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# Pilots to Inform the Creation of Potential New Manufacturing Technology Acceleration Centers (M-TACs)

*Response to Request for Information*

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## Introduction

A myriad of challenges, both technical and business related, face small to mid-sized manufacturers (SMMs) throughout the U.S. as they struggle to grow their businesses, create jobs and adopt advanced technologies in order to remain competitive in the industrial market. This is particularly true for legacy businesses that may be resistant to change and/or lack the resources to properly adopt new technologies and/or train their current workforce on implementation. With this knowledge, NIST has participated in and presented many opportunities for organizations to rally to support the U.S. value chain industry including the highly successful support to and funding of the Manufacturing Extension Partnerships (MEP) Centers and the Joint Innovation Accelerator Cluster (JIAC) Programs. As a close partner to the local MEP center in our region, and an awardee of one of the JIAC awards, NCMS has an important and unique view on the organization of future M-TACs as well as their plan for enticement, engagement and education offerings to SMMs and their elevation to eventual self-sustainability.

In 2010, the National Center for Manufacturing Sciences enlisted the University of Michigan's Tauber Institute to execute a study, survey and business plan for an initiative to bring advanced manufacturing tools, such as modeling and simulation to the nation's SMMs. The results of this study, which surveyed nearly 300 SMMs across the U.S. is the basis for our Digital Manufacturing initiative which we believe is a perfect fit for the planned M-TAC network.

### *Question 1*

### What are the specific types of technology transition and commercialization tools and services that should be provided by M-TACs?

By translating designs into new products, and ensuring the availability of skilled workers to undertake diverse work, SMMs will be able to unify the value chain from concept, to engineering, to production, and to service. An unprecedented array of technologies now enables rapid evaluation of product and manufacturing process design options, permitting rapid launches and designed-in producibility. Further, SMMs who adopt advanced modeling and simulation (AM&S) tools have an advantage in global competitiveness, increasing exports from their region and growing the economic base. M-TACs should not only help new companies grow, but help existing ones diversify, both growing and saving jobs.

Over the years, SMMs have taken on more obligations from OEMs, particularly in R&D, even as economic realities force them to ever-leaner operations. Doing more with less requires that they consistently and aggressively improve Cost, Quality, Timing, and Capacity (CQTC). These are the four fundamental drivers of industry, and a savvy business makes every decision based on how it impacts one or more of them. Historical means to improve CQTC included the adoption of such tools and processes as assembly lines, CAD and even desktop computing. However, to accelerate future innovation and competitiveness, SMMs require affordable access to new and existing AM&S tools for design and process improvement, help identifying and penetrating the right customers and

markets, workers talented in rapid and custom set-up for machining and end-products, access to a diverse supplier base to meet the needs of an increasingly diverse customer base, connection to and fostering of relationships with large OEMs and guidance, training, mentorship and business counseling.

Of course, the bigger something is the more complex and challenging it tends to be to adopt… AM&S is not at all like adopting a new CAD package. In fact, the closest corollary may be that foundation of modern life itself. Mass Production empowered manufacturers to reliably build products more quickly and cheaply than Craft Production. But the barriers to entry, many of which seem rather trite now, must have seemed staggeringly out of reach in the early 1900s. One can imagine manufacturers of the day shuddering at the requirement for fully-electrified factories, especially given the absence of a national power infrastructure. In their own way, these advanced manufacturing tool prerequisites are just as intimidating:

- Peta-scale data
- Intelligent machines
- Modeling and simulation software
- Predictive analytics
- High performance cluster computing
- Skilled users

No wonder SMMs have been slow to adopt these tools. They may not even know what some of those prerequisites *are,* let alone have any way of obtaining them. In fact, **84% of manufacturers with fewer than 500 employees have no Predictive Simulation capabilities at all**[1]**.** That's the functional equivalent of a modern office attempting to operate using typewriters instead of word processing applications. For SMMs, the up-front investment in dollars, human capital, and infrastructure is just too much of a risk and investment, regardless of demonstrated long-term ROI. Ultimately, the barriers to Mass Production were overcome collaboratively. Manufacturers, government stakeholders, providers, and private interests worked together to build what was needed. Now in the 21st Century, the originator of modern cross-industry collaboration, NCMS has turned its attention toward overcoming the barriers to adoption of AM&S tools.

## *Question 1a*

### How would M-TAC services complement those currently offered by MEP Centers?

The strengths of the NIST MEP centers are found primarily in innovations strategies, market research/costing, executive/leadership training, matchmaking, lean processes and green manufacturing – all integral needs of an SMM in today's manufacturing base. However, NCMS has been working closely with the Michigan Manufacturing Technology Center (MMTC), the MEP center in Michigan and have found that they feel that manufacturers they come into contact with every day, would benefit immensely from access to advanced manufacturing tools, but do not know where to find them affordably, bundled with the important resources, like engineering support, required to execute and read the data properly.

In 2008, NCMS assembled a broad strategic interest group to define a sustainable long-term strategy for bringing advanced manufacturing tools to SMMs. The result is the Grid Initiative™: a national innovation network connecting manufacturers physically and virtually to an affordable, single-stop, impartially-managed home for all things Digital Manufacturing including AM&S tools. To begin, NCMS developed a four-rung engagement model designed to promote the awareness and adoption of Digital Manufacturing among the SMM community:

1. **Educate:** outreach and training builds awareness of Digital Manufacturing concepts among the "Missing Middle." Education focuses on use of case studies and relevant data to demonstrate that adoption of Digital Manufacturing provides tremendous ROI.

[1] *Source: NCMS survey, 2010*

2. **Entice:** draw SMMs into the fold by providing affordable access to Digital Manufacturing tools such as AM&S in a risk-free environment. Use brick and mortar centers as hubs for hands-on experience and training, plus collaborative and business development opportunities.
3. **Engage:** once an SMM understands the value, the next step is to get them using the tools. SMMs on the Grid will have affordable, pay-by-use access to software, hardware, and expert support for their own projects, without a massive up-front investment in resources or human capital.
4. **Elevate:** at the Elevate level, SMMs may choose to bring the capabilities in-house, investing directly in cluster computing and advanced modeling and simulation software. Elevated SMMs may no longer need the Grid; having seen the value, they choose to make it their own. Other organizations may prefer to stay with the Grid's collaborative pay per core/hour model, allowing them to quote the service on a per project basis.

Because it is fundamentally a collaborative effort, the Grid reduces individual investment and risk for all parties. Establishing collaborations with providers and leveraging existing resources eliminates the most significant barriers to entry. NCMS has partnered with hardware and software vendors, OEMs, and academic institutions – and they are ALL IN. Collectively, their products, knowledge, and capabilities will provide the foundation of tools and expertise that the Missing Middle needs. Shared at Grid Cells™ and provided online via the Grid Portal™, affordable, pay-as-you-go access to core capabilities will overcome the barriers of cost, expertise, and infrastructure.

## Grid Cell™ = M-TAC

If the Grid is a network for tomorrow's manufacturing, Grid Cells™ are its anchors, holding it secure to spread awareness and access across the country. Grid Cells should be co-located or one-in-the-same as M-TACs as these facilities, deployed throughout the United States, will provide an affordable, accessible, low-risk environment for visitors to discover and experience the value of Digital Manufacturing techniques. At these facilities, users will connect with experts, trainers, and tools, collaborating across industries and time zones on advanced R&D projects and manufacturing opportunities. SMMs will experience the power of the Grid without any up-front investment. Outreach programs started at each Cell will spread knowledge throughout the region, educating manufacturers of all sizes, evangelizing the capabilities of Digital Manufacturing.

The key is to educate SMMs on the value of these tools and entice them to begin thinking of ways that they might be applied to their own processes. M-TACs, managed by a neutral third party, such as NCMS, could provide a shared physical space where resources can be accessed on an as-needed basis, allowing SMMs to quantify potential return on investment for long-term adoption of Digital Manufacturing techniques.

Each NCMS Grid Cell™ currently on the map is collaboration between NCMS, key regional stakeholders in government and academia, and industry supporters. Opening in October 2013, the Grid's inaugural innovation center will be hosted by General Electric at the **GE Advanced Manufacturing Software Technology Center (AMSTC)** in Van Buren Township, Michigan. With a focus on innovations in advanced materials and composites for manufacturing, the Michigan Cell is being supported by a wide array of participants:

- General Electric
- Altair Engineering
- ANSYS
- Ford Motor Company
- Perficient, Inc.
- Michigan Economic Development Corporation
- InnoState (JIAC Award Team)

NCMS Grid Cells™ have specific focus on technology areas relevant to their region. Starting with the launch of the Michigan Cell which is focused around advanced materials, the Virginia Grid Cell located in Fairfax at

George Mason University will be the second to launch (also in the fall) and will focus on crash worthiness and safety for the transportation industry.

## *Question 2*

### What role should future M-TACs play with respect to supply chain needs? How should OEMs participate? How can industry associations, professional societies and other appropriate national organizations participate?

Each M-TAC should engage one or more large-scale, cross-industry collaborative R&D efforts, managed by a neutral third-party and supported by industry OEMs. Outreach partners such as MEP centers could work with OEMs to identify and engage SMMs in the projects, providing direct links to industry and providing new business opportunities for smaller manufacturers including inclusion in a preferred supplier network of the OEM participants.

As the network matures, self-selecting collaborations will begin to emerge based on shared need or perceived opportunity. Simply by sharing the same space, SMMs, OEMs, **independent software vendors (ISVs), industry associations, professional societies and other appropriate national organizations** will begin to network and identify potential collaborative prospects supported by the M-TAC's technology infrastructure.

SMMs have differing levels of knowledge regarding the value, applicability, and even the existence of Digital Manufacturing. NCMS Grid Cells™ will offer more than just shared collaborative space to experience new tools. Each location will also host seminars on a variety of subjects, such as application-specific software training, security requirements, certification in physical disciplines, and more. NCMS has already partnered with ISVs, training organizations, and thought leaders in Digital Manufacturing to produce and provide this material at their Grid Cells™, ultimately leading to a certification path for SMMs.

Though each NCMS Grid Cell has a technical focus, activities there won't be limited to it, neither should M-TACs. The digital connections between Grid Cells™ will enable manufacturers to collaborate with other manufacturers across the country. More exciting still is the opportunity for unexpected cross-disciplinary partnerships – composites innovators working with precision manufacturing, for example, or logistics experts coordinating with automobile safety manufacturers. NCMS has found that the most beneficial collaborations often come from organizations that initially appear unrelated – even outside of manufacturing entirely.

NCMS will manage a series of collaborative R&D projects at the Cells to build initial awareness and provide innovation ROI for hosts and public sector funding providers. Some major projects are already in the formative stages:

- **Michigan – High Strain Rate Hybrid Materials:** develop, assess, and optimize new lightweight, high-strength hybrid materials for manufacturing stronger, lighter components at lower cost and with greater sustainability
- **Michigan – Shared Outreach & Engagement Infrastructure Development:** develop and prototype a shared online infrastructure for affordable physical and virtual access to Predictive Simulation capabilities across the Grid
- **Virginia – Integrated Vehicle Structure Modeling:** develop and evaluate an integrated vehicle structure model for the analysis and optimization of occupant safety during collisions and development of new vehicle designs for improved crashworthiness

Grid Cells™ are places where people can *learn*, and a whole-pipeline approach includes retraining/up-skilling of the existing skilled workforce. Community colleges and vocational training programs will be instrumental in this, and NCMS is reaching out to a number of educational institutions and professional associations. Unsurprisingly, most

have been quite eager to get involved. There are a number of potential stakeholders for a steering group in high-level workforce development issues, including:

- Washtenaw County Community College
- Lawrence Tech University
- Wayne State University
- Macomb Community College
- Kettering College
- Workforce Intelligence Network (WIN) of Southeast Michigan
- American Welding Society
- Michigan Manufacturing Association
- NAFEMS

## *Question 3*

### Is there a particular long-term scalable and financially sustainable business model that should be implemented by future M-TACs that will enable small and mid-sized U.S. manufacturers to effectively access and benefit from the technology transition and commercialization assistance and other resources they need?

One of the chief obstacles SMMs face in adopting Digital Manufacturing – particularly AM&S tools – is the cost of the software. ISVs that produce simulation software are used to dealing with OEMs: companies with very large budgets and very high usage. That volume licensing doesn't translate to SMMs, and the lack of an SMM-friendly licensing model is part of the reason ISVs have been unable to penetrate that market.

By including ISVs in the NCMS business plan for the Grid network from the beginning (2008), NCMS has addressed this challenge. SMMs on the Grid will have access to an ever-growing marketplace of software and hardware resources with licensing options tailored to their needs: typically pay-as-you-go subscription models, or bundled packages that include all the necessary software and hardware time and expertise to complete a specific, fixed task.

SMMs on the Grid will be able to visit the Marketplace and comparison shop for the application or solution that best suits their current need. User reviews, flash sales, and free product demos – reinforced by the hands-on activity taking place in the Grid Cells™ - will help SMMs gain greater understanding of the available software landscape and better determine their own needs. Crucial to the success of the Marketplace is the fact that it, like the rest of the Grid, it is managed by an impartial, nonprofit consortium. NCMS can mediate price negotiations, assess and recommend software packages, and ensure that the Marketplace remains customer-focused in pricing and features.

Everything done in the real world at the Grid Cells™ will find a parallel in the digital world on the Grid Portal™. In the case of education and training, that means supplementing the traditional, scheduled classroom events at Grid Cells™ with robust multimedia e-Learning.

Another challenge faced by SMMs is internal capability. Many SMMs don't have personnel on staff with the requisite expertise to use Predictive Simulation software, interpret the results of data mines, or perform the complex physics calculations necessary for optimization in a Digital Manufacturing environment. The Grid Cells™ will provide some training, plus access to experts who can provide on-site consulting and support. Where possible that will be mirrored on the Grid Portal™, which will also feature an array of unique digital training options.

Grid users will find an ever-growing library of training for all levels of expertise, ultimately leading to competency certifications for individuals and companies. Some training will be provided by ISV partners, academic institutions, and educational non-profits through agreements negotiated with NCMS. In cases where training material doesn't exist or isn't available, custom multimedia e-Learning will be developed and integrated into the online curricula.

Large challenges are best overcome through collaboration, which drives massive outcomes faster, and at lower risk and cost, than traditional "go it alone" approaches. When it comes to Digital Manufacturing, NCMS knows that SMMs can't go it alone – most simply they cannot undertake the cost and risk of adoption. The solution is to do it together, to collaborate, thereby reducing those costs and risks.

The NCMS Grid is envisioned as a unique hybrid: a national innovation network that exists in both the physical and virtual worlds. Grid Cells™/M-TACs are pins on the map – cornerstones of awareness, access, and outreach that will spread the message of Digital Manufacturing throughout their region. Cells are connected by digital strands, a secure virtual network for online access and collaboration called the Grid Portal™.

First and foremost, the Grid Portal™ is a secure environment for project participation. Starting with large-scale NCMS-managed R&D projects and eventually expanding to support dynamic user groups and self-selecting collaborations without NCMS oversight, the community portal is part social network, part project management hub:

- Users and groups
- Private and public forums
- Secure document sharing
- Project management tools
- Social networking
- Online help and support

NCMS is currently working with a number of enterprise network providers to develop and prototype the community portal, using commercial off-the-shelf tools where possible, to control project costs. The first stage portal prototype will be available on a limited basis by the time the Michigan Grid Cell™ opens its doors in the fall. The team will iteratively update and improve its capabilities on an ongoing basis.

Digital Manufacturing is revolutionary. It represents an absolute change; a complete restructuring of everything we know about how things are built. In this way, it is no different from Mass Production: just as large, just as complex, just as disruptive. Looking back over the 20th Century, we can see how little of it would have been possible without Mass Production. Today, Digital Manufacturing offers a similar future – the idea of precognitive industry, where massive-data simulations allow business to look into the future, to optimize products and processes while innovating unimaginable new ones. Adopting it is not going to be an easy task.

At NCMS, we believe anything worth doing is best done together. The more insurmountable and overwhelming something seems, the more readily it is accomplished in collaboration. Our commitment and responsibility to American manufacturing demands that we be part of driving this new revolution. Together – and *only* together – we'll change the way America builds.

Because the Future of the U.S. is Not *Made*, it is **Manufactured**.

The National Center for Manufacturing Sciences (NCMS) is an Ann Arbor, MI based not-for-profit 501(c)3 corporation established in 1986 to bring innovations out of the exploratory phase and into commercial implementation. Through the development of collaborative partnerships to address strategic issues, NCMS accomplishes this goal more quickly, at lower cost, and with fewer risks than going it alone. NCMS leverages the resources and infrastructure of each participant to arrive at solutions that improve the competitive standing of our manufacturing base. In addition, NCMS elevates the national awareness and importance of the manufacturing sector to the overall health of the economy and the nation's standard of living. It was the first and is still the only cross-sector consortium that is addressing the competitiveness of the nation's manufacturers.

NCMS membership is comprised of nearly 300 North American corporations and organizations committed to manufacturing. Working with collaborative project teams, the NCMS focus is to bring new technologies and capabilities to the manufacturing community in order to improve their competitiveness and produce more robust systems quickly, economically, and with higher quality.

NCMS has nearly 27-years of award winning experience in the formation and management of complex multi-partner cross-industry collaborative research and development (R&D) programs including:

- 215 Department of Defense (DoD)projects totaling over $500M
- 6 Department of Commerce (DOC) National Institute of Standards and Technology Advanced Technology Program (ATP) awards totaling $115M
- 17 Department of Energy (DOE) projects totaling $120M
- 10 Environmental Protection Agency (EPA) projects totaling $7.7M
- 7 State of Michigan projects totaling $1M
- NCMS has been awarded ten Defense Manufacturing Excellence awards
- NCMS won five consecutive R&D 100 Awards
- NCMS has negotiated more than 65 CRADAs or MOUs between Government and industry

NCMS provides a full complement of program support capabilities:

- Program Management
- Finance and Accounting
- Contract Administration
- Communications & Public Relations
- Electronic Collaboration
- Multimedia Creative and Training Development

NCMS works closely with federal agencies, leading OEM's, entrepreneurial technology companies, and SMMs in all industrial sectors. Both industry and government agencies reach out to NCMS and our cross-industry network of members to ensure that their new technology efforts are focused on real-world applications with inherent and immediate viability. We serve as a "trusted third party" for these groups in order to accomplish their research and development goals.

Program management and contract administration at NCMS are noted for their speed and flexibility. Once projects are approved, contracts with our industry and university participants can be prepared and issued within a month or less of time. Our financial and accounting system has been audited and approved by the Defense Contract Audit Agency (DCAA), and our contract administration can be specifically designed to meet the needs of specific programs. NCMS does not have in-house R&D capabilities, but collaboratively manages our member companies, universities, and Government participants at their locations with the needed expertise and capabilities to develop and implement the targeted technologies. This neutral, third-party position enables NCMS to be a trusted partner whose sole objective is to meet the program needs of the participants and to smooth the technology transition and deployment into commercialization and use.

*[Question 3a — re: Cost Share not addressed]*

## *Question 3b*

### The generation of intellectual property is possible, and even likely as a result of M-TAC operations. What types of intellectual property arrangements and management constructs would promote active engagement of industry in these pilots, especially among small and mid-sized U.S. manufacturers that would be supportive of the business model?

NCMS is more than just a pioneer in collaborative management: it invented modern collaboration. Since 1986 it has netted nearly 30 international awards, leveraged billions of R&D dollars, and commercialized hundreds

of innovative products and processes, all thanks to an ever-evolving proprietary model that defines every aspect of managed cross-industry collaboration. Funding management, IP protection, legal support, competitive issues, contracting, and a thousand other factors can stand in the way of an effective cross-industry collaboration, but over 27 years NCMS has developed a process that addresses them all, for companies of all sizes.

NCMS operates under an Inventor-Owns Intellectual Property (IP) Model. In such an arrangement, companies can retain their early advantage in the marketplace and drive faster implementation. Background IP contributed to the project and to project participants and third parties is solely at the discretion of the owner and under conditions established by the owner. At the same time, title to foreground IP vests in the developer/inventor who pays for patent, copyright, trademark and other legal protection. Project participants receive nonexclusive, royalty-free licenses to foreground IP and participants can sublicense IP they develop, but not IP developed by other participants (Notwithstanding the above, participants may sublicense foreground IP to wholly-and majority-owned subsidiaries). Royalties generated stay with the licensing party. The government receives government purpose license rights as appropriate.

Recognized for collaboration, product development, and sustainability, NCMS offers the cutting edge programs and approaches that will drive the success and innovation of manufacturing and technological research and development well into the 21st Century.

*[Questions 4 & 5 not addressed]*