



National Network For Manufacturing Innovation

**RESPONSE TO: REQUEST FOR INFORMATION ON PROPOSED NEW PROGRAM
NATIONAL NETWORK FOR MANUFACTURING INNOVATION (NNMI)**

DOCUMENT CITATION: 77FR 26509

DOCKET NO. 120418419-2419-01

OCTOBER 25, 2012

RESPONSE TO REQUEST FOR INFORMATION

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1. The Challenges and Opportunity for the National Network for Manufacturing Innovation (NNMI)

1.1. A Need for Innovation

The published request for information from NIST from May 4th 2012 clearly summarizes the nature of the challenge facing U.S. manufacturing. The case for a National Network for Manufacturing Innovation (NNMI) is clear, composed of applied research institutes (in the following “Institutes”). Through these reports, and through the numerous workshops held before and after the RFI release, there is a clear commitment to finding the right model.

1.2. Challenges and Risks

The proposed NNMI faces the challenge of creating a new institution to reinvigorate U.S. manufacturing while optimally leveraging the U.S. ecosystem of pre-existing organizations that engage in applied research activities.

The U.S. leads the world in research and development (R&D) at universities and federally-funded research and development centers (including the recent Energy Innovation Hubs). There are also advanced manufacturing centers and organizations like Fraunhofer USA and the Edison Welding Institute, which have also made progress as U.S. based, non-profit applied research institutes for advanced manufacturing. The new Institutes should complement and augment the existing network.

Answers to the questions below will inform a successful model for the NNMI:

- How can an Institute benefit a wide range of industry participants?
- Should the “customer” for this research be industry or government?
- How can the Institutes be implemented without damaging the existing R&D network?
- How do we define sustainability?
- How can the program be structured to maximize the probability that an institute will be sustainable past the end of federal funding?
- How can an Institute’s R&D operation adapt to changing industry needs?
- Can Institutes lead U.S. industry, or should they follow it?

1.3. Exploring a Structural Model

Fraunhofer USA is responding to this request for information in order to expand on and clarify the references to the “Fraunhofer model” in studies and workshops related to the NNMI. We put forth below key attributes that have proven successful in Fraunhofer’s history of sustaining manufacturing preeminence across multiple technology areas. Background information on the Fraunhofer Society in general, and Fraunhofer USA in particular, is provided to illustrate how Fraunhofer has addressed these questions both here and in Germany.

The focus of this response is on the governance structure and operations of the proposed Institutes, rather than on any particular technology area.

2. Designing a National Network of Institutes

The responses to this section are presented based on the questions in the request for information and the Fraunhofer experience.

2.1. Performance-Based Government Funding

The structure of federal funding for the NNMI is a critical component of the operation of the proposed Institutes. To explore this issue, a distinction must be made between different types of federal support, including:

- (i) Initial funding for the startup of an Institute
- (ii) Follow-on, competitively-won federal contracts
- (iii) General federal support for industry contract research

In the startup phase, the proposed structure for NNMI relies on an initial funding commitment over 4-5 years with a matching investment required by industrial partners. After this period there is no planned follow-on federal funding. This model may work well for certain types of manufacturing innovation, primarily those that focus mainly on services with a high degree of repeatability and that rely on operations of unique capital resources that require an investment which may be too expensive for any one individual company. Other advanced manufacturing challenges are unlikely to fit this model.

Instead of relying on a surge of unique capital equipment, for example, to try to germinate successful R&D projects, it may be desirable for the federal funding to be spread out over longer time periods, to partly subsidize private-sector contract research projects with the Institutes. The Fraunhofer Society example suggests that government subsidy of applied research for industrial partners can be equitable to all industry participants and insures that the Institute retains a strong private sector focus.

If federal support emphasized the longer-term support of the cost of contract research for industry partners, rather than large up-front capital investments, this would improve the effectiveness of the Institutes by providing:

- Improved access for small- and medium-sized enterprises to the Institute's resources
- Operating freedom to expand and adapt capacity to respond to industry demands
- Added incentive to secure new industry contracts
- The ability to attract and retain top talent through changing business cycles
- Flexibility to pursue industry initiatives and strategic workforce education

Within the NNMI network, funding should not be guaranteed for any individual Institute. Instead, a set operating budget for the entire network should be approved for a given period. Federal operating support could be apportioned based on the private-sector revenue of each Institute. Therefore, no particular technology area is guaranteed government support unless the Institute continues to adapt to serve the private sector.

2.2. Earned Revenue From Industrial Customers as the Primary Metric of Success

For an applied research institute to function effectively, it must, by definition, help for-profit U.S. manufacturing customers. The best evidence of an Institute's private sector relevance is the industry's willingness to continue to pay for contract research from the Institute. The Institute's need to earn substantial contract revenue ensures it will adapt and grow (or shrink) as necessary to remain focused on industry needs. Institutes that do not adapt to serve industry must be restructured, or allowed to fail. Market forces, rather than centralized decision-making, therefore should guide the direction of the Institutes.

A longer-term federal incentive system, based on contract revenue, may be a better source of base funding than a membership commitment from individual enterprises. Small- and medium-sized enterprises, and emerging enterprises, are more able to participate on a project-by-project basis, thereby aligning the Institute with the needs of the entire industry rather than just the largest firms (which are more likely to be able to maintain membership fees). Membership-based funding favors the status quo, as emerging enterprises, the very ones likely to fuel future innovation, are least likely to have an established presence. A market-oriented organization would therefore have several benefits:

- Performance-based incentives ensure continued industry focus
- Under-performing centers are restructured or closed
- Problem of “picking winners” is minimized: the R&D service model is a market mechanism that performs services for a wide base of U.S. customers, including emerging enterprises

2.3. Leveraging the US Higher Education System for Advanced Manufacturing

The higher education system in the United States has world-leading capabilities in research and development. While some universities are more industry-oriented than others, in general, contract R&D does not fit their primary mandates of education and basic research. Nonetheless, there is opportunity to leverage the U.S. university system to support the private sector and, in the process, help educate the university students that will become the next generation of technologists.

The incentive structure of the applied research Institutes should be in the service of the private sector. To preserve the educational mandate of the universities, the organization leading the coordination with universities should have:

- An independent business unit that provides the interface with industry
- A permanent research staff dedicated to executing projects, and providing continuity
- Robust mechanisms to ensure client confidentiality

In the U.S., applied research institutions like Fraunhofer USA and SEMATECH have developed models that address these challenges, giving them the ability to meet the needs of industry and engaging university resources. In these models, the Institute, not the university, has the ultimate responsibility for contract fulfillment. The primary features of such a relationship are:

- Joint appointments for faculty as Institute research leaders
- Flexibility for students to pursue degree programs using Institute assets
- Internship opportunities to work for commercial clients
- Shared facilities for contract work and university research
- Collaborative grant applications

Benefits to the university include:

- A clearer pathway for early-stage technology concepts to reach commercial readiness
- Increased applied research training opportunities for students
- Additional funding for graduate student and faculty research

The U.S. manufacturing industry benefits from this partnership through managed access to university resources that can be directed towards the growth and profitability of the industry as a whole. The nature of the resources that universities provide is such that even projects with substantial proprietary content usually yield results that the university can publish, to the benefit of the industry at large.

2.4. A Semi-Autonomous Governance Structure

The industry focused incentive structure described previously is designed to allow research Institutes to grow and change in response to customer demand. This flexible structure can be mirrored in the organization of each research institute with each Institute having control of its own operation. A “semi-autonomous” structure would mean that each Institute would:

- Be a non-governmental body that operates as a business
- Be independent from the success or failure of peer institutes
- Have an independent advisory board of industry leaders
- Determine technical focus areas based on board guidance
- Make spin-out and licensing decisions on a distributed rather than centralized basis

The autonomy allows an Institute to remain flexible and innovative to develop and terminate programs in accordance with its need to earn private-sector revenue. The entrepreneurial, market-based structure of Institute governance also serves to attract business-oriented technical leaders, those that might otherwise remain in less-influential positions within a particular enterprise. An ancillary benefit is that the semi-autonomous structure also prevents any one interest group from controlling the Institute to the detriment of its competitors.

The board of directors can be selected from the private sector to advise on medium- and long-range goals. This structure has the benefit that government oversight of the unit can focus on the operating principles of the organization, rather than area-specific research efforts. This structure would ultimately inoculate the government against “picking winners” at the expense of other promising technology directions.

3. The Fraunhofer Model in Germany

The Fraunhofer Society was founded in 1949 to strengthen and build manufacturing in Germany. Initially funded by the Marshall Plan, it has grown to over 20,000 researchers in eighty research units with an annual budget of over \$2 billion.

The Fraunhofer model has been adapted in many countries for formation of their domestic applied research organizations, and has been the subject of numerous academic studies on innovation infrastructure and technology transfer.

Fraunhofer has acquired an impressive track record of building and maintaining preeminence in manufacturing research. In addition, it has shown the ability to spin-off development concepts into successful new companies. This is true across the multitude of sectors covered by Fraunhofer Institutes, including life sciences, advanced manufacturing, materials, energy conversion, building systems and infrastructure, and information management.

3.1. Funding Model – Encouraging Industry Relevance

A defining feature of the Fraunhofer Society is its funding model. Each Fraunhofer Institute is run like a business, with a consistent focus on applied research to serve industrial clients. 70% of the total Institute funding is expected to be generated from a combination of industry and competitive government research contracts. The remaining 30% of the budget is provided as performance-based funding. The amount of base funding is not fixed, but is tied to earned revenue from contract research. This enables successful institutes to grow and respond to client demand, while limiting government investment into research that is less responsive to the market. Because funding depends on the successful acquisition of industry contracts, the funding model provides powerful incentives to adapt to changing industry requirements.

The ratio of revenue between industry contracts and competitively-won government grants is a separately-measured metric for each Institute. The target for industry revenue varies, but is typically about 50%. While the ratio will fluctuate over time, the institute will be asked for a change of strategy if the percentage should be higher.

Within each Fraunhofer Institute, research groups form the functional units. Funding for research groups works the same way as for the Institute as a whole. Each research group is its own small business unit, with the same incentives. Groups are started, grown, re-tooled, or even shut down based on market-driven demand. Heads of the research groups need to be adept in not only maintaining close contact with their industrial customer base, but also to anticipate strategic market shifts. This constant exposure has enabled many Fraunhofer research groups to become leaders in their respective fields.

Performance-based funding is another essential ingredient of the Fraunhofer model. This funding enables the Institutes to invest in future capabilities and to take risks in the development of new, cutting-edge technologies. It also helps to soften the impact of variable economic conditions. Performance-based funding enables individual research groups to attain and keep world-class status in their respective fields.

3.2. Licensing and Spinoffs

The most famous Fraunhofer innovation is the MP3 compression algorithm. While this is the most successful licensing effort, it is by no means the only one. Over the past ten years, Fraunhofer has spun-off more than two-hundred companies and supports researchers in becoming entrepreneurs. New companies are founded at a rate of about a dozen spin-offs per year. The long-term success rate of these companies is high, with a continuing solvency level of over 90%. This can be attributed, in part, to the amount of industry domain knowledge the founders were able to acquire at Fraunhofer before the spin-off.

3.3. Common Misconceptions

Questions sometimes arise about the fairly unique Fraunhofer model. The following may help clarify some of these questions:

Fraunhofer USA is an American non-profit corporation that benefits U.S. industry - The Fraunhofer USA mandate is applied R&D for the benefit of U.S. industry and U.S. economic development. It has an independent board of directors. U.S. Federal law prohibits Fraunhofer USA from providing material benefits to the Fraunhofer Society without fair market compensation under a formal contract. Proprietary client information is never shared between Fraunhofer USA and Fraunhofer Gesellschaft without written client consent.

Industry is the primary target customer for Fraunhofer Institutes, rather than government - This reduces the government funding required to support the Institutes and helps ensure that the projects pursued are relevant to industry's needs.

Fraunhofer does not produce commercial products - Fraunhofer performs applied research that benefits industrial partners, but does not compete with for-profit manufacturers. Commercialization is carried out by for-profit companies, supported by Fraunhofer research groups.

Fraunhofer Institutes are not dependent on government contracts - In Germany, competitive government grants are considered to be separate from performance-based funding. Fraunhofer Institutes commonly apply for competitive research contracts with German and European government agencies. The portion of revenue from industry or competitively-won government contracts varies by Institute. Some Fraunhofer Institutes in the U.S. and in Germany function with very few government contracts.

4. Fraunhofer in the U.S.

Fraunhofer USA was founded in 1994 as an independent 501(c)(3) non-profit organization to support various industries. The organization has a current annual budget of about \$50M. While Fraunhofer USA leverages the Fraunhofer model developed in Germany, it serves U.S. industry.

4.1. Focused on Manufacturing

The first Fraunhofer Centers in the U.S. were sited in Michigan to work on tool and die making to support U.S. automotive manufacturing. The Center for Laser Technology (CLT) partners with the University of Michigan and Wayne State University and the Center for Coatings and Laser Applications (CCL) partners with Michigan State University. Today CCL is considered one of the world's leading labs for developing synthetic diamond coatings for drill bits.

The Center for Manufacturing Innovation (CMI) at Boston University develops precision tools and equipment for manufacturing in the fiber-optical, medical and other industries. The Center for Molecular Biotechnology (CMB) is developing rapid manufacturing processes for plant-based vaccine production.

The Fraunhofer Center for Sustainable Energy Systems (CSE), which collaborates with MIT, is the most recent addition to Fraunhofer USA. It works with manufacturers in photovoltaics, energy-efficient building materials and systems and "smart grid" technologies.

4.2. Adapting the Fraunhofer Model to the U.S.

While the core Fraunhofer model remains the same, the U.S. Fraunhofer Centers operate slightly differently from those in Germany. Fraunhofer USA receives some performance-based funding from the Fraunhofer Society, in part to promote international applied R&D collaborations between the U.S. and Germany. States, foundations, and private donors compose an important part of the base funding in the U.S. Non-Federal sources of performance-based funding in the U.S. have thus far enabled Fraunhofer USA to achieve significant growth. Limited performance-based funding from the Fraunhofer Society means that new sources are needed in order to maintain its increasing impact.

The more entrepreneurial environment that exists in the U.S., paired with the Fraunhofer non-profit structure, has led to some new and interesting programs. One such program is Fraunhofer TechBridge. TechBridge is designed to ensure that Fraunhofer resources are available to startups and other subject matter experts that need them the most. TechBridge is funded in part by a U.S. Department of Energy Innovation Ecosystem Grant to develop and introduce new products in the marketplace.

After two years of operation, more than \$23M in follow-on funding has been raised by TechBridge client companies, with approximately half raising that funding within a year. TechBridge focuses on technical hurdles faced by early-stage companies and applies Fraunhofer R&D capabilities to help bridge the gaps.

5. Concluding Perspective

We believe that the proposed applied research institutes of the NNMI are urgently needed and can significantly advance the cause of revitalizing and sustaining manufacturing in the United States. Based on Fraunhofer's successful experiences in the U.S. and in Germany, we feel that the Institutes should be independent, non-profit enterprises that perform contract research in a competitive environment. Government funding for the NNMI can be even more effective if awarded based on the Institutes' ability to secure contract research revenue. This performance-based funding should be put in place to give Institutes adequate operating horizons to provide continuity, enable strategic thinking, and attract and retain talent. The structure described in this document can help ensure that organizations developed with NNMI funding will remain industrially relevant and sustainable. Fraunhofer USA looks forward to an opportunity to participate in the NNMI program.

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