RFI response for NNMI

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Dialogue Topic 1: Technologies with Broad Impact

1. What criteria should be used to select technology focus areas?
Previous discourse offered the following general design principles in previous workshops:

1. Technologies should have broad application across multiple industries, and should address a national need. Technologies should leverage and enhance the regional supply chain.
2. The targeted Technological Readiness Level and Manufacturing Readiness Level should be 4-7; there should be a strong market potential, and 3-5 year time-to-market.
3. Technologies should be enabling, with transformational potential; they should be cross-cutting, widely adaptable, and driven by industry needs.
4. The technologies should have the potential to increase the number of domestic jobs, and should have an impact on energy and environmental sustainability.

My comments: TRL and MRL should be balanced. It should have great focus on 4-7 level but it also should have a component of 1-3 to advance targeted mfg. technology.

- TRL/MRL 8-10: SME would need immediate assistant for their concurrent problems. NNMI should be able to support those needs.
- TRL/MRL 4-7: Common issues and challenges become a project and provide solutions within 2-4 years.
- TRL/MRL 1-3: Future needs and challenges of targeted mfg. technology should be identified and relevant research should be initiated.

2. What technology focus areas that meet these criteria that would you be willing to co-invest in?

The technology focus areas that were most frequently quoted were sensors; modeling/simulation software; composites; biomanufacturing, additive manufacturing, advanced materials (and composites); and nanotechnology. More generally, participants pointed out the need to address challenges faces by small and medium-sized companies, namely, scaling up and gaining access to modeling and simulation abilities, access to verification and validation processes and metrology.

My comments: Many of government programs usually focus on very trendy and emerging topics as listed above. One thing that should be noticed is that most of manufacturing to produce goods utilizes very conventional manufacturing processes such machining, forming, molding, casting, etc. and assembly. Highly competitive manufacturing practices are coming from those processes where skilled labor, low cost infra-structure, well-established supply chain, and strong ties among industries, research institutions, and schools exist. I am not saying that we ignore the above-mentioned area to improve our mfg. competitiveness but very often, fundamentals have been ignored. So far, almost none of government research programs has funded these fundamentals.

SMEs in USA especially in this area are very primitive level while Japan, Korea, and China have abundant vendors with highly skillful technologies. In order to have proper industrial structure (pyramid or diamond shape), having and being able to provide competitive fundamentals are a critical component to US manufacturing renaissance.

3. What measures could demonstrate that Institute technology activities assist U.S. manufacturing?

To demonstrate that the institute technology programs assist U.S. manufacturing, participants recommended metrics on jobs created (re-shored or new), the number of startups including SMEs, partnerships in the institute, application of methods developed into the marketplace (using a process similar to NASA's "mission use agreements").

My comments: Additional to the above, how many companies are utilizing the institute would be a good measure.

4. What measures could assess the performance and impact of Institutes?

1. The number and quality of new or re-shored manufacturing jobs, global market share of exports, and trade balance.
2. Number of new partnerships and number of applications of the technology (touchpoints).
3. Infusion of technologies into the marketplace, the number of new startups in the region, and the size of the Institute's IP portfolio.
4. Retention rate for Institute members, participation of SMEs in the institute, and the amount of industry funding received.
5. The number of projects that develop from TRL5 to TRL8, and the number of licenses generated from the Institute.

My comments: Additional to the above list, qualitative measure should account for the success of NNMI. SMEs are not always able to demonstrate such measures. More likely, many of them would benefit from consulting their everyday problems such as some materials challenges, tolerance requirements, quality of products, etc. If NNMI can provide a certain extent of consultancy or solutions and have SMEs absorb those technologies, SMEs becomes highly competitive. The question is how do we account for this measure…

Dialogue Topic 2: Institute Structure and Governance

5. What business models would be effective for the Institutes to manage business decisions?

A number of models were suggested, notably the Fraunhofer-Gesellschaft model, non-profit associations [501(c)(3) or (6)] Sematech, the National Science Foundation Engineering Research Centers, EWI, and national laboratories like Sandia and Oak Ridge. It was suggested that the Institutes remain flexible, not prescriptive, in developing business models. The business model will need to evolve during transition from federal funds to private sector funding.

6. What governance models would be effective for the Institutes to manage governance decisions?

Institutes can take many forms, with different management structures and membership rules. The business models that were suggested included the type normally used by business (a Board of Directors with a CEO that reports to the board, perhaps including a private sector advisory board), as well as referring to existing models as examples of effective structures (Fraunhofer, Sematech, NSF Engineering Research Centers, Edison Welding Institute). A holacracy (refer to http://www.holacracy.org/) model was also suggested. The vision of a National Network of Institutes can be promoted by forming a council of IMI directors to share best practices.

7. What membership and participation structure would be effective for the Institutes, such as financial and intellectual property obligations, access and licensing?

Regardless of the structure, the Institute should have certain characteristics. It has been suggested that there should be a low barrier for entry for all stakeholders, and a fee for services should be considered. Participation structures could be modeled after Fraunhofer or I/UCRCs, etc. The treatment of intellectual property has had a number of suggestions, including the pooling of IP, where the institute controls maturation and licensing and perhaps with limited licenses granted to all Institute members. Alternatively, the Institute could follow an "inventors owned" model, where IP and licensing rights are shared by the contributors to the project.

8. How should a network of Institutes optimally operate?

The network should be flexible, growth-oriented, and responsive to changing needs in industry. The Institutes should adopt consistent contractual vehicles, forms, and guidelines to establish trust with multiple institutes. Institutes should share pre-competitive information and research results with one another and with the public. This could be done through an annual conference, annual technology showcase, and via the website. Members could also form self-assembled teams to work on proprietary projects.

My comments: The challenge will be utilizing each institution's expertise for the project requiring multi-institutional core technologies. It would be ideal to have

representative group who can oversee most of activities of all institutions or regular gathering of representatives institutes self-educating technical governance (more frequent than annual conference). Building expert map would help to easily pull talents to the proper project. Expert map is a list of people with their core and secondary expertise. Also, equipment list should be accessible to all institutions.

9. What measures could assess effectiveness of Network structure and governance?

The effectiveness of the Network structure could be assessed by tracking the number of member companies, technology transfer successes, venture capital raised, and new IP. Other measures of assessment include surveys of stakeholders; the number of projects completed and time required; and the number of new and retained manufacturing jobs.

My comments: Additional to the above major indicators, in order to promote active collaboration among institution, utilization of technical talents and resources by other institutions should be considered.

Dialogue 3: Strategies for Sustainable Institute Operations

10. How should initial funding co- investments of the Federal government and others be organized by types and proportions?

It was common to attempt allocations of federal funding, such as (but not limited to): 2/3 R&D, 1/6 industry, 1/6 educational outreach; 50% equipment and facilities, 30% students and training, 20% strategic hires; 50% industry and 50% government. There was a desire expressed to limit overhead to 20%, and to avoid bricks and mortar investments. The suggestion was made to fund part-time sabbaticals to enable industry to work in academia and vice-versa. The Institute should also request machines and equipment to be donated.

Assessment measures included the number of new products created, and the increase in the manufacturing section of the US balance of trade.

11. What arrangements for co- investment proportions and types could help an Institute become self- sustaining?

Self-sustainability was discussed at length, with recommendations of fostering industry presence by gradually decreasing federal funding on projects to allow SMEs to join activities with an incentive to invest later. Sustainability requires generation of funding, which can be done by collecting membership fees; by encouraging investment by allocating percentage of IP ownership with investment; and funding from revenues and royalties associated with IP. The National Nanotechnology Initiative, the Fraunhofer Institute and the STAR agency for Science, Technology, and Research were references as useful models for co-investment.

My comments: Can we consider a revenue generation activity such as processing service for a unique fabrication need? Or can we operate a spin-off production company and its profit can be used for the institution?

12. What measures could assess progress of an Institute towards being self-sustaining?

It was expressed that the IMIs need to be hands-on and one step ahead of industry; in other words, a place where stakeholders can get work done more effectively than they would on their own. Measures to assess the progress of an Institute could include the growth in the number of industry members over time, particularly small and medium-sized businesses, the number of early members that reinvest, the IP licensing revenue, the development of new products and/or processes, or the Institute's income compared to recurring expenses.

13. What actions or conditions could improve how Institute operations support domestic manufacturing facilities while maintaining consistency with our international obligations?

Prior to accepting a project, the IMI could review each business plan to see where the company plans to manufacture, and charge higher licensing fees for manufacturing

performed abroad, and/or could offer right of first refusal for domestic manufacturing. Workshop participants noted the supply chain as a key determining factor in domestic manufacturing and noted that the IMIs could serve as a source to help fill gaps in the supply chain and help manufacturing for these technologies become more sustainable in the U.S.

My comments: The supply chain is indeed a key to succeed for US manufacturing. But again with only focusing on high tech, high skilled technology would not serve to boost or establish a good manufacturing supply chain in US. However, labor intensive manufacturing would not work either due to high labor cost and relatively low competitive skill sets. The key point would be how NNMI could fill the gap. I think it would be highly automated flexible manufacturing system (dual direction) with policy support from federal and state government.

There might be a concern that automated factories would not create a job in US but if this can be successful and with a holistic view, it would definitely create more jobs in US.

14. How should Institutes engage other manufacturing related programs and networks?

Manufacturing programs and networks should be engaged by helping companies overcome and eliminate bottlenecks in the supply chain, helping companies move from TRL or MRL of 4-7 to 8-10, and identify partners to solve multi-disciplinary challenges. Some workshop participants also suggested that NNMI critically evaluate all existing manufacturing programs and networks to see whether they successfully increase TRL for basic research, generate revenue through IP, or provide significant cost savings to the government.

My comments: One concern I have for this, if we put too much focus on higher TRL or MRL, then we may lose the balance between actual implementation of technology and advancement of technology. There should still be a good emphasis on fundamental research with low TRL level. That's the portion we need to be careful when we review other manufacturing programs. If we can incorporate those basic aspects of other programs and connects them into NNMI program, it would be really beneficial.

Some of manufacturing technologies can make a huge difference by subtle understanding of technology. We should pay attention to Japan and German cases. One can easily find researchers who are working on the same subject for really a long time. Such a dedicated research effort develops pure expertise on the subject and lead to a subtle improvement here and there, which builds up a very competitive technology at the end. Due to this core expertise, many companies in Japan invest on them or have them to be on their technology consultancy.

15. How should Institutes interact with state and local economic development authorities?

IMIs could offer a tax rebate or other tax incentives to promote collaboration with state and local economic development authorities. The state and Institute should have a strong partnership to create a strong strategy toward cluster building and incubators. SSTI (www.ssti.org) could be a useful resource to engage states and coordinate efforts. In addition, these local and regional organizations can help attract new manufacturers to the region who are symbiotic with the technology focus of the Institute. One participant suggested that a formal process be established to allow states to discuss their needs with the Institute. A searchable database could help people identify initiatives relevant to their needs and avoid duplication of efforts.

My comments: A certain level of duplication of efforts should be encouraged in order to promote competition and cross-checking purpose.

16. What measures could assess Institute contributions to long term national security and competitiveness?

Several measures can be used to evaluate Institute contributions to national security and competitiveness, including the following:

- Institutes create new markets, techniques, products (e.g., could be measured by awards)
- Institutes address and overcome pain points in industry
- More technologies are manufactured in the U.S.
- More technologies are developed for federal acquisition programs (DoD, DOE, NASA, etc.)

In addition, IP licenses could be limited to domestic use.

Dialogue 4: Education and Workforce Development

17. How could Institutes support advanced manufacturing workforce development at all educational levels?

Discussions centered around suggested best practices and assessment. Suggested activities to promote education and workforce development included:

1. Bring manufacturing to students, such as by bringing 3D printers to schools.
2. Bring students to manufacturing. Industry partners can host them, or Institutes can develop on-site fab labs.
3. Offer free online training courses (based on Khan Academy model).
4. Use video games for recruiting.
5. Educate children before 7th and 8th grade so they don't track out of pre-algebra & courses for STEM careers.
6. Gender differences need to be acknowledged and projects design accordingly. For example, design projects can be a toothbrush; not a car transmission.
7. Internships are critical for college-age students.
8. Incorporate manufacturing into the curriculum and develop materials (high schools & community colleges).
9. Change the perception of manufacturing with youth, students, and parents.
10. Fund scholarships at associate, undergraduate and graduate levels.

My comments: 1. Increase social respect toward engineers, 2. Improve job opportunity (this would work with increased US manufacturing), 3. Higher salary (or reduce the salary gap with other jobs such as financial field), 4. Change perception in the media (TV, movie, etc.)

18. How could Institutes ensure that advanced manufacturing workforce development activities address industry needs?

The Institutes should have industry representation in the governance. As new technologies enter industries that require manufacturing, new sets of skills are required. The Institutes need to take the pulse of regional industry needs and ensure that lower skill workers are getting the training they need to enter middle skill jobs. The focus should be on unemployed, underemployed, and displaced workers, as well as returning military personnel. Master's Degree programs can be developed at regional universities to address emerging needs.

My comments: The NNMI issues a certificate of technology mastership at several levels which can be well recognized by industry.

19. How could Institutes and the NNMI leverage and complement other education and workforce development programs?

The NNMI could leverage and complement other education and workforce development programs by benchmarking best practices. TechShop (a membership-based

workshop that provides access to tools and instruction), Dept. of Labor workforce development programs and SME videos were identified as models.

The Institutes could each establish a library so members can easily learn about complementary education and workforce development programs, and federally funded programs such as NSF's Advanced Technology Education Program and NIST's Manufacturing Extension Partnerships. Industry partners could publish information that details the types of skills they would like to see in their current and future employees and the IMIs. IMIs could bring in high-profile speakers and develop seminars/programs that piggyback on regional events. They could also establish an Office of Workforce Development Advisory Council to ensure that industry, academia, and government labs are collaborating and supporting one another in education and workforce development. Similarly, the Institutes could partner with jobs centers to establish training pathways for displaced workers. They could also engage vocational/technical schools, skilled trade organizations, trade unions, and apprenticeship programs.

20. What measures could assess Institute performance and impact on education and workforce development?

The following were suggested: take measures of employment, either from number of employers that hired new workers, numbers of student placements in industry, job performance, etc. Assessment could be performed with a five-year follow-up. A useful measure of performance and impact could be the number of courses offered by the IMIs. ABET outcomes could also be used. Participants noted the importance of publicizing the impact of the Institutes, to demonstrate their value to stakeholders and voters.

21. How might institutes integrate R&D activities and education to best prepare the current and future workforce?

Students at all levels should be involved in industry-driven R&D programs. Industry participants pointed out that they have good success using internships, co-ops, and apprenticeships as a way to prepare their workforce. Teacher/faculty externships were also proposed. The Institute could offer continuing education units and training focused on specific employer needs. They might also offer a prize or award for completing an NNMI project. It was noted that teaching hospitals are a useful model: the institutes could connect industry with educators and provide students opportunities for real-world experiences.

My comments: For engineering students (undergraduate level), mandatory industrial project during their junior or senior year would be very beneficial for both students and industry who hosts the student. Students can learn actual practice of their study and industry can screen student's quality for their hiring requirement.