

Advanced Manufacturing National Program Office

**Public Comments Received For Draft
Institute Performance Metrics
for the
National Network for
Manufacturing Innovation**

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http://www.manufacturing.gov/docs/nnmi_draft_PM_comments.pdf

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Foreword

The interagency Advanced Manufacturing National Program Office (NPO) is hosted by the National Institute of Standards and Technology (NIST). Creation of the Advanced Manufacturing NPO flows from the recommendation of the President's Council of Advisors on Science and Technology (PCAST), in its June 2011 Report to the President on Ensuring American Leadership in Advanced Manufacturing,¹ that the Federal government launch a concerted, whole-of-government Advanced Manufacturing Initiative. To that end, this interagency office is charged with:

- Convening and enabling industry-led, private-public partnerships focused on manufacturing innovation and engaging U.S. universities, and
- Designing and implementing an integrated whole-of-government advanced manufacturing initiative to facilitate collaboration and information sharing across federal agencies.

By coordinating federal resources and programs, the Advanced Manufacturing NPO seeks to enhance technology transfer in U.S. manufacturing industries and help companies overcome technical obstacles to scaling up production of new technologies.

The National Network for Manufacturing Innovation (NNMI) proposed by President Obama has the goal of advancing American domestic manufacturing² by creating a robust national innovation ecosystem anchored by a network of Manufacturing Innovation Institutes (Institutes). The NNMI will fill a gap in the innovation infrastructure, allowing new manufacturing processes and technologies to progress more smoothly from basic research to implementation in manufacturing. The NNMI program will have a scale and focus that is unique, and it is built upon concepts of a strong public-private partnership.

Abstract

Using a strategy of broad public engagement, in April 2012, the Advanced Manufacturing NPO began collecting input on the National Network for Manufacturing Innovation (NNMI or Network) program design. The collection of information from the public was initiated by a NIST Request for Information (RFI), published in the Federal Register,³ followed by a series of regional workshops sponsored by Advanced Manufacturing NPO partner agencies and focused on the issues presented in the RFI. Reports summarizing the findings from the RFI and each workshop were published.⁴ In January 2013, the National Network for Manufacturing Innovation: A Preliminary Design report was published, built upon public input received.⁵

The Advanced Manufacturing NPO task team focused on Institute Performance Metrics for the NNMI was formed to develop and recommend policy for the NNMI. A draft set of institute performance principles, intended to guide Institute applicants, was published on November 13, 2013. The current document presents public comments received in response to that document.

¹ Available at <http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-advanced-manufacturing-june2011.pdf>.

² President Obama to Announce New Efforts to Support Manufacturing Innovation, Encourage Insourcing; <http://www.whitehouse.gov/the-press-office/2012/03/09/president-obama-announce-new-efforts-support-manufacturing-innovation-en>.

³ "Request for Information on Proposed New Program: National Network for Manufacturing Innovation (NNMI)," 77 FR 26509, May 4, 2012. Available at <https://federalregister.gov/a/2012-10809>.

⁴ Reports are available at http://www.manufacturing.gov/pubs_resources.html, under the "Advanced Manufacturing National Program Office (AMNPO)" heading.

⁵ Available at http://www.manufacturing.gov/pubs_resources.html.

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To learn more about the interagency Advanced Manufacturing NPO, visit www.manufacturing.gov

Disclaimer

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A. BACKGROUND

The “Draft Institute Performance Metrics for the National Network for Manufacturing Innovation” (attached as an Appendix below) was published on November 13, 2013, as part of a Request for Comment from the public. The performance metrics listed in the report are intended to be used to help measure the successes of the Manufacturing Innovation Institutes (Institutes) that will comprise the National Network for Manufacturing Innovation (NNMI) or Network. These would apply to the Network and the Institutes that are created once appropriate legislation has been enacted.⁶ This document is one of a series of documents generated to inform and seek feedback from the public on various elements that go into the creation and growth of the Network.

B. COMMENTS RECEIVED

Public comments were requested through December 13, 2013. There were 68 individual comments submitted by 11 organizations — including industry, academia, nonprofits, and government — which are presented below in the current report.

The table that follows presents the comments received in response to the request for public review and comment on *Draft Institute Performance Metrics for the National Network for Manufacturing Innovation*. Comments are presented verbatim, and without attribution as to the sources. Grammatical and other minor edits for clarity are contained within square brackets [·].

C. NEXT STEPS

The public comments and other sources will be used along with other input to develop a revision of the Institute Performance Metrics policy document.

⁶ Current proposed legislation includes: H.R.2996 entitled “Revitalize American Manufacturing and Innovation Act of 2013,” found at <http://thomas.loc.gov/cgi-bin/bdquery/z?d113:HR02996>; , and the corresponding “Revitalize American Manufacturing and Innovation Act of 2013” introduced on August 1, 2013 by U.S. Sens. Sherrod Brown (D-OH) and Roy Blunt (R-MO).

D. PUBLIC COMMENTS RECEIVED – General Comments

Section	Para, Fig Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
A (Intro)	Paragraph 3	Add a sentence or two to state that the institute should select/define a reasonable size set of metrics that are of greatest importance and that are the strongest indicators of genuine success to monitor and report.	The list of required and suggested metrics is exhaustive and if implemented in its entirety will present undue analysis/ tracking/ reporting burden without adding significant value. In the attempt to be comprehensive, there is a risk of data overload and obfuscation of the true success level of a given institute. In addition, the list gives no indication of what is truly essential (i.e., there is no prioritization on the most important metrics).
All	N/A	Add guidance and/or formulae for comparison of institutes across the network.	Quantitative metrics should have specific guidance and/or calculation formulae listed so that results can be meaningfully compared between Institutes and aggregated across the entire program.
B. Institute Metrics	Paragraph one and overall section	The Institute's impact on manufacturing innovation, employment, and the regional manufacturing ecosystem are particularly of interest. Improvement in performance over time towards measurable targets or stretch goals for each NNMI [Institute] could also be considered.	Metrics as described can provide baseline data. It may be beneficial to also understand the baseline performance relative to a measurable target or stretch goal for each NNMI [Institute].
B. 1.1	1st bullet	Tracking an innovation through the defined Technology Readiness Levels (TRLs)/ Manufacturing Readiness Levels (MRLs)...	TRLs/MRLs should be clearly defined for common use throughout all the Institutes.
B. 1.1	2nd bullet - 4th sub-item	Company testimonials (including SMEs utilizing institute resources for prototyping or product development)	To include [Small and Medium-sized Establishments] SMEs who might otherwise be overlooked.
B. 1.1	3rd bullet - after 4th sub-item	Add sub-item: Measuring inquires with regards to workforce or technology assessment	To include a further tracking point for industrial interactions.
B. 1.2	Following 3rd bullet	Add sub-item: Number of internships, apprenticeships, veterans positions obtained with help from the institute	To include a further tracking point for job creation.

D. PUBLIC COMMENTS RECEIVED – General Comments

Section	Para, Fig Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
B. Institute Metrics	B.1.2 Number of jobs created and retained	Regional employment rates related to the diffusion of NNMI generated capabilities[.] National employment rates related to the diffusion of NNMI generated capabilities[.] Number of graduates and non-graduates finding employment in the sector[.]	Measures need to relate to the NNMI subject matter/technical area. Regional and national employment rates would have significant drivers outside of NNMI. Also, focusing only on graduates jobs may miss the broader workforce benefits of an NNMI.
B	1.2	Add a metric using dollars of industry sales per employee to measure efficiency within Category 1 (Impact). The change in this number over time would be a good indicator of efficiency provided by the NNMI Institute.	While number of jobs created or retained is an attractive measure of impact on industry, it does not provide a good measure of increased efficiency of the work force enabled by the Institute.
B.1.2	Page 2 of 8	Delete Section B.1.2	The collection of this information for awards funded by the [American Recovery and Reinvestment Act] (ARRA), proved to be difficult, burdensome[,] and flawed. The intent of the metric is laudable, but the data culled by the exercise is vague and largely meaningless.
B	N/A	Include measurements of collaboration such as number of joint ventures, engagement in networking events, engagement in technical meetings, and other industrial interactions. As such measurements may be minimal, they may be included as examples under 1.1 Success stories and case studies.	With funding under 2012 AMJAIC, our team has found that fostering business-to-business interactions can catalyze positive results, such development of collaborations and supply chains. The draft metrics do not measure interactions among the partner companies.

D. PUBLIC COMMENTS RECEIVED – General Comments

Section	Para, Fig Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
1.4	N/A	Recommend that the business case and regional ecosystem maturities are equally important and necessary for accelerated translation of technology and to ensure that the product is made here in the United States.	[See comments from Organization X that are not tabulated for more details.]
Add 1.6	N/A	1.6 Cost Savings - Institute collaborations with partner companies will often result in cost savings from production process improvements, access to specialized equipment, resources, testing facilities or technical assistance, etc. This metric accounts for the net cost savings partner companies realize as a result of their Institute collaboration and should be collected annually from partner companies beginning at project inception through to project completion plus 5 years to adequately capture the realized partner company savings impact from Institute collaboration.	In addition to broad economic impact metrics, Institutes should also measure economic impact realized directly from collaborations with partners companies. These metrics may be the best and most reliable measures of economic development in the manufacturing sector directly resulting from Institute activities. Partner company economic impacts include jobs created and retained, increased sales / company revenues, cost savings, investments leveraged[,] and capital expenditures. Impacts should only be reported that are directly attributable to Institute collaborations. Impact statements should be collected from partner companies on an annual basis from project inception through to project completion plus 5 years, and certified by an officer of the reporting company. Economic impact reporting of this nature is performed by MEP Centers across the country and [Organization Y] as a measure of each center's effectiveness and to demonstrate the public benefit of these economic development programs.

D. PUBLIC COMMENTS RECEIVED – General Comments

Section	Para, Fig Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
Add 1.7	N/A	<p>1.7 Grants and Investments Leveraged Additional partner company funding through research grants (government and non-government, other than Institute funds), and venture capital, and other business investments resulting from Institute collaborations are realized economic impacts. This metric accounts for any grants or investments leveraged as a result of partner company collaborations with Institutes (other than research funds directly obtained from Institutes), and should be collected annually from partner companies beginning at project inception through to project completion plus 5 years to completely capture the realized impact from Institute collaboration.</p>	<p>In addition to broad economic impact metrics, Institutes should also measure economic impact realized directly from collaborations with partners companies. These metrics may be the best and most reliable measures of economic development in the manufacturing sector directly resulting from Institute activities. Partner company economic impacts include jobs created and retained, increased sales / company revenues, cost savings, investments leveraged, and capital expenditures. Impacts should only be reported that are directly attributable to Institute collaborations. Impact statements should be collected from partner companies on an annual basis from project inception through to project completion plus 5 years, and certified by an officer of the reporting company. Economic impact reporting of this nature is performed by MEP Centers across the country and [Organization Y] as a measure of each center's effectiveness and to demonstrate the public benefit of these economic development programs.</p>

D. PUBLIC COMMENTS RECEIVED – General Comments

Section	Para, Fig Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
Add 1.8	N/A	1.8 Client Company Capital Expenditures Any infrastructure improvements, capital equipment purchases, or new construction resulting from partner company collaborations with Institutes are economic impacts. This metric accounts for any client company capital expenditures resulting from collaborations with Institutes, and should be collected annually from partner companies beginning at project inception through to project completion plus 5 years to completely capture the realized impact from Institute collaboration.	In addition to broad economic impact metrics, Institutes should also measure economic impact realized directly from collaborations with partners companies. These metrics may be the best and most reliable measures of economic development in the manufacturing sector directly resulting from Institute activities. Partner company economic impacts include jobs created and retained, increased sales / company revenues, cost savings, investments leveraged, and capital expenditures. Impacts should only be reported that are directly attributable to Institute collaborations. Impact statements should be collected from partner companies on an annual basis from project inception through to project completion plus 5 years, and certified by an officer of the reporting company. Economic impact reporting of this nature is performed by MEP Centers across the country and [Organization Y] as a measure of each center's effectiveness and to demonstrate the public benefit of these economic development programs.
2.13	N/A	Add Supply Chain impact - (Sales, Cost Savings, Resulting Investments, and Capital Expenditure.)	Institutes should also measure economic impact (as above) in supply chains resulting from Institute activities. These metrics may at times be anecdotal and estimates at best. However, in time, a more complete picture of the entire economic development ecosystem surrounding each Institute will emerge if supply chain development is considered along with direct economic impacts realized through partner company collaborations.
B	2.7	Break down number of retained companies by size with the knowledge that smaller companies may not be retained in similar ratios compared to larger companies.	While the number of retained partner companies may be a good indication of commitment for larger companies, it fails to account for the possibility that small companies may only need a minimal number of services or may have a varying need for assistance. These companies are more likely than larger companies to need assistance with a small number of projects and would graduate from the Institute once these needs are met.

D. PUBLIC COMMENTS RECEIVED – General Comments

Section	Para, Fig Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
2 (Industry Value)	2.3 and 2.8	Add verbiage that the reason(s) for losing company members needs to be considered, and that consolidation of membership may actually indicate technology advancement success and a desirable focusing of [I]nstitute technology development efforts.	With a new technology that is genuinely emerging, there will be a good number of initial technology options that will undergo down-selects as technology advances are made; this natural evolutionary process will result in consolidation of approaches, and a desirable focusing of institute technology R&D. In as much as a candidate technology championed by a given company is de-selected, there will be a natural consolidation of company membership. However, this consolidation and decreased membership would reflect overall [I]nstitute success not failure.
2. Industry Value	Additional point after 2.8	Add new point after 2.8: Trend in In-kind support (example) Partners will offer in-kind support as well as financial support. A measurement of the impact of in-kind support on workforce training and technology transfer to ensure this support is adding value. A reasonable measure might be technicians/engineers gaining relevant skills and competence resulting from in-kind support.	To establish [whether] in-kind support is assisting workforce training and technology transfer.
B	3	Specific metrics for R&D should form a separate category of Institute metrics. Sample metrics include R&D funding from non-NNMI federal grants, publications (including impact factor), and presentations.	Research, education, and training are associated throughout category 3. However, research has fairly different measures of success compared to education and training. Additionally, this categorization seems to de-emphasize the importance of R&D within the Institutes. While many metrics for R&D are encompassed within categories 3 and 4, they do not seem sufficient to encourage significant investment in R&D.

D. PUBLIC COMMENTS RECEIVED – General Comments

Section	Para, Fig Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
3. (Education and Workforce)	All	Add wording up front on importance of assessing outcomes over tracking activities.	All metrics are pure quantitative numbers of participants in[]various programs. Although [number]s are a measure of activity and outside interest, they are NOT a measure of effectiveness or success. As for all educational efforts, educational outcomes must instead be measured. Such an assessment effort is significant and the resources and expertise required should not be underestimated.
3.1	Addition to header	Add: Number of partner and non-partner professionals participating in research, education, [·] training (core), [·] internships/ apprenticeships and veteran's programs.	[T]o include internships/ apprenticeships and veteran's programs.
3	Addition to include 3.7	Add: 3.7 Number of Teach the Teachers/Counselor courses offered by university/community/technical colleges to K-12 educators/counselors.	[T]o include teaching the teachers and counselors in the metrics.
5	5.2	Add to the sentence: , and fee-based training programs including executive education.	[T]o include fee-based training programs, including executive education.

E. PUBLIC COMMENTS RECEIVED – Technical Comments

Section	Para, Fig, Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
B.1.0 Impact	N/A	Consider environmental impact.	While an Institute’s impact may be expressed and measured by manufacturing innovation, employment, and the regional manufacturing ecosystem as described in the report, environmental impact should also be considered. The report lists B.1. subcategories: number of success stories, jobs created, technologies commercialized[,] and transitioning efficiency through TRL/MRLs as metrics. The addition of an environmental impact subcategory will augment impact description and serves to document and track an important metric in manufacturing for many federal agencies such as the U.S. Department of Energy (DOE). Cumulative effects on key environmental issues are of particular interest,[]for example, the cumulative effect of greenhouse gas emissions. Such support the national interest in science and sustainability, where energy, economic[s] and the environment all intersect.
B.1.2		Clarify employment metrics by FTEs or people employed. The addition of a metric for part-time employment within 1.2 would give a more nuanced description of the employment trend in a region.	The definition of jobs is not well-defined. Jobs may be measured in terms of full-time employee (FTE) equivalents or by the number of people employed. In academic environments, students are often a highly-valued human resource; however, they are commonly employed part-time.

E. PUBLIC COMMENTS RECEIVED – Technical Comments

Section	Para, Fig, Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
1	1.2 (page 2 of 8)	<p>As far as is practical, this metric should include only jobs directly attributable to the efforts of the Institute. This is a statistic that is more readily available to organizations focused on the economic development of the region and sponsored by the regional local governments.</p> <p>Trends may be available such as:</p> <ul style="list-style-type: none"> - Regional employment rate and delta over previous reporting period - National employment rate - Number of graduates from universities, community colleges, and training programs who find employment in the sector - Number of start-ups created, as these represent a viable source of employment[.] 	<p>Number of jobs created and retained must be performed by an independent organization (not by the Institute) having focus on the economic development of the region. Most likely, the Institute can only affect the regional economy. An organization, sponsored by the regional local governments, which collects and tracks this data will be most likely more reliable to make these assessments. Also, partner companies do not have this data or track it. Thus, relying on them, the conclusions most likely will be not be reliable.</p>
B.2.0 Industry Value	2.1	<p>Add: Access to next[-]generation workforce and middle and advanced manufacturing skills training within an Institute.</p>	<p>Level and quality of co-investment by non-federal sources (core) - As the report states, 'non-federal partners dedicate resources when they believe that there will be economic benefit. Non-federal sources include cash and in-kind provided by industry partners of all sizes, state and local governments, economic development entities, institutions of higher education, private organizations[,] and individuals. Access to next[-]generation workforce and middle and advanced manufacturing skills training within an Institute also reflect industry value and incentives for investment.</p>

E. PUBLIC COMMENTS RECEIVED – Technical Comments

Section	Para, Fig, Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
2	New Item	2.14. Total revenue and contracts distribution among large, medium, and small companies. This provides an indication of the Institute service to the constituency and its impact on the region. It is expected that most of the revenue will come from large companies, while the number of contracts will be large from medium and small companies, and small with respect to large companies (i.e.,there will be a lot of small contracts, \$100K, from small and medium companies, while there will be few large contracts, \$2M, from large companies).	[Respondent left comment blank.]
3	New Item	2.15. Total number of workforce attending the "Stackable Certificate" Program. Workforce participating in the Institute Education & Training Program (ETP) may elect to take a course on specific subject receiving a certificate after completion. Later, same person may receive another certificate in an adjacent subject. After few certificates, that person can receive credits which make him or her eligible to either receiving a higher level of certificate or attending a community college for associate degree, or registering to attend a university for a degree.	[Respondent left comment blank.]
2.4	N/A	Evaluate team for correct partners for each project.	[See comments from Organization X that are not tabulated for more details.]

E. PUBLIC COMMENTS RECEIVED – Technical Comments

Section	Para, Fig, Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
B. Institute Metrics	2. Industry Value 2.5 Number of partner companies by size	Number and mix of partner companies by size and type (core)[.] Successful Institutes will need partners of all sizes (small, medium, large) and types (end producers, supply chain manufacturers, service providers, educational institutions.)	A rich NNMI partner ecosystem would no doubt include organizations with a range in size (small, medium[,] and large) However, it would also include a mix of end producers, supply chain manufacturers and service providers - who play fundamental[,] yet critically important roles in manufacturing growth/sustainability. Furthermore, involvement from universities, community colleges[,] or other training programs would be expected in order to continue innovation and workforce development. Overall rich and diverse partner participation is a CORE issue.
B.2.0 Industry Value	2.7	Add: [C]ompany revenue, IP (number patents) and number of employees.	Growth in partner company size - The report might take time to express growth [-]not only as company revenue, IP (number patents)[,] and number of employees.
B. Institute Metrics	3. Education and Workforce Development 3.5 Number of veterans participating in research, education, and training	Number of 'underemployed/displaced' workers participating in research, education, and training (core). [Type of comments was left blank. – This comment was assigned the value Technical by the editor.]	Overall, the concept to draw attention to, and encourage employment of under-employed human capital has significant merit. Specific region[s] may have different communities that represent this 'under-employed' group. In some regions there may be a significant veteran group, in other regions where industries have declined, the group may be displaced industry workers. Overall there is opportunity to allow regional NNMI centers to define which specific populations would be most impactful to focus on and measure.

E. PUBLIC COMMENTS RECEIVED – Technical Comments

Section	Para, Fig, Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
B.4.0 Portfolio	N/A	Track low TRL level scientific discoveries that may lead to commercialization later.	While the number of projects is important, and while this number (and its change / growth) may express certainly the quality of projects, quality of the portfolio as a direct reflection of R & D innovation. This might be expressed for example at lower TRL levels where new scientific discoveries may be reported (within [the] ca[s]e of IP), and relative scientific competitiveness/merit. This comment is made with an understanding of the sensitive nature of protect[ing] IP and reporting scientific breakthroughs to advance[] commercialization.
4.1	N/A	Consider quality over quantity for project portfolio metrics. - Use a balanced initial [eXtensive-Readiness-Level (from below)] (xRL) for each of the following (technology, manufacturing, business case, and ecosystem maturity) per project.	[See comments from Organization X that are not tabulated for more details.]
B	4.1	Projects should be defined to include certain minimum time periods, dollar amounts, and level of engagement. Project descriptions should be carefully audited by program managers to ensure that significant overlap is not occurring.	The definition of projects is not specifically defined. One project can in fact lead to multiple products or one large project can be broken up into smaller sub-projects to inflate project reporting.
B. Institute Metrics	4. Portfolio 4.1 Number of projects in the portfolio	4.1 Number and mix of projects in the portfolio.	The mix of projects in the portfolio is important to consider. Topic impact: Do topics cover key milestone or bottleneck challenges? What is the time horizon of impact? What is the risk profile of projects (some incremental-low risk, some disruptive-high risk)? Consider additional methods to measure portfolio health beyond the number of projects. The quality and health of the portfolio is very important to understand.

E. PUBLIC COMMENTS RECEIVED – Technical Comments

Section	Para, Fig, Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
B.Institute Metrics	4. Portfolio 4.3 Number and value of IP products produced and licensed	This metric includes patents, forward references, provisional patents, trade secrets, etc.	May consider including number of forward references in IP generated by the center. This is an indication of the merit of []the IP; the extent to which the NNMI IP is leveraged in the development of other IP beyond our outside of NNMI. It maybe that the originator of NNMI is unsuccessful in commercializing, however another entity may leverage that IP for commercial success.
B	4.3	Specifically include licenses and other Intellectual Property (IP) products in 4.3 metrics.	As patents are often time-consuming and expensive to obtain, many small companies are moving more towards licensing agreements. Revenue from licensing by R&D organizations is on the rise and should be emphasized in the metrics.
4	New Item	4.5 Technology Refresh Number of new projects (or technologies) started each year in new technology and number of projects terminated due to lack of progress or otherwise. This metric demonstrates the ability of the Institute to adapt as technology changes and/or evolves.	[Respondent left comment blank.]
B.5.0 Financial	N/A	Add these revenue streams that support self-sustainment.	Other revenue might include fees from conferences and workshop, industry, skill sets[,] or product[-]based standardization and certification.

E. PUBLIC COMMENTS RECEIVED – Technical Comments

Section	Para, Fig, Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
B.2.0 Industry Value, 5.4;	N/A	Add new federal awards (including public-private partnerships, PPPs) for spin-offs from original work. Add sources of private investment for spin-offs from original work.	Another measure of Industry Value may include number of new federal awards (including public-private partnerships, PPPs) that spin from work performed within the Institute, therefore generating again, other sources of investment, and further acceleration [of] innovation, discovery, IP, workforce etc. Similarly, new sources to track private investment such as venture capital and asset portfolio growth stemming from work initially started within a PPP project at an Institute may also serve to document and measure success. This is expressed partially in Section 5.4.
B.5.0 Financial	N/A	(The comment above) [B.2.0 Industry Value, 5.4;] supports financial self-sustainment.	(The comment above) [B.2.0 Industry Value, 5.4; “Add sources of private investment for spin-offs from original work.”] See comment to support self-sustainment.
5.1-5.5	N/A	Include measures of NNMI expenses and/or the efficiency of expenses across the manufacturing innovation chain.	[See comments from Organization X that are not tabulated for more details.]
5	New Item	5.6 Income Membership Distribution The income membership distribution involving the number of large, medium, and small companies participating as paid members in the Institute, it provides the necessary metric assessing the Institute impact on the community. Also, the inclusion of companies in that metric contributing in-kind funds could also be useful.	[Respondent left comment blank.]
5	New Item	5.6. Return-on-Investment (ROI) The amount invested in (a) recruiting new members, (b) developing pervasive technology, (c) setting-up laboratories to serve the constituency as necessary, and (d) other applicable expenses, versus the revenue gained directly from these activities.	[Respondent left comment blank.]

E. PUBLIC COMMENTS RECEIVED – Technical Comments

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6 (Network)	6.1	Delete the phrase: "building common legal and management frameworks"	The suggestion that [I]nstitutes in the network should focus on "building common legal and management frameworks" is neither practical [n]or desirable. Every industry sector is unique, and forcing a one[-]size[-]fits[-]all framework on all of them will result in less than optimal structures and ultimate performance.
6	New Item	6.5 Number of Projects Co-executed in Partnership with Other Institutes in the Network. This metric provides a very good indication of the synergy among the Institutes in the network. This also provides unique emphasis on how well the people skills are used within the network to execute successfully multi-disciplinary complex projects.	[Respondent left comment blank.]
6	New Item	6.6 Number of Technical/Administrative Personnel Moved in the Network This metric provides again a unique perspective on the synergistic cooperation among the Institutes in the network. Occasional shortages of specific skills in an Institute can be temporarily covered by borrowing technical staff from another Institute having core mission on the technology gap of the other Institute.	[Respondent left comment blank.]
N/A	N/A	Criteria related to number of articles highlighting the [I]nstitute in industry trade journals, magazines[,] and newspapers. Especially after the first year "newness" wears off. These would be articles written specifically about the details of the [I]nstitute, not related to the initial decision[s] and award[s] by the DOE.	After reviewing the Draft Institute Performance Metrics, I would like to see some metrics related to PR & Marketing. It is important to market and promote the Institute to the community to help ensure long-term success.

E. PUBLIC COMMENTS RECEIVED – Technical Comments

Section	Para, Fig, Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
N/A	N/A	Criteria related to number of speaking engagements at conferences, tradeshows[,] and other outreach (city council, academic[,] and federal meetings).	After reviewing the Draft Institute Performance Metrics, I would like to see some metrics related to PR & Marketing. It is important to market and promote the Institute to the community to help ensure long-term success.
N/A	N/A	Criteria related to number of tradeshows and conferences where the [I]nstitute is exhibiting. Could show long[-]term trends if the level of participation (exhibiting) drops each year.	After reviewing the Draft Institute Performance Metrics, I would like to see some metrics related to PR & Marketing. It is important to market and promote the Institute to the community to help ensure long-term success.
N/A	N/A	Establish [eXtensive Readiness Level (from below)] xRL and a collaborative stakeholder methodology to assess maturity levels for any project in the NNMI portfolio. This xRL measure provides a holistic system view of project readiness from the perspective of (t) technology, (m) manufacturing, (b) business case, and (e) ecosystem maturity.	[See comments from Organization X that are not tabulated for more details.]

F. PUBLIC COMMENTS RECEIVED – Editorial Comments

Section	Para, Fig Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
B	(Was left blank)	Change the title of B from "Institute Metrics" to "Institute Metrics and Measures of Success."	Several of the "metrics" provided are not actual performance metrics and do not meet the standards provided under SMART-Specific, Measurable, Attainable, Realistic, and Time-bound. Many, such as 1.1, 2.13, 6.1, and 6.3 [are] certainly measures of success, but it may be prudent to define the document as such.
1.1	Under Documenting changes in tech ecosystems	"Companies whose business is within the focus area relocating to or establishing a presence near the Institute"	The first bullet (regarding companies relocating near the Institute) should also take into account companies that open satellite offices near the Institute.
1.1	Under Documenting changes in tech ecosystems	"New companies formed in the sector near the Institute or beyond the region"	A bullet should be added regarding company formation. While this appears later in the draft guidance document under Section 2.12, establishing case studies for spin-off companies derived from innovations created at the Institute also serves as a strong indicator of the Institute's value.
2.1	Under "Level and quality of co-investment by non-federal sources"	Add a sentence: "Co-investment from industry partners should be uniquely measured and assessed to evaluate market need and commitment to long-term Institute sustainability."	Co-investment by non-federal sources is key to Institute success and long-term viability/ sustainability. Of note, we believe that co-investment from industry is particularly indicative of industry support for the need of the Institute, the capabilities of its team, and likelihood of self-sufficiency over time.
B.2.2	Page 3 of 8	Change the third sentence from "...the level of non-federal investment should increase." to "...the level of industrial investment should increase."	As above, section B.2 in its entirety appears to address metrics for the industrial partners in the Network Institute. Given that education institutions generally and public institutions in particular do not have the same capacity to fund a Network Institute, we suggest that the role of the industrial partners be made explicit.

F. PUBLIC COMMENTS RECEIVED – Editorial Comments

Section	Para, Fig Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
2.5	After "Number of partner companies by size"	2.X Total number of manufacturing and related sectors represented (example.) Successful Institutes will engage industry partners from multiple sectors within manufacturing (e.g., consumer products, aerospace, logistics, and defense), ensuring broad-based relevance and applicability of the Institute in responding to industry needs.	In addition to the total number of partner companies and number companies by size (under Section 2, Industry Value), it is important for applicants / Institutes to demonstrate support from a broad array of manufacturing sectors (e.g., consumer products, aerospace, logistics, defense, etc. depending on the nature of the Institute).
2.11	Under "Number of companies making use of Institute facilities"	2.1X Number of companies leveraging their own facilities / equipment for projects (example)[.] While it is anticipated that partners will make use of the Institute's equipment, facilities, and resources for projects, the companies providing their own resources (beyond cash or personnel) demonstrates the value they place in Institute activities and commitment to the overall success of the NNMI.	The number of companies leveraging their own facilities and equipment for projects (e.g.[,] networked equipment) in conjunction with the Institute is also a compelling indicator of industry buy-in and validation of the Institute's value. We recommend including another bullet after 2.11 to this effect.
3.1	Under first bullet, "Number of non-partner attendees..."	Add to the bullet: "The Institute's educational content could also be delivered directly at partner sites."	The workshops and short courses available to non-partner attendees developed at or in conjunction with the Institute don't necessarily need to be physically hosted at the Institute. E-learning opportunities, webinars, or Institute workshops hosted at partner facilities should also count towards the Institute's broader regional impact.
B.3.6	Page 5 of 8	Change the second sentence from "Institutes will help develop new and expanded certification, training programs, degree programs[,] and other educational opportunities." to "Institutes will help develop new and expanded certification, training programs, and other educational opportunities."	While a long-term effect of the Network could result in new degree programs being developed, listing degree program development as a short-term metric constrains the academic freedom of educational institutions to develop their own curricula.
3.6	"Number of certification and degree programs..."	"Number of certification and degree programs created in collaboration with K-12 institutions, colleges, universities, and professional organizations (core)"	K-12 institutions should also be included alongside colleges, universities, and professional organizations.

F. PUBLIC COMMENTS RECEIVED – Editorial Comments

Section	Para, Fig Tab, Note	Proposed Change	Comment (justification for change and associated verbiage)
B.4.3	Page 6 of 8	Change the second sentence from "Institutes will be free to set their own IP policies, consistent with the published IP guidance..." to "Institutes will be free to set their own IP policies, consistent with Federal statutes (e.g., Bayh-Dole and the published IP guidance[...])..." Change the third sentence from "... (all members pay some, so some funds flow to the inventors and some to help the Institute become self-sustaining)..." to "... (all members pay some, so some funds flow to the inventors, some to the inventing institution, and some to contribute to the Institute's future self- sufficiency)..."	We agree that a significant metric of success for any Network Institute will be the intellectual property (IP) produced, although the value of the IP may not be immediately known. However this metric, as written, is over broad and could put Network members' policies in conflict with the Institute's policies.
6.1	"General Interaction with the larger Network of Institutes"	Add a sentence: "To the extent feasible and practical, Institutes also are encouraged to leverage one another's physical and intellectual resources for projects."	We strongly agree that interaction with the broader NNMI is critical to the sustainability of the overall network. To the extent feasible, Institutes may want to consider leveraging one another's physical and intellectual resources, in addition to information sharing, etc.

G. PUBLIC COMMENTS RECEIVED - in Non-Tabulated Form

[Some comments that were not in the requested format were received, and they are presented here after the tables. Two organizations placed names within the comments. One organization used the name often and placed text in paragraph and graphic form, and will hereafter be designated as respondent Organization X. The organization name has been replaced with [Organization X], where there is room to do so. Where there is not room to place the entire text block [Organization X] such as within submitted graphics, then [Org X] is used instead.] [Another organization above referred to itself and placed text in tabular form and that organization is designated in the document as Organization Y].

Summary: The AMNPO “Performance Metrics for NNMI” document states that these are “example metrics” and other metrics may also be important. These example metrics focus primarily on Institute outcomes, such as impact, industrial value, education[,] and workforce development, as well as Institute inputs/enablers, including the Institute’s portfolio of projects, finances, and network contributions.

The AMNPO NNMI Performance Metrics do not specifically address the Institute’s Operating System capability and performance that must transform the required NNMI inputs to the intended NNMI outcomes. It is recommended that Institute leadership address operating capability and performance measures to ensure that the intended outcomes are attainable.

Understanding [Organization X] approach to NNMI Performance Metrics:

The Advanced Manufacturing Partnership (AMP) 1.0 and other studies have shown that the current, “as-is” U.S. manufacturing innovation ecosystem has two major deficiencies: 1) it is not performing well in the sense that bringing a new technology, a new material, or a new process to market costs too much, takes too long, and the outcomes are too random; and 2) the United States has lost several critical industrial commons due to enterprises seeking a manufacturing source outside the United States to build the product after its invention here in the United States – also known as “invent here, build elsewhere.”

[Organization X] intends to leverage these study findings to fundamentally improve the U.S. manufacturing ecosystem’s performance by executing projects with a collaborative capability of key stakeholders across the “discovery-translation-build here” manufacturing innovation chain. The first step toward achieving this occurred in 2012 when [Organization X] identified several key missing capabilities:

1. Concurrently maturing the technology, manufacturing, and business case readiness for new technologies, materials, and processes[.]
2. Establishing an interdisciplinary research approach guided by product exemplars. A product exemplar is a component or article that has “at risk” or “representative” characteristics of a real product, and is typically provided by a collaborating company[.]
3. Aligning the regional manufacturing ecosystem early on to “accelerate innovation and build here.”
4. Developing policy to incentivize (e.g., intellectual property) “to-be” capability[.]
5. Developing metrics and measuring institute performance to drive improvement. (see Figure 1).

[Organization X] then analyzed the AMP research translation model to develop a new socio-technical approach for improving manufacturing innovation in the U.S. (see Figure 2). This approach incorporates all key stakeholders (industry, workforce, education, government, NFP, etc.) and enablers (technology, infrastructure, ecosystem, capital, etc.) in the innovation process.

Finally, [Organization X] expanded this socio-technical operating approach from the perspective of the manufacturing innovation value chain (see Figure 3) to include progress measurements that systematically move technology from discovery to accelerated translation to building new products in the United States. [Organization X] named this metric the extensive readiness level (xRL). xRL measures, on a scale from 1-10, the required integrated inputs and outcomes from discovery to product commercialization.

These three phases of analysis have led to a new operating approach that provides critical measurements for manufacturing innovation and deployment. When executed by the NNMI, this approach will reduce cost, time[,] and risks in managing research translation into real-life products that will ultimately result in gains for the U.S. manufacturing industry.

Conclusions related to the AMNPO Metrics:

1. The AMNPO input and output metrics are very useful, and in most cases necessary, but they are not sufficient to accelerate manufacturing innovation for the United States. For example:

a. Impact (1.4): Transitioning efficiency through TRL/MRL levels – Although TRL and MRL measures are important, [Organization X] recommends that the business case and regional ecosystem maturities are equally important and necessary for accelerated translation of technology and to ensure that the product is made here in the United States.

b. Industry Value (2.4): Total number of partner companies – The total number of partners is not as important as having the correct partners for the project. Without the correct partners for each project, the collaboration will not be in place and skill sets will not be available to accelerate translation to product.

c. Portfolio (4.1): Number of projects in the portfolio – Similarly, quality over quantity should be considered for portfolio metrics. The information content of fewer projects that yielded more data or better results should have as much impact as several projects with less valuable content. Initial xRL (technology, manufacturing, business case, and ecosystem maturity) assessments for portfolio projects are required, and this information can help the Institute prioritize project ideas and investment.

d. Financial (5.1-5.5): The AMNPO financial measures are all useful but they do not include the measures of NNMI expenses or the efficiency of expenses across the manufacturing innovation chain.

2. The [Organization X] analysis (Figures 1-3) provides insight [in]to capabilities and measures not fully covered by the AMNPO metrics. As previously discussed, [Organization X] has established xRL and a collaborative stakeholder methodology to assess maturity levels for any project in the NNMI portfolio. This measure provides a holistic system view of project readiness from the perspective of technology, manufacturing, business case[,] and ecosystem maturity. [Organization X] found that in all instances the manufacturing maturity lags technology maturity and that business case, and ecosystem maturities lag far behind both technology and manufacturing, or are even totally ignored until it is too late. This metric concurrently matures all readiness levels on a project that will result in accelerated translation of inventions to products.

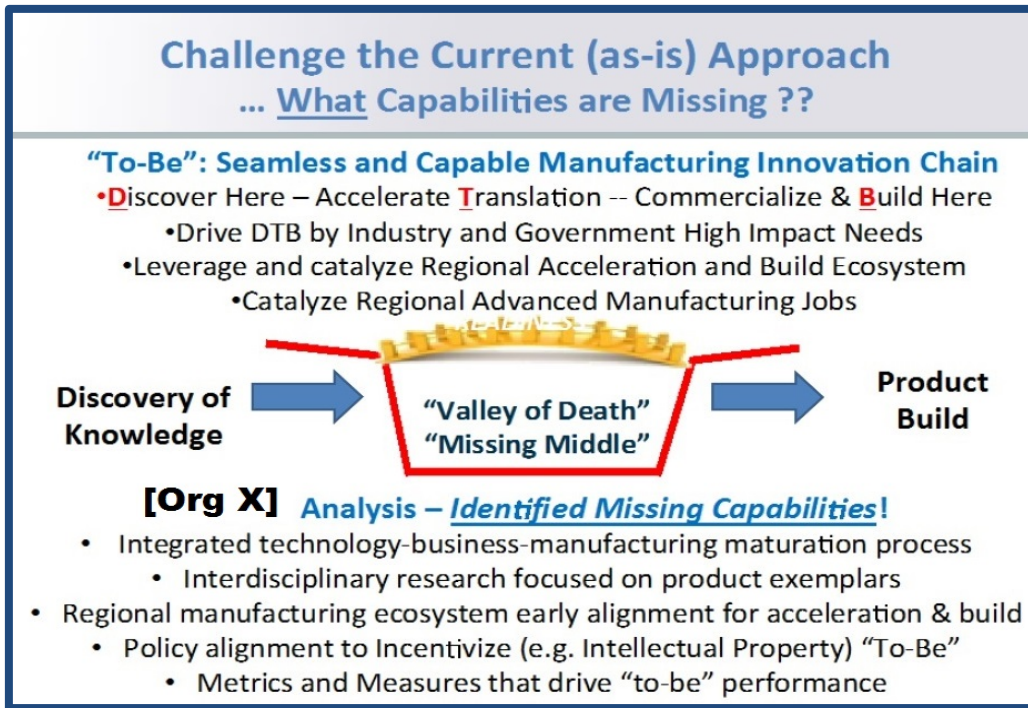


Figure 1 – [Org X] Analysis of AMP [1.0] document and findings

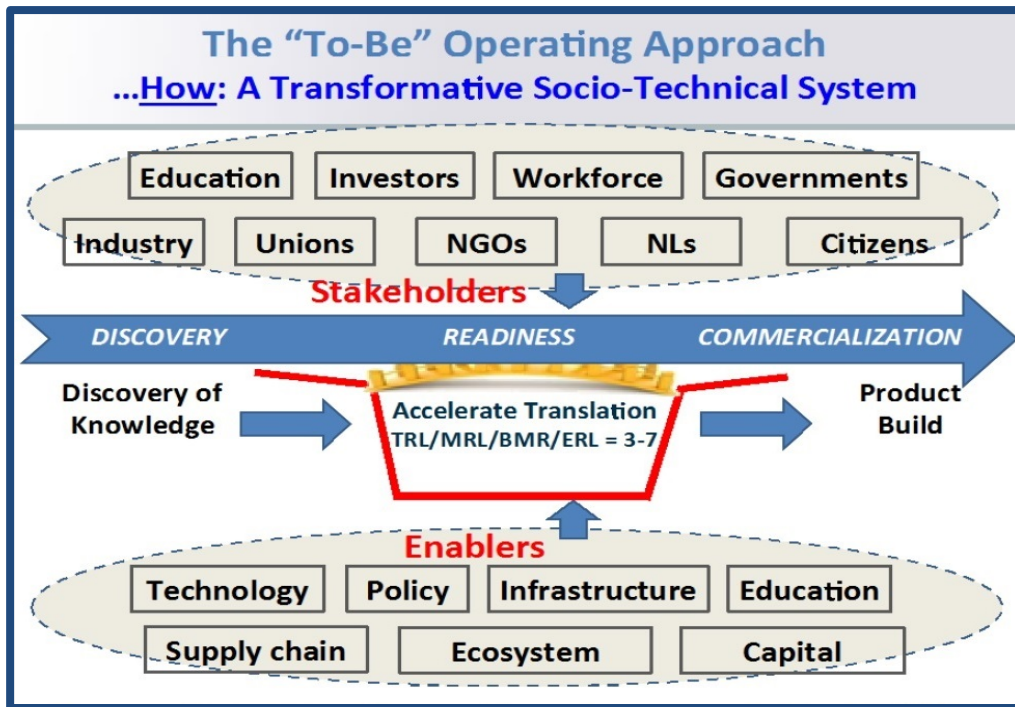


Figure 2 – [Org X] Operating Approach for NNMI

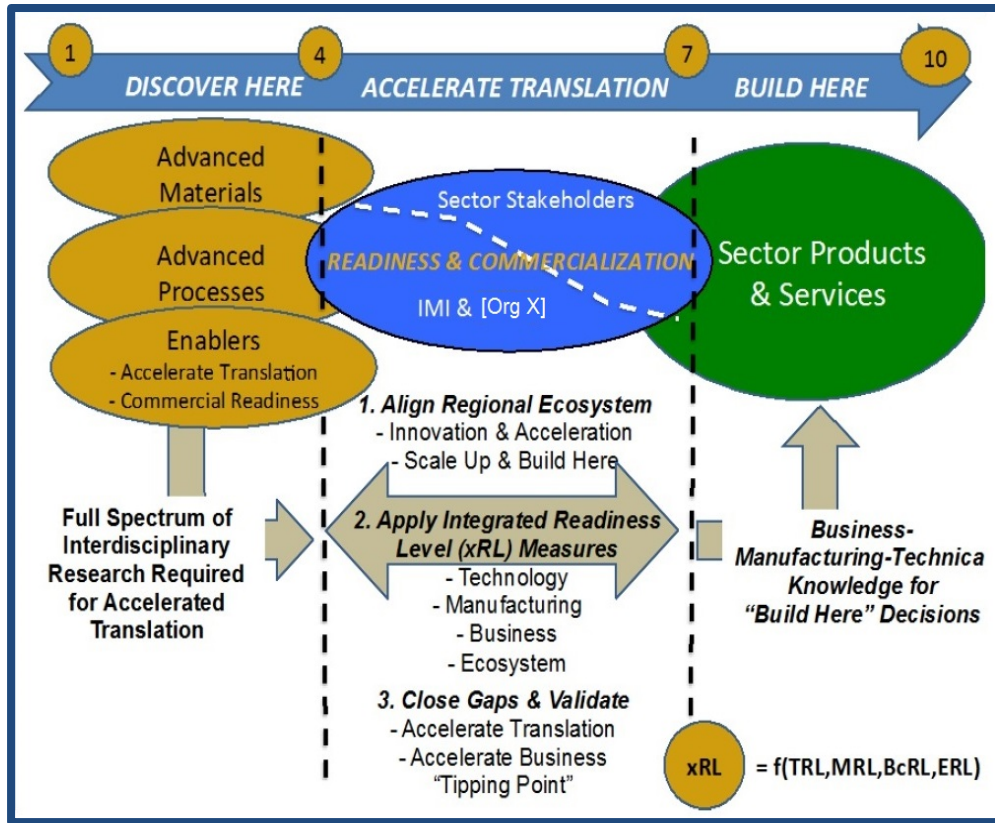


Figure 3 - [Org X]’s Operating Approach with Integrated Measures across the US Manufacturing Innovation Chain

H. LIST OF ABBREVIATIONS

· BcRL	Business-case Readiness Level
· ERL	[(manufacturing)] Ecosystem Readiness Level
· IMI or MII	Manufacturing Innovation Institute (or simply Institute)
· IP	Intellectual Property
· MRL	Manufacturing Readiness Level
· MEP	Manufacturing Extension Partnership
· NGO	Non-Governmental Organization
· NIST	National Institute of Standards and Technology
· NL	(federal) National Laboratory
· NNMI or Network	National Network for Manufacturing Innovation
· NPO	National Program Office
· PCAST	President’s Council of Advisors on Science and Technology
· RFI	Request for Information
· SME	Small and Medium-sized Establishment
· TRL	Technology Readiness Level

I. APPENDIX- Draft Institute Performance Metrics

**“Draft Institute Performance Metrics for the National
Network for Manufacturing Innovation”**

as presented for public comment

Advanced Manufacturing National Program Office

**Draft Institute Performance Metrics
for the
National Network for
Manufacturing Innovation**

Edited by
Michael F. Molnar, Director
Advanced Manufacturing National Program Office

http://www.manufacturing.gov/docs/nnmi_draft_performance.pdf

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To learn more about the interagency AMNPO, visit www.manufacturing.gov

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Foreword

The interagency Advanced Manufacturing National Program Office (AMNPO) is hosted by the National Institute of Standards and Technology (NIST). Creation of the AMNPO flows from the recommendation of the President's Council of Advisors on Science and Technology (PCAST) in its June, 2011, Report to the President on Ensuring American Leadership in Advanced Manufacturing,⁷ that the Federal government launch a concerted, whole-of-government Advanced Manufacturing Initiative. To that end, this interagency office is charged with:

- Convening and enabling industry-led, private-public partnerships focused on manufacturing innovation and engaging U.S. universities, and
- Designing and implementing an integrated whole of government advanced manufacturing initiative to facilitate collaboration and information sharing across federal agencies.

By coordinating federal resources and programs, the AMNPO seeks to enhance technology transfer in U.S. manufacturing industries and help companies overcome technical obstacles to scaling up production of new technologies.

The National Network for Manufacturing Innovation (NNMI) program proposed by President Obama has the goal of advancing American domestic manufacturing.⁸ The program will seek to accomplish this by creating a robust national innovation ecosystem anchored by a network of ~~Institutes for~~ Manufacturing Innovation [Institutes (Institutes)]. The NNMI will fill a gap in the innovation infrastructure, allowing new manufacturing processes and technologies to progress more smoothly from basic research to implementation in manufacturing. The NNMI program has a scale and focus that is unique, and it is built upon concepts of a strong public-private partnership.

Abstract

Beginning in April 2012, a broad public engagement strategy by the Advanced Manufacturing National Program Office (AMNPO) was used to collect extensive input on the National Network for Manufacturing Innovation (NNMI or Network) program design. The collection of information from the public was initiated by a NIST Request for Information (RFI), published in the Federal Register⁹, followed by a series of regional workshops sponsored by AMNPO partner agencies and focused on the issues presented in the RFI. Reports summarizing the findings from the RFI and each workshop were published.¹⁰ In January 2013, the *National Network for Manufacturing Innovation: A Preliminary Design* report was published, built upon public input received.¹¹ This AMNPO document utilizes the information gathered and provides draft performance metrics that can be used to evaluate the performance of Institutes for Manufacturing Innovation (Institutes) within the NNMI program, and that would apply to the NNMI and the Institutes that

⁷ Report available at <http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-advanced-manufacturing-june2011.pdf>.

⁸ President Obama to Announce New Efforts to Support Manufacturing Innovation, Encourage Insourcing, <http://www.whitehouse.gov/the-press-office/2012/03/09/president-obama-announce-new-efforts-support-manufacturing-innovation-en>

⁹ "Request for Information on Proposed New Program: National Network for Manufacturing Innovation (NNMI)," 77 FR 26509, May 4, 2012. Available at <https://federalregister.gov/a/2012-10809>.

¹⁰ Reports are available at http://www.manufacturing.gov/pubs_resources.html, and are listed under the "Advanced Manufacturing National Program Office (AMNPO)" heading.

¹¹ Available at http://www.manufacturing.gov/pubs_resources.html.

are created once appropriate legislation has been enacted.¹² This document is one of a series of documents generated to inform and seek feedback from the public on various elements that go into the creation and growth of the NNMI.

More specifically, this document describes draft metrics that can be used to help evaluate the performance and success of Institutes within the NNMI. These draft metrics were developed by an interagency team of experts, building on the initial metrics and lessons learned from the pilot institute, the National Additive Manufacturing Innovation Institute (NAMII). It is recognized that Institutes will vary considerably in their focus areas and perhaps in their structures as well; hence not all of the proposed metrics will be appropriate for all Institutes. However the six categories of draft metrics shown below are considered applicable to all Institutes:

1. Impact (1.1 – 1.4)
2. Industry Value (2.1 – 2.13)
3. Education and Workforce Development (3.1 – 3.6)
4. Portfolio (4.1 – 4.2)
5. Financial (5.1 – 5.5)
6. Network Contribution (6.1 – 6.4)

Within each broad category, several example metrics are given, and a short rationale is included for each. The examples are not intended to be comprehensive, and Institutes should be free to propose other metrics that are applicable to their particular focus areas. Among the example metrics, an effort was made to minimize the reporting burden. Some of the draft metrics are quantitative and some are qualitative. The example metrics also include items that are measurable in short, medium, or long time-frames.

¹² Current proposed legislation includes: H.R.2996 entitled “*Revitalize American Manufacturing and Innovation Act of 2013*,” found at <http://thomas.loc.gov/cgi-bin/bdquery/z?d113:HR02996>; and the corresponding “*Revitalize American Manufacturing and Innovation Act of 2013*” introduced on August 1, 2013 by U.S. Sens. Sherrod Brown (D-OH) and Roy Blunt (R-MO).

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A. INTRODUCTION

The draft performance metrics listed in this report are intended to be used to help measure the successes of the Institutes of Manufacturing Innovation (Institutes) that are a part of the National Network for Manufacturing Innovation (NNMI or Network). The metrics are intended to serve multiple purposes. This includes, as examples, performance measurement of an Institute, self-evaluation that could result in better management, and reports that convey information about Institute and NNMI impacts to a broad audience. Two characteristics can be assigned to each metric. One characteristic is whether the metric is quantitative or qualitative. The second characteristic is the time-frame over which a metric should be assessed. Table 1, at the end of this document, notes both characteristics for all metrics presented.

Institutes will vary considerably in their focus areas and perhaps in their structure, so all metrics may not be appropriate for all Institutes. However, it is anticipated that the six categories of draft metrics will apply to each Institute. The metrics categories are:

1. Impact,
2. Industry Value,
3. Education and Workforce Development,
4. Portfolio,
5. Financial, and
6. Network Contribution.

All Institutes will utilize these six categories of metrics. Some of the draft metrics are designated as “core,” indicating that they are common to all Institutes. Other metrics, designated as “example” may or may not be appropriate for a particular Institute, and Institutes could certainly propose alternate metrics of their own. The following Section presents both core and example metrics within all six metric categories.

B. INSTITUTE METRICS

1. IMPACT

Impact metrics are intended to measure the broad impact of an Institute on U.S. manufacturing. The Institute’s impact on manufacturing innovation, employment, and the regional manufacturing ecosystem are particularly of interest.

Core and example Impact metrics include:

1.1 Success stories and case studies (core)

Success stories may be difficult to quantify, but they are an excellent measure of the health of an Institute. The stories can provide a comprehensive look at how the investments in the Institutes and the Network have succeeded, and how the Institutes and the Network have achieved their missions. Success stories will vary between and within Institutes, but they should be easily understood, compelling, and supported by objective data. Success stories may combine information specifically available from other metrics in a way that provides a more complete picture, or they may add information not easily measured elsewhere.

Case studies tell the stories of particular activities undertaken by Institutes to address their missions. Case studies might include items such as:

- Tracking an innovation through the Technology Readiness Levels (TRLs) / Manufacturing Readiness Levels (MRLs) into a commercial product.
 - Identifying manufacturing innovations passing through the Institute
 - Tracking the innovation into the marketplace as a new product or process, including lessons learned; noting what worked and what did not along the path to development (so others can learn from them, too)
 - Documenting the impact of the new product or process on competitiveness (for example cost reduction, quality improvement, new market creation, etc.)
 - Envisioning what future uses and impacts might be
- Documenting changes in technology ecosystems.
 - Companies whose business is within the focus area relocating near the Institute
 - Regional employment rates in the focus area
 - Job creation in the sector beyond the region
 - Company testimonials
 - Federal agency benefits
 - Hiring at regional educational institutions in support of the focus area
 - Technical ecosystem expansion
- Tracking evolving industrial interactions.
 - Identifying the reasons a company became involved with an Institute
 - Tracking the value perceived by partner companies
 - Measuring the number of hires made through the Institute
 - Measuring intellectual property (IP) licensing

1.2 Number of jobs created and retained (core)

As far as is practical, this metric should include only jobs directly attributable to the effects of the Institute. This is a statistic that is more readily available from partner companies, but which may be difficult to quantify beyond the partners. Trends may be available such as

- Regional employment rate
- National employment rate
- Number of graduates from universities, community colleges, and training programs who find employment in the sector

1.3 Number of Institute technologies reaching commercial production (example)

This metric consists of tabulating and tracking the TRL / MRL of the technology over the life of the Institute. This metric addresses the Institute mission to move innovation from basic research to commercial application.

1.4 Transitioning efficiency through the TRL / MRL levels (example)

Some of the technologies that pass through an Institute will reach commercial applications quickly, some more slowly, and some not at all. A high-performance Institute will improve the efficiency at which new technologies progress within and between TRL / MRL levels, reach the marketplace, and compete internationally.

2. INDUSTRY VALUE

Industry Value metrics are intended to measure the extent to which the industrial partners perceive that they are receiving value from the existence of the Institute. They measure the industry view of the appropriateness of the selected focus area and of the structure and operation of the Institute.

Core and example Industry Value metrics include:

2.1 Level and quality of co-investment by non-federal sources (core)

This metric enables evaluation of how well the focus area of the Institute matches a real national need. Non-federal partners dedicate resources when they believe that there will be economic benefit. Non-federal sources include cash and in-kind provided by industry partners of all sizes, state and local governments, economic development entities, institutions of higher education, private organizations and individuals.

2.2 Trend of co-investment by non-federal sources (core)

In a successful Institute, there must be strong partner co-investment. The co-investment requirement is not trivial, and at the start of an Institute there must be sufficient commitment to warrant the award. Even so, as time goes on, the level of non-federal investment should increase. As the Institute demonstrates success and value, it is expected that new partners will engage, and existing partners will increase their level of engagement.

2.3 Ratio of received to originally committed co-investment (example)

In the proposal phase, partners may commit support to an Institute that would be spread over a number of years. The magnitude of these commitments as measured in financial, personnel, and resource services will be as important as the number of the commitments at all stages of an Institute's lifecycle. If an Institute is successful, the ratio of received to originally committed co-investment will grow. If the Institute is not successful, the number of partners and the size of their investments will diminish and the ratio will drop.

2.4 Total number of partner companies (example)

If a broad industrial base recognizes value in an Institute focus area and sees positive impacts from Institute activities, then many companies will want to be partners.

2.5 Number of partner companies by size (small, medium, and large) (example)

Successful Institutes will need partners of all sizes. Historically, many innovations make it to the shop floor or marketplace through the efforts and growth of small and medium-sized (SMEs) companies that are very cash limited. Hence the Institutes will need significant and sustained monetary support from large industry members.

2.6 Trend in total partner companies (example)

Partner companies may come and go depending on their financial situations, perceived value from the Institute, personnel changes, etc. In a successful Institute, it is expected that the number of partner companies will increase from initiation but will nominally stabilize over longer time periods.

2.7 Growth in partner companies by size (example)

Growth in a large company could be used, for example, as an indicator of stable and reliable long-term funding. Growth in SMEs could be used as an indicator of dynamic innovation deployment.

2.8 Total number of retained partner companies (example)

Partners who return with new projects, who continue to provide funding and other resources, who continue to hire from an Institute are an indication of the success of the program. Failure of companies who join at the start to continue their participation could indicate a problem. A reasonable measure might be the yearly ratios of partners from prior years who continue to participate to those who do not.

2.9 Number of retained partners by size (example)

Institutes need to retain participation of large company partners for stability and SMEs for growth and dynamism.

2.10 Investment by partners in advanced manufacturing innovation (example)

It is expected that Institutes will encourage not only partner investment in the Institute activities, but will lead to increased investment in advanced manufacturing innovation by the partner. Measures that may be used as a proxy of a partner's increased investment in innovation can be improvements in R&D investment, an increase in products developed, and changes in IP developed and/or licensed, as examples.

2.11 Number of companies making use of Institute facilities (example)

It is expected that Institutes will have unique and advanced facilities compared to their partners and that companies in the ecosystem will want to use the Institute facilities, whether they are partners or not. The uses might include:

- Fee for service
- Participation in training
- Number of startup companies incubating in the Institute.

2.12 Number of spin-off companies created (example)

Innovations from the Institute could be absorbed by partner companies or may lead to formation of new companies. The latter is particularly true if the innovation is disruptive in some segment. Spin-off companies may provide a means to prove the commercial value of a new innovative technology.

2.13 Supply Chain Engagement and Development (example)

A robust supply chain is critical to continued expansion of technology transition. As the number of technologies transitioned increases, it is expected that Institutes will actively seek to establish or expand supply chains. Measurement of supply chain engagement and development is possible. Opportunities exist to partner with the NIST Manufacturing Extension Partnership (MEP) Program (<http://www.nist.gov/mep/>) to develop metrics in this area. The NIST MEP Program surveys clients to measure jobs created, jobs retained, change in sales, investments leveraged, and cost savings. This knowledge could be expanded to reflect and measure supply chain engagement and development.

3. EDUCATION AND WORKFORCE DEVELOPMENT

The Institutes will have a mission to increase and improve the workforce prepared for advanced manufacturing jobs. This group of metrics is intended to measure success in this mission across a broad spectrum of activities.

Core and example Education and Workforce Development metrics include:

3.1 Number of partner and of non-partner professionals participating in research, education, and training (core)

A successful Institute will provide opportunities and programming for education and workforce development. These activities will improve the manufacturing climate in the broader community and draw new partners to the Institute. It is expected that these activities will be interesting not only to partners, but to non-partners as well. Examples of metrics include:

- Number of non-partner attendees at workshops and short courses. The workshops and short courses could be created by Institute staff or they could be related to the focus and simply hosted at the Institute.
- Number of undergraduate students, graduate students, or post-docs drawn from outside the partner institutions to work on the Institute's focus areas.
- Participants from the non-technical community in open-houses, demonstrations, science fairs, Engineer's Day, etc.

3.2 Number of university students participating in research, education, and training (core)

It is expected that the Institutes will draw students, particularly from the partner educational institutions, to work in the Institute. Geographical proximity would allow part-time work, student projects, shadowing, and the like. Also, the use of facilities during courses, either in-person or remotely using distance learning technologies, will indicate the educational impacts of the Institute.

3.3 Number of community/technical college students participating in research, education, and training (example)

It is expected that the Institutes will provide practical exposure to state-of-the-art facilities for community/technical college students, and facilitate pathways for students to learn about educational options that might best suit their long-term interests and capabilities. Institutes and community/technical colleges will promote various technical engagement opportunities including course and work participation. It is expected that institutes will leverage geographic proximity, established regional and professional networks, and forge new relationships.

3.4 Number of K-12 students and teachers participating in research, education, and training (example)

Institutes will have a central role in improving the image of manufacturing. Showcasing the activities of the Institute and partner companies to K-12 students, teachers, parents, and families builds recognition for the interesting, challenging, rewarding careers in manufacturing. It is expected that Institutes will provide easy access for tours, and the Institutes will engage in outreach activities.

3.5 Number of veterans participating in research, education, and training (core)

One of the NNMI missions is to tap the talent pool of military veterans. Institutes will provide workforce development programs with specific attention to veteran needs including: certifications, educational opportunities, skills redirection, and others as examples.

3.6 Number of certification and degree programs created in collaboration with colleges, universities, and professional organizations (core)

In addition to providing training and education, Institutes will help develop new and expanded certifications, training programs, degree programs, and other educational opportunities. Institutes might make available examples of course materials that could be developed by Institute members (e.g., lecture materials and homework problems) in the context of undertaking technology development at the Institute. These course materials can be made available to educators to provide real-world content for their curricula.

4. PORTFOLIO

This group of metrics is intended to measure the breadth and depth of projects contained in the Institute portfolio and to track progress toward completion of project objectives.

Core and example Portfolio metrics follow:

4.1 Number of projects in the portfolio (core)

A well-functioning Institute will have a portfolio of projects that is broad and deep. Through the life of the Institute, some projects will move out into the commercial world, some will terminate, and new ones will arise. It is expected that the number of projects will grow in the beginning and stabilize at a level that is appropriate for the focus area and size of the Institute.

4.2 Number of project-level metrics achieved (example)

Each of the projects pursued by an Institute will have measurable outcomes. It is expected that the Institute will make consistent progress in achieving the metrics, or projects should be terminated.

4.3 Number and value of IP products produced and licensed (core)

This metric includes patents, provisional patents, trade secrets, copyrighted works, and generally, any form of IP. Institutes will be free to set their own IP policies, consistent with the published IP guidance and to use them as a means of encouraging companies to join, especially SMEs. For example, an Institute can consider tiered royalty rates within the Institute (all members pay some, so some funds flow to the inventors and some to help the institute become self-sustaining) and without (non-members pay more for IP).

5. FINANCIAL

Institutes need to establish stable revenue streams that will lead them to self-sufficiency after the initial NNMI funding expires. While many long-term funding models are possible, Institutes should demonstrate progress toward self-sufficiency.

Core and example Financial metrics follow:

5.1 Ratio of membership dues income to Institute expenses (core)

One source of on-going revenue for an Institute could be dues paid by partner organizations. The ratio of dues income to Institute expenses could be a measure of transition toward sustainability.

5.2 Level of fees for services or publications (core)

Because the Institute will have unique equipment and capabilities, potential revenue stream could be realized from fees-for-services. The Institute's unique capabilities may also lead to revenue generating publications and fee-based documents.

5.3 Level of non-federal contracts and grants (core)

An Institute may perform work under contracts with both member and non-member organizations, though the terms of the contract may vary depending on the membership status of the organization. In addition, an Institute may be successful in obtaining non-federal funding from various sources through grants or other agreements. Thus the revenue stream an Institute is able to generate through contracts and non-federal funding will help to measure the Institute's progress toward self-sufficiency.

5.4 Level of non-NNMI federal contracts and grants (core)

Federal funding for the NNMI is time limited by design. Institutes are intended to become self-sufficient, meaning not dependent on further NNMI funding. However, Institutes can compete for non-NNMI funding from federal sources. The success of an Institute in securing other federal funding, whether in number of awards or dollars, may be a useful indicator of the value of the Institute to agencies and their missions. .

5.5 Level of Intellectual Property (IP) revenue (core)

This metric may be stronger for some Institutes, and less so for others. IP revenue can come from:

- Direct IP licensing
- The rise in value of a start-up company where the Institute has an equity stake (in exchange for the IP)
- Increased participation in the Institutes by member companies benefiting from the IP produced.

6. NETWORK CONTRIBUTION

Each Institute is a member of the larger NNMI. The interaction of Institutes through the Network will amplify the benefit beyond what any Institute could achieve alone.

Core and example Network Contribution metrics follow:

6.1 General Interaction with the larger Network of Institutes (core)

A successful Network relies on a multitude of interactions between the individual Institutes and the Network. The interactions include sharing best practices, sharing case studies, building common legal and management frameworks (to the extent possible), and sharing aggregated financial and technical performance information.

6.2 Number of referrals of projects or partners to other Institutes in the Network (example)

Institutes will have an understanding of unique skills, capabilities, and services other Institutes possess within the Network, and they therefore can serve an important role in referring potential partners to the most appropriate Institute for their interests. The number of referrals received and that lead to substantive joint activities within the Institute would be a measure of Institute and Network performance.

6.3 Number of projects or partners received from other Institutes in the Network (example)

By strongly communicating their focus areas to other Institutes, an Institute can better attract referrals from across the Network.

6.4 Institute participation in Network governance (core)

Institute participation in Network activities on a regular basis will strengthen the Network, may strengthen the performance of the Institute, and would be an indicator of the Institute's leadership. Consequently, contributions made by an Institute to the governance of the Network should be assessed using qualitative and quantitative methods.

Table 1 Classification of Metrics

METRIC CLASSIFICATION	Short Time Frame	Medium Time Frame	Long Time Frame
Qualitative	1.1 2.13 4.2 6.1 6.4	1.1 2.13 4.2 6.1	1.1 4.2 6.1
Quantitative	2.1 3.1 4.1 5.1 2.3 3.2 4.3 5.3 2.4 3.3 2.5 3.4 2.10 3.5 3.6	1.2 2.2 3.1 4.1 5.1 6.2 1.3 2.3 3.2 4.3 5.2 6.3 2.4 3.3 5.3 6.4 2.5 3.4 5.4 2.6 3.5 5.5 2.7 3.6 2.8 2.9 2.10 2.11 2.12 2.13	1.2 2.2 3.1 4.1 5.1 6.2 1.3 2.3 3.2 4.3 5.2 6.3 1.4 2.4 3.3 5.3 6.4 2.5 3.4 5.4 2.6 5.5 2.7 2.8 2.9 2.10 2.11 2.12 2.13