From Discovery to Scale-up: About the National Network for Manufacturing Innovation

In his 2012 State of the Union address, President Obama laid out his "blueprint for an economy that's built to last – an economy built on American manufacturing, American energy, skills for American workers, and a renewal of American values."

"This blueprint," he said, "begins with American manufacturing."

The President chose this starting point for good reason. Numerous recent reports have documented how critical U.S. manufacturing is to innovation,[1] jobs,[2,3] the economy,[4] exports,[5,6] and national security.[7] He has initiated a set of actions designed to make our manufacturing sector more competitive and to encourage more investment here, in the United States. Together, these actions encompass sound tax policies, enforcement of trade laws, and investments in innovation, advanced technology, education, and infrastructure.

According to the non-partisan Council on Competitiveness, "U.S. manufacturing is more important now than ever." While not dismissing serious challenges posed by low-cost competitors and rivals that are fast advancing in technological capabilities, the council maintains that "enormous opportunities to increase production and grow exports" lie ahead for U.S. manufacturers. "The digital, biotechnology, and nanotechnology revolutions," it reports,"are unleashing vast opportunities for innovation and manufacturing."[8]

Moving to put his blueprint into action, the President has launched a major, new initiative focused on strengthening the innovation performance, competitiveness, and job-creating power of U.S. manufacturing: the National Network for Manufacturing Innovation (NNMI). The network will help to address a damaging inconsistency in U.S. economic and innovation policies. The federal government invests more than $100 billion in research and development (R&D) and offers a tax credit for industry-funded R&D. Yet, these measures are not matched by corresponding, strategically designed and implemented efforts and incentives to encourage domestic manufacturing of technologies and products ultimately arising from U.S. discoveries and inventions.

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[1] President's Council of Advisors on Science and Technology (2011), *Report to the President on Ensuring Leadership in Advanced Manufacturing*.
[2] Bureau of Labor Statistics, *2011 Employer Costs for Employee Compensation*, Table 6.
[3] National Science Board, *Science and Engineering Indicators 2012*, Appendix Table 4-14 and Table 3-32
[4] Bureau of Economic Analysis, *2010 U.S. Economic Accounts by Industry*, see http://www.bea.gov/industry/index.htm.
[5] Bureau of Economic Analysis, *Industry-by-Industry Total Requirements Table*, see http://www.bea.gov/industry/iotables/prod/
[6] Bureau of Economic Analysis and Census, *U.S. International Trade in Goods and Services*
[7] National Science and Technology Council (2012) *A National Strategic Plan for Advanced Manufacturing*
[8] Council on Competitiveness (2011), *Make, An American Manufacturing Movement.* Available at: http://www.compete.org/publications/detail/2064/make/

The NNMI Proposal

In his budget for fiscal year 2013, the President proposes creating a network of up to 15 regional Institutes for Manufacturing Innovation (IMIs). Funded by a proposed one-time,$1 billion investment, this network—the NNMI—responds to a crucial competitiveness challenge and threat to future prosperity: Closing the gap between research and development (R&D) activities and the deployment of technological innovations in domestic production of goods.[9]

IMI activities may include, but are not limited to: applied research and demonstration projects that reduce the cost and risk of commercializing new technologies or that solve generic industrial problems, education and training at all levels, development of innovative methodologies and practices for supply-chain integration, and engagement with small and medium-sized manufacturing enterprises (SMEs).

The proposal implements recommendations made by the President's Council of Advisors on Science and Technology and a wide range of other experts and organizations.[10,11,12,13] It reckons with the reality that investing in basic research isn't enough to make sure that a new technology crosses the bridge from invention to product development and process prototyping to manufacturing at scale.

The IMIs will bring together industry, universities and community colleges, federal agencies, states, and localities to accelerate innovation and subsequent market-share growth by investing in industrially-relevant manufacturing product and process technologies with broad application.

The President unveiled his proposal to build the NNMI on March 9, 2012. At the same time, he initiated steps to jumpstart the network by launching a pilot Institute for Manufacturing Innovation, using existing resources from the Departments of Defense and Energy and, perhaps, other federal agencies. On May 9, the federal government issued a solicitation for proposals from teams led by non-profit organizations or universities to establish an Additive Manufacturing Innovation Institute, which would serve as a proof-of-concept/ prototype IMI.

Together, industry partners, state and local agencies, foundations, and others will co-invest with the federal government in each IMI. A strong partnership between industry and local stakeholders is required for federal efforts to serve as a catalyst.

The Need for NNMI

Many technologies rooted in U.S. research fail to mature to full scale-up and commercialization in domestic factories. As documented by National Science and Technology Council, "A gap exists between R&D activities and the deployment of technological innovations in domestic production of goods," contributing significantly, for example, to the disturbing and still-growing trade deficit in advanced technology products.

[9] National Science and Technology Council (2012), op. cit.
[10] President's Council of Advisors on Science and Technology (2011), op. cit.
[11] Brookings-Rockefeller Project on State and Metropolitan Innovation (2011), *Accelerating Advanced Manufacturing with New Research Centers.*
[12] Information Technology and Innovation Foundation (2011), *The Atlantic Century II: Benchmarking E.U. and U.S. Innovation and Competitiveness*.
[13] National Science and Technology Council (2012), op. cit.

In 2011, the U.S. ran a $99 billion deficit in trade of advanced technology products, accounting for 17 percent of the total U.S. trade deficit.[14] The U.S. has lost 687,000 high-technology manufacturing jobs since 2000,[15] when the nation posted a $5 billion trade surplus in advanced technology products.

Manufacturing plays a disproportionately large—and valuable—role with respect to the nation's innovation capacity. It accounts for about 12 percent of the nation's gross domestic product, but performs 70 percent of domestic industry R&D and employs 60 percent of industry's scientists and engineers. Thus, manufacturing remains the essential core of the U.S. economy's innovation infrastructure. The rapidly growing high-tech service sector gets most of its technology from manufacturing firms.

Other nations also recognize the strong links between manufacturing, innovation, and prosperity. Not only that, many are making investments to strengthen the links. Currently, Germany, Korea, and Japan each have more R&D-intensive manufacturing sectors than the United States, and all three have positive balances in trade of goods.[16]

Accelerating innovation and implementation of advanced manufacturing capabilities requires bridging a number of gaps in the present U.S. innovation system. "Market failures" are a major deterrent to private-sector investment to advance and refine new, cutting-edge technologies with the ultimate goal of realizing their transformative potential. Time horizons typically exceed investor expectations for realizing returns, and technical and commercial risks are greater.

As a result, companies are reluctant to invest in technology development efforts that aim beyond incremental improvements in existing products and processes.

Knowledge spillovers are a related obstacle to patient, sustained private-sector investment in developing promising leapfrog technologies all the way through to the points of manufacturing and commercial feasibility. Similarly, because of spillovers and the so-called free-rider problem, no single company will take on the risk and devote the resources needed to build the full infrastructure of underpinning manufacturing capabilities and complementary resources that would benefit an entire industry and even groups of industries.

Historically and even today, the U.S. has excelled at basic science, invention, and innovation. But the commercial and economic rewards that can sprout and grow from these important early-stage accomplish are realized in the post-innovation stages—especially at the points manufacturing scale-up and commercialization.

As technologies and products become ever-more complex and their life cycles shrink, successfully mastering all the stages from lab to marketplace requires contributions from a large network of organizations—from suppliers of equipment, parts, and services to schools, colleges, and training programs to utilities and other infrastructure systems. And, as global competition to manufacture and sell high-value-added products heats up, the capabilities and performance of these so-called innovation ecosystems also must improve.

The President's proposed NNMI and the regional collaborations it catalyzes will tackle barriers to rapid and efficient development and commercialization of new advanced product and manufacturing-process innovations. The network and its individual IMIs will enable companies to collaborate and access the capabilities of our research universities and other science and technology organizations to support scaling up manufacturing and

[14] U.S. Census Bureau, "Trade in Goods with Advance Technology Products," 2011.
[15] National Science Board, *Science and Engineering Indicators 2012*.
[16] National Science and Technology Council (2012), op. cit.

assembly process At the same time, the IMIs will help to meet the challenge of building the pool of high-skilled talent that advanced manufacturing requires.

Defining the NNMI

The NNMI will consist of up to 15 dynamically linked regional clusters of manufacturing innovation. An IMI—each with technology focus will leverage and expand the industrial, research, and institutional strengths of the region—will be a central element, designed to catalyze collaboration and maximize shared infrastructural resources. The focus of each Institute will be unique, determined through a competitive application process, but all IMIs will concentrate on adopting, refining, and applying promising emerging technologies.

In bridging the gap between applied research and product development, IMIs will provide shared assets to help companies gain access to cutting-edge capabilities and equipment, and to educate and train students and workers in advanced manufacturing skills. Over a specified period, each IMI will become a self-sustaining technical center of excellence

As nodes of a network, IMIs will complement each other's capabilities and benefit from shared approaches to such matters as intellectual property, contract research, and performance metrics. While the institutes will be regionally focused, the network will be national, integrated, and dynamic, aiming to fostering innovation and delivering new capabilities that can impact the manufacturing sector on a large scale.

Planning the NNMI

The NNMI program will be managed by the interagency Advanced Manufacturing National Program Office (AMNPO). Participating agencies include the Department of Defense, Department of Energy, Department of Commerce's National Institute of Standard and Technology (NIST), NASA, the National Science Foundation, and other agencies. Industry, state, academic, and other partners will co-invest in the IMIs. As proposed, the federal government will make a $1 billion, one-time investment in the NNMI program.

Federal, cost-shared funding will be allocated by means of competitive solicitations staged over several years. This start-up investment will support capital and initial operating expenses for up to 15 Institutes. Federal support will be contingent on co-investment by businesses and other non-federal entities and on progress toward sustainable operations. Institutes must become financially sustainable within seven years.

Each IMI will integrate capabilities and facilities required to reduce the cost and risk of commercializing new technologies and to address relevant manufacturing challenges on a production-level scale. Each will have a well-defined technical focus and will be selected through a competitive process.

Institutes will be able to form multi-disciplinary research and demonstration project teams that include both industrial and academic experts. Integral elements of IMI partnerships, participating research universities and other educational institutions will allow affiliated researchers and students to participate in these project teams, which also will include personnel from participating companies.

Next Steps: Detailed Design from Broad Public Engagement

To strengthen the information base for Congressional consideration and to facilitate input from key stakeholders, the AMNPO has issued a Request for Information (RFI) specific to the NNMI. As part of its outreach and information-gathering effort, the office is holding regional workshops across the country. The workshops also will focus on the design, operation, technology emphases, and other as aspects of the network and its constituent IMIs.

This consultative process for the NNMI will have similarities to the consultative process for the pilot institute but will be much broader in scope. Through these outreach efforts, the federal agency partners will seek to identify a wide-ranging set of technology focus areas for up to 15 IMIs The RFI and workshops also will explore institutional design and governance issues, such as the ownership and handling of intellectual property generated by the NNMI and management of the network as a whole to amplify the impact of its member Institutes.

Specifically, the AMNPO is seeking input pertaining to four key aspects critical to the effectiveness of the NNMI:

- IMI Focus Areas: Technologies with broad impact , such as an emerging process technology, class of advanced materials, broadly useful enabling technologies for optimizing manufacturing capabilities, or industry sector;
- IMI Structure and Governance;
- Strategies for Sustainable Institute Operations; and
- Education and Workforce Development

An interagency program management team will review public input gathered through workshops, responses to the NNMI RFI, and the AMNPO's Advanced Manufacturing Wiki. The interagency will be responsible for designing the network and conducting open competitions for selecting recipients of IMI awards.

For more information, go to the AMNPO's advance manufacturing web site at: http://manufacturing.gov/advanced_manufacturing.html