



DoD Manufacturing Phase II Study – National Academy



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DOD Engagement with Its Manufacturing Innovation Institutes Phase 2 Study: Final Report

Discussion with NDIA Manufacturing Division
16 February 2022

Background

- In 2020, the OSD ManTech asked the Academies to perform a second rapid response study to examine three important suggestions from the first study. The Statement of Tasks for the Phase 2 Study is to provide general strategic guidance in:
 - a) Task 1: Protocols for conducting long-term engagement assessments of the MII, including evaluation criteria;
 - b) Task 2: Best practices in education and workforce development (EWD) for the MII, including scale-up methodologies for collaborative efforts by the MII in EWD; and
 - c) Task 3: Steps for improving MII linkages with other parts of the DOD and with the broader federally funded research enterprise;
- An Interim Report focused on Task 1 was provided in April 2021. The Final Report, with a focus on Tasks 2 and 3, was provided in November 2021 and is available at:
<https://www.nap.edu/download/26329>

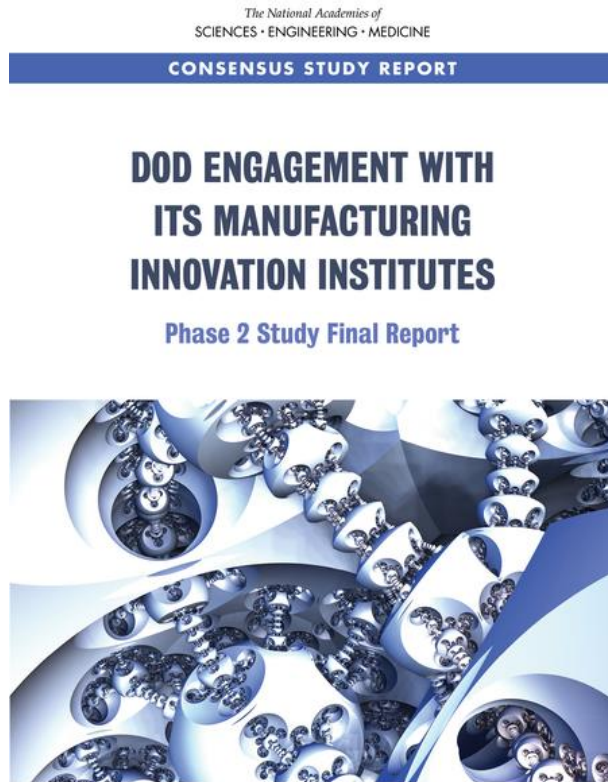
Background: Committee

- WILLIAM B. BONVILLIAN, Massachusetts Institute of Technology, *Co-Chair*
- THOMAS M. DONNELLAN, Applied Research Laboratory, Pennsylvania State University, *Co-Chair*
- MEGAN BREWSTER is the VP for Advanced Technology at Impinj
- GAIL L. (DOLAN) HAHN, Boeing
- THERESA KOTANCHECK, Evolved Analytics, LLC
- MICK MAHER, Maher & Associates, LLC
- MICHAEL McGRATH, Independent Consultant
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- JAMES LANCASTER, Director, NMMB and the Board on Physics and Astronomy (retired)
- NEERAJ P. GORKHALY, Associate Program Officer
- JOSEPH PALMER, Senior Project Assistant
- AMISHA JINANDRA, Research Associate

Report Contents



Summary

1. Introduction
2. Protocols for Long-term Engagement Assessments for the DoD MIIs (including ecosystem recommendations)
3. Education and Workforce Development
4. Improving MII Linkages with DoD and Other Federal Sponsors for Technology Development and Transition
5. Trends in Manufacturing and Workforce Development Driven by Covid-19 effects

Appendices (including full text of Interim Report)

Presentation Outline

- Manufacturing Ecosystems (from Chapter 2)
[Ben Wang](#)
- Education and Workforce Development (Chapter 3)
[Bill Bonvillian](#)
- Engagement Strategies for DoD and Federal Agencies for the DoD MII's (Chapter 4)
[Mike McGrath](#)
- Open Discussion

Manufacturing Ecosystems

Advanced Manufacturing Ecosystems	Focus Areas of Shared Objectives
Supply Chain Ecosystem	Source raw materials, calibrate supply to demand, facilitate storage and distribution of finished product to customer.
Production Ecosystem	Make products that meet customer requirements, quality standards, and cost margins.
Customer Ecosystem	Connect and engage with customers, enable customers to order, maintain, and service products.
Talent Ecosystem	Create pipelines for skills and roles that are needed to support smart (advanced) manufacturing.

Ecosystem Recommendations (1 of 4)

2.1 - OSD ManTech should create an **Advanced Manufacturing Ecosystems Team**.

Such a team will (1) help shape a vision and key strategies for the DoD MII ecosystems, (2) identify and share best practices across all DoD MIIs, and (3) coordinate manufacturing ecosystems initiatives across DoD-funded MIIs similar to what the education and workforce development lead does for education and workforce development.

Ecosystem Recommendations (2 of 4)

2.2 - With respect to manufacturing ecosystem development, OSD ManTech should **direct each MII to:**

- 1) Describe the advanced manufacturing ecosystem that they envision based on the needs of DoD science and technology, acquisition, and sustainment, as well as the commercial manufacturing community they serve.
- 2) Articulate its role and responsibilities and develop a well-thought-out plan for growing and improving the ecosystem.
- 3) Develop a process by which the MII will monitor the health, resilience, return on investment, and effectiveness of its ecosystem; identify gaps—innovation, human capital, partnership, risks, supply chains, infrastructure, and other factors; and take necessary actions or make actionable recommendations to DoD to close the gap as quickly as possible.

Ecosystem Recommendations (3 of 4)

2.3 - To ensure effective and broad-based deployment and adoption of the technologies and workforce developed by the MIs and the strengthening of manufacturing ecosystems, **OSD ManTech should assist MIs in forming strong partnerships with other federally-recognized regional ecosystems,** as well as the federal offices that promote these ecosystems, including the state-level Manufacturing Extension Partnerships, the Defense Manufacturing Community Support Program hubs, and their federal offices (the Department of Commerce's National Institute of Standards and Technology Manufacturing Extension Partnership and DoD's Office of Local Defense Community Cooperation, respectively).

Ecosystem Recommendations (4 of 4)

2.4 - To leverage DoD's investments in MII in building and growing U.S. manufacturing ecosystems, **OSD ManTech should continue to assist MII in forming symbiotic partnerships with state and local government** for economic development, education and workforce development, and research and development.

The committee recommends that OSD ManTech initiate a couple of pilot projects across all MII in key regions and then scale across the balance of the United States after refinement.

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Task 2, Chapter 3 - Education and Workforce Development

- Task 2(a) - Workforce Education Models from Across the Nation Relevant to MII Workforce Efforts
- Task 2(b) - Manufacturing Innovation Institutes and the Organic Industrial Base
- Task 2(d) - Online Education as a Scaling Mechanism for Workforce Education
- Task 2(e) - Credentials and Certifications

General Background - Workforce Education Problems

- Disconnect between work and learning
- Disinvestment by government and employers
- Disconnected federal programs
 - Labor Department training programs don't reach higher technical skills or incumbent workers
 - Education Department programs are focused on college degrees rather than workforce needs and they are not linked to the Labor Dept. programs.
- Vocational education in secondary schools was largely dismantled
- Community colleges are underfunded. They lack resources to provide advanced training in new fields and their student completion rates are too low
- Lifelong learning is missing.
- Colleges and universities are disconnected from workforce education
- Broken labor market information system
- Legacy sectors - hard to change

Task 2(a) - Workforce Education Models from Across the Nation Relevant to Manufacturing Innovation Institute Workforce Efforts

- For Workforce Ed Tasks MII should (Interim Report):
- Develop, with industry and education institution involvement, **knowledge, skill, and ability (KSA) elements and corresponding competencies**;
- Develop **education materials with and to be used in its education and industry ecosystem**;
- Develop **online education materials** available to industry and educational institutions.
- Form **regional engagements** around workforce education needs;
- Work with industry to develop or apply **industry-recognized credentials**;
- **Map skill demand** and developing **skill roadmaps**, both regionally and nationally - w/metrics on national/regional skill supply in tech area

Task 2(a) - Many of the optimal nationwide best practices listed below could inform the recommended MII workforce efforts:

– Approaches to Curriculum Design

- Engage with groups of employers - more efficient and lasting than single employer
- Statewide industry & Community College (CC) coordination mechanisms (Ohio)
- Reach all 3: new entrant, underemployed and incumbent workers (Asnuntuck CC, Conn.)
- Short courses w/stackable credentials leading to degrees. certifications (Valencia CC)
- Modular approaches to curriculum (Monroe CC, Rochester)
- Tie degrees to industry-recognized credentials (Ivy Tech, Indiana)
- Apprenticeships (break down the work/learn barrier - Trident Tech)

Task 2(a) - nationwide best practice approaches, continued

- Preferred approaches for Program Content
 - Systems thinking - the “why” not just the “how” - ability to manage systems across a factory floor, not just one machine
 - Hub and Spoke design - add adv’d mfg. skills to hub of systems thinking - technologist not just technician
 - Completion: build remedial programs into career programs (Tenn. TCATs)
- Preferred approaches for Scaling up Programs
 - Use online education for blended learning model
 - Access to Adv’d Mfg. Equipment - regional equipment-sharing (Conn. CC’s)
- *Note: each best national practices tracks into MII recommended efforts*

Task 2(a) - Nationwide Preferred Approaches Recommendation:

- Recommendation 3.1: OSD ManTech should encourage preferred approaches for workforce education delineated in this report and listed in the above findings be included by MIs through the best practices set out in the Interim Report: forming regional engagements around workforce education needs; developing education materials with the MI's education and industry ecosystem; developing, with industry and education institution involvement, knowledge, skill, and ability (KSA) elements and corresponding competencies; working with industry to develop or apply industry-recognized credentials; developing online education materials available to industry and educational institutions, and mapping skill demand and in developing skill roadmaps. In furthering these best practices, NSF's ATE program, NIST's MEP program, DoD's OLDCC program, Labor Department workforce and apprenticeship programs, and other agency workforce programs, could be expanded or new collaborators on these efforts. OSD ManTech should also encourage the MIs as a network to strengthen ties with programs with connections to community colleges that can help build and spread their programs in these areas. ManTech should provide leadership for MIs in these collaborations and on the MI networking that will be required for creating training packages across technology areas to meet industry needs.

Task 2(b) - Manufacturing Innovation Institutes and the Organic Industrial Base

- The DoD OIB (depots, arsenals, shipyards, and ammunition plants) handle maintenance, repair and overhaul - 88,000 ee's
 - could be a significant ecosystem partner for new technologies developed by the DoD-funded MII's
 - Will require a workforce with the requisite skills.
- Limited examples to date.
- One successful example: partnership between ARM and Warner Robins ALC in Ga. through Joint Robotics Organization for Building Organic Technologies (JROBOT)
 - Developing robotics training and use in depot

Task 2(b) - MII and the DOD Organic Industrial Base

- JROBOT example resulted from personal contacts and leadership from senior personnel in DoD.
- It presents a “best practice” opportunity for MII-OIB partnerships to be developed more systematically.
- Aim: establish formal engagements between the DoD MIIs and appropriate DOD tech working groups
 - via JTEG (Joint Technology Exchange Group) and other joint technology collaborative groups in DOD.
- MEP could also help in reaching SMMs on this engagement

Task 2(b) MII/OIB Recommendation

- Recommendation 3.2: OSD **ManTech should work to ensure a systematic link between the DoD OIB (i.e., depots, arsenals, shipyards, and ammunition plants)** and the MIIs, for both new manufacturing technologies and adoption of related EWD.
- Recommendation 3.3: OSD and the **MIIs should** strengthen MII engagement with the DoD OIB by **identifying, encouraging, adopting and generalizing best practices (such as the Advanced Robotics for Manufacturing [ARM] partnership with Warner Robins ALC through JROBOT)** across the MIIs.
- Recommendation 3.4: OSD ManTech and the MIIs should **strengthen partnerships with the NIST MEP centers** to ensure connections to the DoD OIB (as well as to the commercial SMMs that are part of the DoD industrial base) and to facilitate new manufacturing technology adoption and workforce training.

Task 2(d) - Online Education as a Scaling Mechanism for Workforce Education

- Online is a critical way to scale workforce education
- New technologies - simulations, gaming, VR/AR can enhance online for workforce ed - enable hands-on approaches need for workforce ed
- Online education can apply new learning science (ex's: ten minute chunks, desirable difficulties, frequent quizzes, interleaved content, assessment and feedback loops) to optimize effectiveness
 - asynchronous video not zoom, which misses the learning science
- Blended is best

Task 2(d) Recommendation

- Recommendation 3.5: Given manufacturing workforce needs and because of their importance as a scaling mechanism, OSD ManTech should continue to encourage, support, and expand the initiatives for online and blended workforce education by manufacturing institutes. Online education and related blended learning should become a significant focus of institute education and workforce development efforts, including their efforts with their regional manufacturing ecosystems, because of its potential to scale up skills training in their advanced manufacturing fields. This should include support by OSD ManTech for: institute use of new educational technologies such as computer gaming, simulations, blockchain certifications, virtual and augmented reality (VR/AR), and digital tutors; incorporation by institutes of online materials of pedagogies that reflect learning science advances; collaborations between ManTech and military services' VR/AR training simulation development programs; expanded use by institutes and other DoD agencies of the Open edX platform for access to online education materials; and other approaches noted in this discussion.

Task 2(e) - Credentials and Certifications

- Industry credentials:
 - tell employers what skills employees have,
 - tell employees what skills they need, and
 - tell education institutions what to educate for
- Yet: inconsistently or not widely used in manufacturing
- Industry-recognized credentials can be a foundation for a strong workforce in advanced manufacturing
 - Ex.: Cisco/Microsoft skills certifications key to IT sector talent
- MIs with their ties to industry are in good position to help develop these credentials

Task 2(e) - Credentials, con't

- 2 kinds of MIs:
 - “closer-in” - technologies starting to enter factories
 - “further-out” - technologies still in development
- Further-out MIs can work with industry members in establishing new credentials in their technology areas
- Closer-in MIs can review and endorse established credentials
 - Ex: ARM has reviewed credential packages and developed KSA and is certifying adv'd robotics programs in CCs as endorsed by ARM

Task 2(e) Recommendations

- Recommendation 3.6: OSD ManTech should encourage the MIs to build **strong partnerships with** educational institutions including **2-year colleges and industry in developing credential curricula and programs** that meet the needs of regional manufacturers.
- Recommendation 3.7: OSD ManTech should encourage the MIs to engage industry, education, training, and credentialing organizations, standards development organizations, and other government agencies in increasing public awareness, and accelerating the recognition and acceptance of industry-recognized credentials in their technology areas.

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Chap 4. Improving MII Linkages with DoD and Other Federal Sponsors

Key Points

1. **There has been progress** since the 2019 recommendation to increase customer sponsored projects
2. **OSD's Strategic Communications Plan** is good approach to increase awareness, identifies key stakeholders. Need to add engagement plan for project sponsorship.
3. **Engagement with S&T communities** beyond core funded projects is spotty, engaged through personal connections. MIIs need DoD help for more structured engagement.
4. **Linkages with Acquisition and Sustainment will require changes.** MIIs are structured for TRL/MRL 4-7 and some have slow contracting process. Transition and commercialization customers need path to maturity and scale-up, including openness to new participants and contracting convenience.

Key points (cont'd)

5. **Best practices for Transition and Commercialization** involve: dedicated personnel, assistance to non-traditional contractors, facilitated relationships with ecosystem providers and transition-friendly contracting mechanisms. Other Transaction Agreements (OTAs) have attractive features.
 - Service ManTech Practices for Transition
 - Metals Affordability Initiative
 - SBIR Practices for Transition
 - Use of OTAs and OTA Consortia
 - DARPA Embedded Entrepreneurship Initiative
6. **Linkages to Other Agencies** can tap the basic research pipeline and partner to mature technologies and transition for scale-up. The NSTC Subcommittee on Advanced Manufacturing is a good forum for engagement

Recommendations (1 of 5)

4.1 - OSD ManTech should continue implementation of the Strategic Communication and Outreach Plan, and develop a **supplementary Engagement Guide** as a resource for direct engagement with MII stakeholders.

The Guide should identify the contractual vehicles available for contracting with the MII organizations, explain the unique capabilities and benefits of the DoD MIIs to the broader DoD S&T, acquisition, and sustainment communities, and provide a starting point for engaging stakeholders to sponsor work at DoD MIIs.

Recommendations (2 of 5)

4.2 - OSD ManTech should develop a **formal strategy of engagement with the S&T community** to facilitate connections with MIs who have capabilities to help with MRL advancement.

The strategy should include connections with the Reliance 21 Communities of Interest and Service S&T organizations, with assistance from the JDMC. A key component of the strategy would be an S&T Program Development guide for the MIs which documents best engagement practices from Institutes acting individually or in collaboration. OSD ManTech can implement the S&T engagement strategy working with the MIs and government PMs.

Recommendations (3 of 5)

4.3 - OSD ManTech should fund a **team of transition facilitators to assist MII in engaging Service acquisition and sustainment communities.**

This team should establish DoD connections through coordination with the JDMTP, with additional assistance from JDMC when needed or when MII topics do not overlap with a JDMPT subpanel topic, such as bio-related connections. The role of the DoD team is to facilitate initial contacts. MII host organizations and members need to follow through with engagements to iterate with potential DoD sponsors on needs, including DoD needs on MII roadmaps, and identify solution concepts that are mature enough for transition projects.

Recommendations (4 of 5)

4.4 - OSD ManTech should add a transition-friendly contracting interface with the MIIIs configured for projects sponsored by the DoD acquisition and sustainment communities.

A spectrum of effective contracting models is available for transition projects, using OTAs or FAR contracts, implemented at the project level, MII level or Multi-MII level, through a single or multiple contracting offices. The committee saw several advantages in an OTA consortium model across the MIIIs based on the widespread DoD use of such models. The committee recommend OSD ManTech choose a model on this spectrum, with selection based on cost, effectiveness in engaging new transition sponsors and industry performers, and feasibility of implementation.

Recommendations (5 of 5)

4.5 - OSD ManTech should designate a focal point to **develop an MII engagement strategy for other federal agencies which defines the value proposition of the MIIs relative to the organizational needs of these agencies, and to execute this strategy.**

DoD should actively engage members of the National Science and Technology Council Subcommittee on Advanced Manufacturing (NSTC SAM) to raise awareness of the MIIs and their roadmaps, identify common priorities in the technology focus areas of the MIIs, and discover actionable paths forward (including contracting mechanisms) with other federal agencies. Objectives should include enabling researchers funded by other agencies to utilize the DoD MIIs' unique shared infrastructure, co-funded projects of mutual interest, and leverage of loan guarantees and other transition and scale up assistance mechanisms available with non-DoD agencies.

Q&A and Group Discussion