



**Comments submitted in response to the
National Institute of Standards and Technology**

**Request for Information on
Proposed New Program: National Network for Manufacturing Innovation
(NNMI)**

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Introduction

SEMATECH is pleased to have this opportunity to respond to the Request for Information regarding the proposed National Network of Manufacturing Institutes.

The recent decline in the United States' competitive capability in manufacturing and its implications for the overall economy have led to the call from the President's Council of Advisors on Science and Technology (PCAST) for a refocused effort to ensure America's future leadership in advanced manufacturing. PCAST has cited the need for a new mechanism to strengthen the complete innovation ecosystem, with a specific focus on the development and manufacture of high value-added products. In its effort to define what is needed, PCAST has pointed to the success of the SEMATECH consortium, which created an industry-government-university partnership that was instrumental in restoring U.S. leadership in semiconductors, secured a critical national industry, enabled the growth of U.S. based manufacturing, ultimately achieved a self-sustaining industry program, and has become the often-cited and emulated model for creative collaboration.

From our vantage point at SEMATECH, we resonate very strongly with several key components of the proposed NNMI, since there are such clear parallels with our own experience as a groundbreaking consortium:

The focus on pre-competitive enabling manufacturing technologies

- ✓ SEMATECH's mission has been to focus on pre-competitive or non-competitive R&D – cooperatively setting standards, building infrastructure, assuring that key components (tools, materials, processes) are in place when needed by industry – always with an eye toward improving manufacturability and accelerating commercialization.

The importance of roadmaps to identify long-term manufacturing needs

- ✓ SEMATECH has been a key creator and long-time supporter of the International Technology Roadmap for Semiconductors, and more recently, the effort to create a national solar PV (CIGS) roadmap; we concur in the critical importance of aligning strategic planning, forging common priorities, and directing research to the critical technologies required to support the innovation roadmap.

The ability to pool resources and fund key research by universities, government laboratories, and businesses

- ✓ Through SEMATECH, member companies can leverage resources. They cooperatively fund and conduct R&D projects at selected universities, businesses (such as device, equipment, material, and software manufacturers), and U.S. National Labs, to fill key gaps in the R&D/manufacturing infrastructure.
- ✓ SEMATECH's primary focus is on development; we pull university research into the mainstream, and work with partners throughout the supply chain to accelerate technology innovations into manufacturing solutions.



The infrastructure necessary to facilitate technology transfer

- ✓ SEMATECH has developed several methodologies for efficient and effective technology transfer, including member assignees (member company personnel who serve on assignment to SEMATECH, to conduct R&D and transfer knowledge back to the member companies), secure interactive websites, and public conferences/workshops.

The critical support for research and development in advanced manufacturing, with a goal of strengthening long-term U.S. leadership in critical technologies and creating long-term economic benefits

- ✓ The SEMATECH consortium is unique in its focus on the entire innovation spectrum – the entire research-development-manufacturing continuum – with a portion of the program portfolio devoted specifically to *productivity improvements and cost reduction in advanced/future manufacturing*. Without this end-to-end focus, the intertwined development of product and process innovation cannot be maintained since it depends on intimate interactions with manufacturing.

By bringing together industry, government, and university partners to leverage resources, and share cost/risk, SEMATECH has made significant contributions to U.S. industry in terms of industrial competitiveness and job creation.

Technologies with Broad Impact

1. What criteria should be used to select technology focus areas?

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

We believe that the NNMI goals and objectives will be best met and the American economy best served by investments in enabling technologies, i.e. those that can be used across multiple industries, such as the development and production of:

- Advanced nanomaterials common to enabling a host of ultra-low power “smart” electrical/optical device technologies
- Next generation game-changing semiconductor technologies, such as 3D chip stacking,
- MEMS/NEMS and network-driven embedded sensors of all types, and
- Energy efficiency technologies.

Each of these technology areas is a potential area for user-driven consortia (vs. “horizontal” consortia comprised of competitors). A consortium of non-competing users can cooperate to develop generic technology for multiple applications in different industries; applications can be worked in parallel and drive generic technology development, so that the technology transfer gap could be significantly narrowed. We recommend the SEMATECH approach of bringing together experts and industrialists from a wide range of disciplines to identify the problems

requiring fundamental advances, define the solutions and articulate how those solutions address the needs of the consortia members.

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

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

Several specific measures would be useful in assessing the Institutes performance in this regard:

- **Membership:** Do the member companies reflect different aspects of the supply chain? Is membership growing? Is the membership becoming more diverse?
- **Collaborative programs:** Number of programs implemented, number of companies participating in those programs, development and execution of programs that correspond to goals of the roadmapping exercise, and rigorous assessment of program achievement and member satisfaction.
- **Proprietary programs:** Number of companies engaging the consortium to conduct proprietary research, rigorous assessment of program execution and member satisfaction.

Institute Structure and Governance

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

Given the program objectives, we believe that the business model that offers the greatest chances for success is an industrial consortium. A consortium is a collaborative effort that leverages resources; by combining both public and private resources, the consortium can expand the scope of its programs, investigate multiple technology options, and produce higher quality solutions, thereby multiplying many times over the undertaking that any single entity could afford.

A successful consortium must have the trust and confidence of the federal government, private corporations, and researchers/idea generators to provide the framework for, and realize the benefits of, our next generation of innovation-driven manufacturing. Trust and confidence comes from experience; the SEMATECH model has evolved with proven success in fostering technology innovation, reducing the costs of R&D, enabling advanced manufacturing, and creating high wage jobs.

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

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

A consortium must have an effective structure and methodology allowing collaborative, pre-competitive work while maintaining the integrity of the contribution of consortium members' IP and enabling the continuation into the competitive phase. We believe the most effective model is a membership model, with tiered membership levels. A tiered membership structure will enable companies of varying sizes to participate in the manner that makes the most sense for them. These tiers would encompass a broad range of engagement:

- **Anchor members:** These members would form the core of the consortium; they would share in all IP developed in collaborative programs, vote on Institute priorities and activities, participate in the road mapping exercise.
- **Program Members:** This level of engagement would allow companies to participate in specific programs and have access to the IP developed in those programs. Program members would not have voting privileges but would be able to participate in the road mapping exercise.
- **Project-specific engagement:** A company engages with the consortium on a fee-for-service basis to conduct proprietary research and the company has exclusive rights to any IP that is developed. Ideally, these companies would also be engaged in the road mapping exercise.
- **Partner organizations:** Non-profit organizations, such as universities, economic development organizations and industry associations could participate in the road mapping exercise. These organizations would not have voting privileges on the consortium's agenda or access to any of the IP.

8. How should a network of Institutes optimally operate?

The Institutes should collaborate on both administrative and substantive issues.

Administratively, Institutes can and should share lessons learned from defining membership levels, dues structure, IP management, and other operational best practices.

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

The effectiveness of individual Institutes will be evidenced by their existence beyond the period of Federal funding. If these entities present a compelling value proposition, then they will have paying members. Ultimately across the Network, we should see a measureable, increasing economic concentration in the nation of related components in industry supply chains.

Strategies for Sustainable Institute Operations

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

We believe a 1:1 government-industry ratio is optimal. Shared financial commitment ensures that industry is engaged and that the consortium activities are relevant and responsive to industry needs. Ultimately, if the Institutes are to achieve their stated objectives of supporting advanced manufacturing, they must be industry-driven.

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

Ideally, the funding should be structured such that the federal funds are dominant in the beginning and decrease over the five-year period. Similarly, industry funding would likely be the lesser share to begin with and ramp up to be dominant by the final year.

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

Ultimately, a membership organization will be self-sustaining if it is responsive to its members; that is, conducting programs that directly respond to member companies needs and priorities. Appropriate measures would include stability and growth of the membership, growth of both collaborative and proprietary programs, and periodic assessments of member satisfaction.

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

Building and sustaining international partnerships is necessary and valuable. Industries are global; U.S. firms rely on global suppliers and have operations abroad, while many international firms make significant contributions to the development of U.S. innovation and manufacturing. Participation in the consortia needs to be tied to the firm's willingness to tie its innovation to domestic manufacturing, rather than the location of its headquarters. To develop solutions that will be globally competitive, a consortium must have engagement with the global supply chain, especially in areas such as standards setting, establishing common roadmaps, and providing access to critical materials and equipment sets.

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

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

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

As described above, these entities should have a non-voting class of membership that would allow them to engage with the consortium in the road mapping exercise. This type of



engagement allows these other organizations to share information about what they are seeing in their own work with companies, who may represent a different facet of the industry, end users, or a source of skilled workforce. It also provides them with valuable insights about where the industry is going that they can take back to their constituents, thus further extending the impact of the consortium.

Regardless of the how (and whether) membership is structured for these organizations, it is important for the Institutes to have regular communications with them in order to provide one another's members and constituents visibility across program offerings. Ultimately, the Institutes' contributions to national security and competitiveness will be measured by the health and strength of the target industry and domestic supply base.

Furthermore, the Institutes should work with federal, state and local government entities to develop a system to measure and report on the economic and technology activity. Data should be collected with respect to employment and wages as well as detail for each component of the related industry supply chain—including geography. This activity is critical to document the impact of the Institutes, both in terms of regional economic development and particular industries.

Education and Workforce Development

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

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

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

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

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

SEMATECH has experience developing training programs for member companies and then training associate's, bachelor's and graduate students for advanced technology jobs. Five years ago, we worked with a community colleges and universities to design a program focused on the skills needed by companies developing nanotechnology. We then trained over 160 interns in nanotechnology fields, including

- Product engineering
- Electrical test and device characterization
- Semiconductor wafer processing
- Equipment and facilities maintenance



- Materials characterization and failure analysis

Based on our experience, Institutes' activities – not only in education and workforce development, but across the board – will be relevant and responsive to industry needs if industry is defining and driving the Institutes' agenda. As we have argued, this outcome is best achieved by an industrial consortium model. Furthermore, tiered membership is critical, as it allows companies to engage in the activities that are best aligned with their needs.

Conclusion

It is critical that the Institutes pursue revolutionary, as opposed to evolutionary, technology objectives. Instead of focusing on incremental advances within clearly defined fields, the SEMATECH consortium approach is to identify and invest in game-changing, disruptive technologies that span several disciplines. Innovative ideas can spawn entire new industries, built on robust R&D and a strong manufacturing base. The adoption of disruptive technologies allows companies to leapfrog existing industry solutions, open up new markets, and create new revenue opportunities. Moreover, the rapid adoption of disruptive technologies levels the playing field, changes the competitive landscape, and strengthens the innovation ecosystem, removing cost barriers and providing the U.S. with a competitive advantage in a global marketplace.

We believe the SEMATECH model can be leveraged in several ways to meet the goals of this new program. SEMATECH was conceived by industry and government to stop and reverse the exodus of the semiconductor industry from the U.S.; the mission was ultimately successful, and SEMATECH has continued to evolve, adjusting to a dynamic industry and a dynamic world and economy, for the last quarter century. This model is now being applied to PV manufacturing and we believe it can be successfully applied to many others, including MEMS/NEMS, microfluidic devices, wide band gap materials, and nanoscale measurement and instrumentation.