.

In addition to those of the DoD, the DoE has established two MIIs with three in planning and acquisition.

**DoE—2014 Power America.** Headquartered in Raleigh, North Carolina, Power America focuses on wide-bandgap semiconductor technologies for next-generation, energy-efficient high-power electronic components and assemblies that are cost competitive with current silicon-based power electronics.

**DoE—2015 Institute for Advanced Composites Manufacturing Innovation.** Headquartered in Knoxville, Tennessee, the Institute focuses on fiber-reinforced polymer composites targeting clean energy manufacturing industries. There is a particular emphasis on wind, automotive and compressed gas storage tanks applications.

DoC/NIST currently is establishing two additional institutes this year. This will bring the total to 15 institutes established since 2012. The DoD has been operating at breakneck pace since 2012 to establish the MIIs. Early indications suggest that we have made the right call. We are taking the long view toward defense-related manufacturing and its role in innovation, technical dominance and the preservation of our strategic warfighting advantage. Our defense readiness and national security needs demand nothing less. 

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