21st Century Manufacturing: Innovation Strategies and the Role of Technology Extension

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Overview

1. Introduction – and Recent / Current Studies
2. Technology Extension Services – What, How, Why?
3. The National Academies Study
4. Context: Setting the Stage – US Manufacturing Trends
5. The US Manufacturing Extension Partnership
6. National Academies Study: Key Findings
7. National Academies Studies: Recommendations
8. Insights and Issues

DISCLAIMER:
This presentation includes a summary of the National Academies report *21st Century Manufacturing: The Role of the Manufacturing Extension Partnership* (October 2013). It draws upon slides prepared by Academies staff and also includes material added by the presenter from other research and studies. The published NAS report should be reviewed for the Committee's full analysis, findings and recommendations.

Recent / Current Studies

21st Century Manufacturing: The Role of the Manufacturing Extension Partnership

National Academy, National Research Council, Washington, DC, **October 2013**.

Impact of Technology and Innovation Advisory Services

P. Shapira, J. Youtie. Compendium of Evidence on the Effectiveness of Innovation Policy Intervention. NESTA and Manchester Institute of Innovation Research, **December 2013** (advance copy)

Institutions for Technology Diffusion: Technology Extension Services – Operation, Cases and Insights

P. Shapira, et. al., Manchester Institute of Innovation Research and Georgia Institute of Technology. Inter-American Development Bank.

January 2014 (under review)

http://bit.ly/tech-ext

Technology Extension Services

WHAT?

- **Advice and expertise** offered directly to firms to improve technology use and innovation
- **Linked** with management strategy, R&D, training, financial support, marketing, supply and customer relationships
- **Targets** – often SMEs in manufacturing, but also other types of firms
- "**Real services**" (Bellini) - engage directly with companies to transfer knowledge and stimulate learning using nonfinancial means
- **Diverse forms** - also known as "industrial extension" or "innovation advisory services" and can be a component of "business support services" and "applied technology centers."

Technology Extension Services

HOW?

Typical services

- Information provision
- Benchmarking and assessment
- Technical assistance or consultancy
- Referral, links with finance
- Training
- Group or network services; supply chain development
- Collaborative projects (R&D, implementation)
- Strategy development; coaching and mentoring

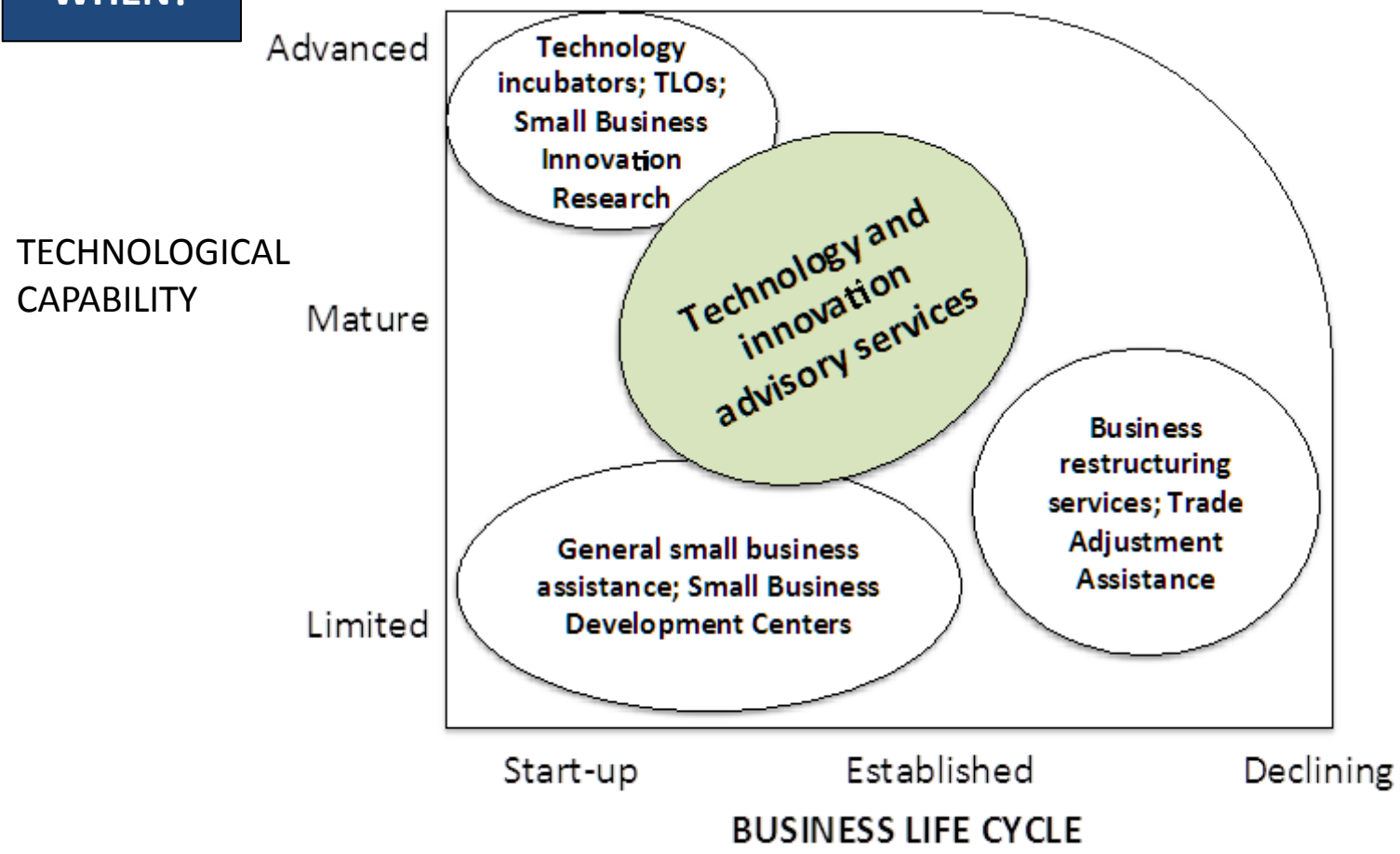
Examples of Types of Technology and Innovation Advisory Services

Dedicated Field Services	Technology-oriented Business Services	Applied Technology Center Services
❑ **Manufacturing Extension Partnership** (MEP) [USA] ❑ **Manufacturing Advisory Service** (MAS) [England]	❑ **Industrial Research Assistance Program** (IRAP) [Canada]	❑ **Public Industrial Technology Research Institutes** (Kohsetsushi) [Japan] ❑ **Fraunhofer Institutes** (FhG) [Germany]

Technology Extension & Innovation Advisory Services

Positioning

WHEN?



Source: Shapira et al., 2014

WHY?

Technology Extension Services:

Rationales for Intervention

❑ Market failures

- Demand-side: SMEs lack information, knowledge, resources to implement modern methods and new technologies
- Supply-side: Large customers, vendors, consultants don't or can't support SMEs; Trade associations weak

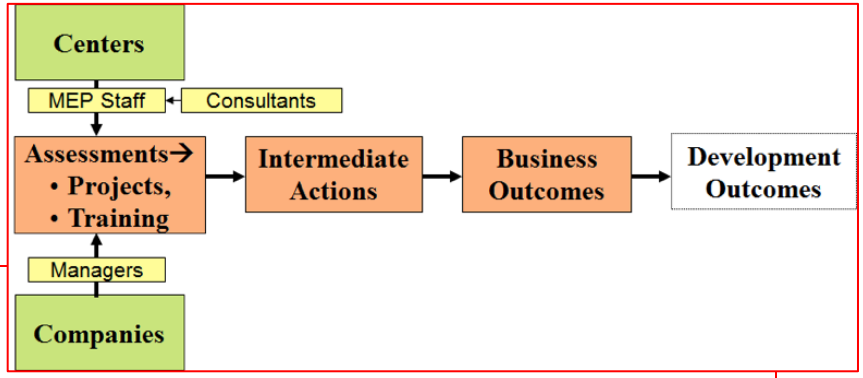
❑ Government and service failures

- Gaps in *public* service provision for SMEs

❑ Strategic concerns

- Economic competitiveness – maintaining jobs while growing wages;
- Rebalancing, expanding exports
- Develop supply-chains and clusters, for new rounds of technological growth
- Foster local and regional economic development

Intervention Logic



❑Program design

- Service ➔Projects ➔Business Outcomes ➔ Economic Impacts
- Important but hard to measure and to attribute

❑Program paradox

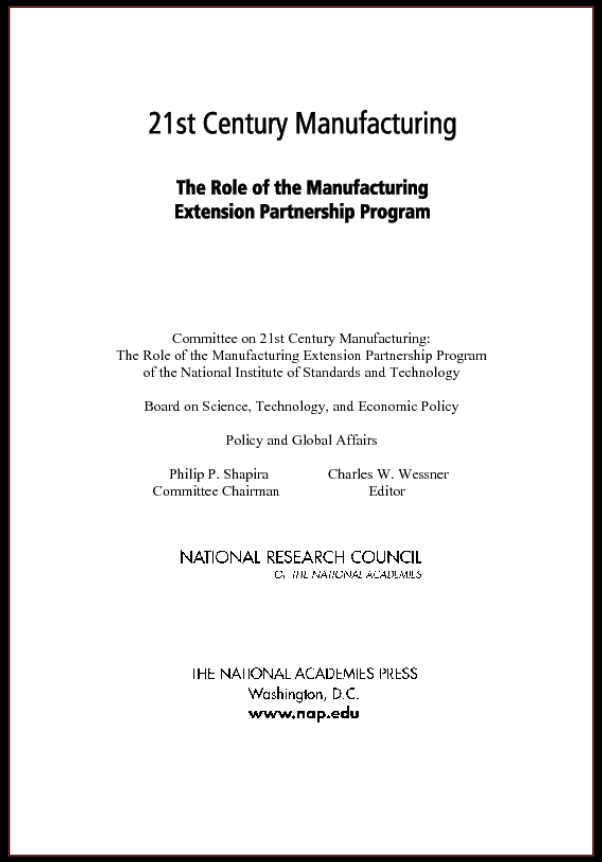
- Modern complex economies are comprised **not just of firms** but of **value-chains and networks** (including technology centers, manufacturers, services providers, entrepreneurs, investors)*
- Industrial networks need to be "carefully tended to and nurtured" – **technology extension services have a key role in "convening and connecting"** – tending to the network, not only specific firms.*
- Critically important, hard to join up, and really hard to measure

*Case study of NE Ohio (Brookings, 2013)

The Academies' Review of the MEP Program

- An evaluation of the operation, achievements, and challenges of the Manufacturing Extension Partnership program at the National Institute of Standards and Technology

- 21st Century Manufacturing: The Role of the Manufacturing Extension Partnership (October 2013)



21st Century Manufacturing

The Role of the Manufacturing Extension Partnership Program

Committee on 21st Century Manufacturing:
The Role of the Manufacturing Extension Partnership Program
of the National Institute of Standards and Technology

Board on Science, Technology, and Economic Policy

Policy and Global Affairs

Philip P. Shapira
Committee Chairman

Charles W. Wessner
Editor

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Earlier report: *Strengthening American Manufacturing: The Role of the Manufacturing Extension Partnership : Summary of a [2012] Symposium* (2013)

Committee and Staff

- **Committee Chair: Philip Shapira -** Professor, Manchester Business School and School of Public Policy, Georgia Institute of Technology
- **Ed Breiner -** President & CEO, Schramm, Pennsylvania
- **Mary Good -** Dean Emeritus, University of Arkansas Little Rock*
- **James Griffith -** President & CEO, Timken Co. Ohio
- **Rob James -** Deputy Secretary General, National Research Council of Canada
- **Ginger Lew -** CEO, Three Oaks Investments, Florida
- **Deborah Nightingale -** Professor, Massachusetts Institute of Technology*
- **Luis Proenza -** President & CEO, The University of Akron
- **Paul Wright -** Professor of Mechanical Engineering, UC Berkeley*

*NAE member

- **Study Director: Dr. Charles W. Wessner**, Director, Program on Technology, Innovation and Entrepreneurship, The Academies Board on Science, Technology, and Economic Policy
- Academies staff and consultant support

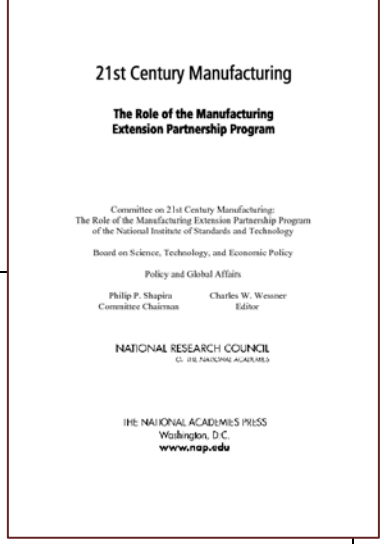
Multiple Sources and Review

- ❑ An informed committee
- ❑ Five NRC workshops
- ❑ Site visits and/or consultations with MEP Centers
  - Georgia: GA-Tech; Ohio: MAGNET; Pennsylvania: DVIRC and Catalyst; Indiana: Purdue; California: CMTC; Minnesota: Enterprise Minnesota; Alabama: Alabama Technology Network; MEP of Mississippi, Tennessee MEP; North Carolina MEP

- ❑ Onsite visits to foreign programs
- ❑ Interviews with MEP and Center staff
- ❑ Interviews with academic and policy experts
- ❑ Input data from the MEP awards base
- ❑ Comprehensive literature review of MEP assessments
- ❑ Analysis of NIST, GAO, and other reports

- ❑ **Academy review**: 14 reviewers, 100+ pages of comments; Coordinator & Monitor review

The Consensus Report



1. The Structure and Role of MEP
2. U.S. Manufacturing in Global Context
3. MEP and Lean Manufacturing
4. Development of MEP Center Metrics
5. MEP Center Performance Measures and Evaluations of Program Outcomes
6. New Approach: Next Generation Strategy
7. Foreign Programs to Support Applied Research and Manufacturing
8. Committee Findings and Recommendation

APPENDICES

A. Reviews of Canada's IRAP, Germany's Fraunhofer Institutes, Taiwan's ITRI, Britain's Catapult, and France's Carnot
B. Cross Study Analysis of MEP Evaluations
C. MEP Center Data and Open-Ended Responses from Center Directors
D. Bibliography

Why Does Manufacturing Matter?

- Manufacturing dominates the U.S. Innovation System
  - 70% of industrial R&D, 80% of patents, employs 64% of scientists and engineers
- An important Source of Employment
  - Manufacturing supports an estimated 18.6 million jobs in the U.S.—about one in six private sector jobs
- An essential element in U.S. National Security: Having on-shore production capacity matters

Trends in US & Global Manufacturing

CHALLENGES

- Decline of vertically integrated industries*
- Focus on stock market valuation, driven by Wall Street*
- Growth in capabilities overseas**
- Foundation capabilities:
  - 270k manufacturers – 99% employ under 500 employees (SMEs)
  - SMEs typically lag in productivity, technology, training, innovation

FUTURE OF MANUFACTURING?***

- New strategies & technologies
  - Digital manufacturing, mass personalization
- New (emerging) markets & new (emerging) competitors
- Sustainability & resilience
- Needs highly skilled workers *and* managers
- Integrated value creation
  - Supply chains, user demand, public-private manufacturing support landscape

* Suzanne Berger, *Making in America*, MIT, 2013

** NRC, *Rising to the Challenge; U.S. Innovation Policy for the Global Economy,* 2012

*** *The Future of Manufacturing*, Government Office for Science, London, 2013

New US Manufacturing Strategy*

- Capitalize on lower energy costs
- Develop a better understanding of the importance of manufacturing and the need for facilitating institutions.
- Make the US more competitive for manufacturing by lowering tax rates and modernizing infrastructure
- **Spur innovation on next generation technologies through support for manufacturing institutes, investments in manufacturing R&D**
- Strengthen workforce skills and regional clusters
- Improve market access with trade agreements

*Gene Sperling, Director, National Economic Council, July 25, 2013

Federal Policy Response: New Manufacturing Organizations

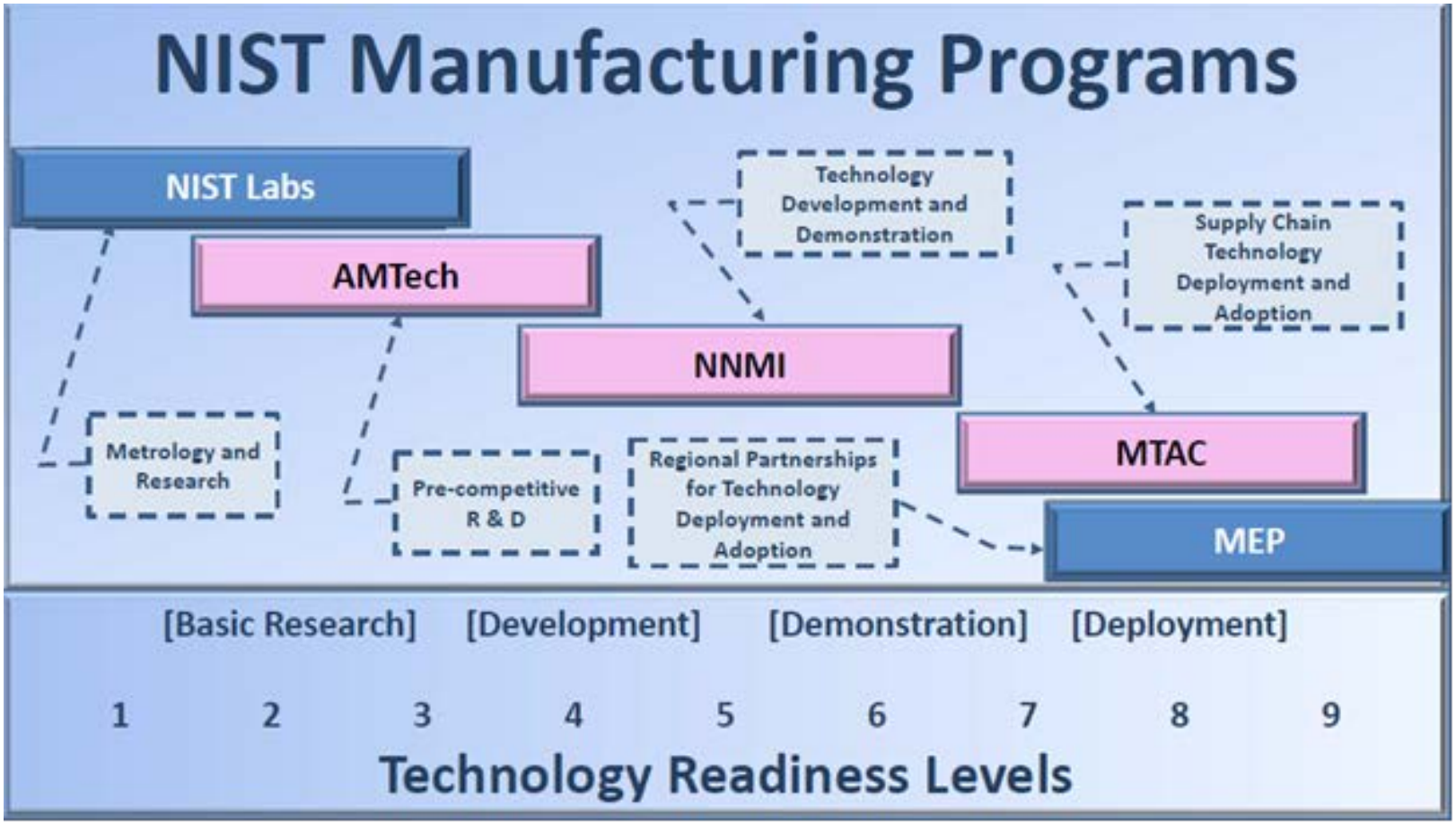
Source: Gayle, Folk, Update on NIST Extramural Programs in Advanced Manufacturing Visiting Committee on Advanced Technology June 11-12, 2013

New U.S. Manufacturing Programs

- **Advanced Manufacturing Technology Consortia** (AMTech)
  - Planning, Implementation Awards
  - $4.5m (NIST), $3m (DOD Institutes for Manufacturing Innovation)
- **National Network for Manufacturing Innovation**
  - Goal: 15 manufacturing development, demonstration hubs ($1b) – **Manufacturing Innovation Institutes**
  - Repurposing of existing funds
    - First round: additive manufacturing ($30m)
    - Second round: lightweight materials/metals, semiconductors for power, digital manufacturing
- **Manufacturing Technology Acceleration Centers**
  - Test business models for accelerating technology adoption via supply chains ($1m)

15 JAN 2014: $140m (5yr) Power Electronics Inst in N. Carolina

MEP in NIST's Portfolio



US Manufacturing Extension Partnership (MEP)

- 1950s+ **State industrial extension services**
- 1988 Trade & Competiveness Act
  - **National Institute of Standards and Technology** (NIST)
  - 3 regional technology transfer centers
- 1990s: Development of MEP
  - 1993 Technology Reinvestment Program
- **2014: 60 MEP centers in 50 states**

- **Federal-state cooperative partnership**
- **Center diversity**: university, non-profit, state
- **$321m** ($123m federal + state and fee income)
- **Field services**: 1200 staff; 2300 3rd party providers
- 30,000 manufacturers assisted in 2013; with **7,000 companies** receiving intense assistance

Metrics and Evaluation

NIST Metrics (FY 2013)

- 31,131 manufacturers served
- $2.2b new sales
- $6.2b retained sales
- 62,703 increased/saved jobs
- $1.2b cost savings
- $2.6b client investments

Evaluations (N=40+)

- Reach: 7-10% of US SMEs manufacturers served, 2% in-depth
- Impacts:
  - Control group studies *mostly* show positive value-added results (Jarmin, 1999; SRI 2009; exc. Cheney et al 2013)
  - More customized services lead to better results (productivity)

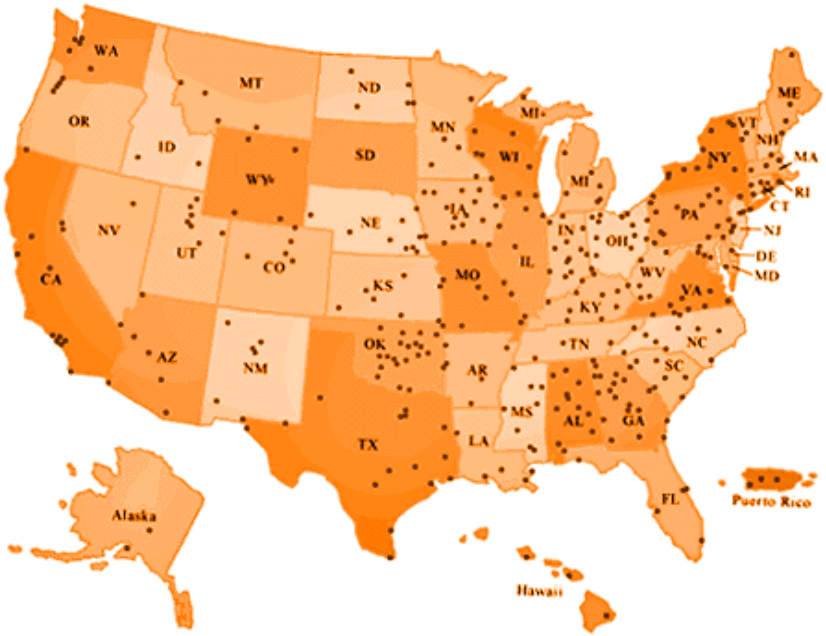
MEP's Unique Role

- Leading US program designed explicitly to provide support services to small and medium manufacturers
  - These SMEs have limited market alternatives
  - Distributed program, with Centers addressing needs particular to different regions
  - Direct assistance
  - Linkages with other services, value-chains, networks
- Key element in NIST's suite of programs to support U.S. based manufacturing

MEP: Decentralized structure:

Customized regional and local presence, field service

MEP Centers (N=60)



Field Offices (N= 300+)
of MEP Centers

MEP • MANUFACTURING
EXTENSION PARTNERSHIP

Challenges facing MEP Today

- **A changing competitive environment**
  - Globalization of Innovation and Manufacturing
- **A challenging mission**
  - High variation in size, technologies, and needs of manufacturing firms
  - Need to maximize mission impact on a small budget, while raising revenues
- **Operational challenges**
  - Budget, stability, staffing
- **New focus on innovation**
  - Need to move 60 Centers that are diverse in size, capabilities, strategic orientation, organization, innovative capacity

Core Findings

❑ 16 topics of study findings – selected core findings include:

- Program Value: The MEP program makes effective use of relatively limited resources for reaching and supporting small and medium sized manufacturers.
- Focus on Lean: MEP has provided valuable help to small manufacturers in the introduction of lean manufacturing techniques.
- Next Generation Strategy: MEP has made a concerted effort to encourage MEP Centers to develop a wider range of services focused on innovation and growth.
- Best Practices: NIST needs to better understand the operations and impact of leading foreign programs and draw on their best practices lessons.

Center Diversity

- Notable diversity among MEP Centers in terms of structure, services, and business models
  - Significant scope for experimentation and adaptation to local needs
  - Large variation in MEP Center performance
- However, MEP does not yet capitalize sufficiently on this diversity of experience
  - Learning across the system could be enhanced

MEP's Focus on Lean

- Most MEP Centers have developed tools and services focused on lean manufacturing as a primary line of business.
- Overall, MEP's support for lean manufacturing shows evidence of success.
  - Based on Case studies, Literature Review, and Interviews
- **But Lean is not enough to grow and expand the innovativeness of the manufacturing sector.**

MEP Next Generation Strategy (NGS)

Emphasis on **innovation** and **growth**

- Support: Centers that are best at adapting new NGS services are also the ones that receive additional investments from their states
- Leadership matters: The Center's leadership and the composition of their Advisory Board play a central role
- Staff capability: field staff matter – need capabilities and tools to support innovation in SMEs
- Networks: Successful MEP Centers are actively connected to local manufacturing networks, universities

MEP's Funding Challenges

- MEP's budget is modest, given the importance of its mission
  - $321M ($123M federal + $198M state and local matches) in 2012
- Formula (target): 1/3 federal: 1/3 state: 1/3 fee income
- Fixed 2:1 matching formula limits adaptability of the MEP system: frozen in place
  - Limits NIST ability to incentivize Centers
  - Amplifies impact of declines in support from states for MEP Centers
  - Incentivizes MEP Centers to focus on clients able to pay and repeat clients rather than on outreach to smaller under-served companies
  - Creates the fog of in-kind contributions

MEP Metrics and Evaluation

- Limitations of old impact measures
  - Reliance on self-reported data
  - Insufficient separation between Center staff and surveyed firms
  - Surveys often deployed too soon to capture impacts
  - Limited use of learning to drive improvements
  - Using highly variable quantitative metrics that may not reflect real performance
- New CORE metrics provide more qualitative indicators, but concerns remain
  - Survey complexity makes it hard for small firms to respond accurately
  - Potential for bias as Center staff are incentivized to encourage positive responses

8 topics of (and 37 detailed) recommendations in the panel report

1. Focus on MEP System Performance

R1. NIST MEP should focus more on driving the overall improvement of MEP centers rather than focusing on outcomes of individual centers

- Develop positive incentives to improve Center performance
- Encourage Centers to share best practices through peer-to-peer exchange
  - Annual conferences
  - Forum for Center Directors
- Encourage experimentation with pilot programs
- Foster Centers of Excellence – use distributed capability

2. Maximize Impact over Coverage

R2. The MEP should use its resources to leverage maximum beneficial outcomes rather than reaching the maximum number of manufacturers

- Be Selective in Choosing Clients
  - Support SMEs that can best benefit from MEP services rather than aim for reaching the most firms: "touches" vs. in-depth services
- Adopt a Longer Term Perspective
  - Focus on improving the long-term productivity, sustainability, innovation performance of clients.
  - Adopt a longer-term framework for assessing Center performance.

3. Enhance Lean Manufacturing

R3. The MEP should continue to encourage lean manufacturing

- Maintain current Center capacities.
- Integrate lean manufacturing with new initiatives related to innovation.
- Adjust metrics to better reflect the importance of lean manufacturing to the Centers.

4. Address Challenges of Next Generation Strategy

R4. MEP should continue … its Next Generation Strategy [yet also] address the challenges inherent in this transition.

- ❑ Review market demand for new services region by region
- ❑ Recognize that Centers need to maintain their revenue base
- ❑ Identify and promote emerging best practices across Centers
- ❑ Recruit and train new staff at center level
- ❑ Draw on Advisory Boards and other expertise to chart NIST-MEP and MEP-Center improved NGS strategies

5. Metrics; 6. Funding; & 7. Match

R5. NIST MEP should significantly improve its collection and analysis of performance data

- Develop in-house and external analytical capability
- Evaluation as a service: Ensure findings are available, identify best practice, use for improvement

R6. Federal funding for the MEP program should be at a level commensurate with its mission, and take into account relevant international benchmarks.

- Current levels of funding are not adequate to address MEP's mission
- Added funds should be use more flexibly

R7. NIST MEP should be more flexible in the management of the funding of MEP centers

- Review 2:1 core funding model, change to 1:1

8. Take on board lessons from US and international best practice

R8. Further support for US manufacturing should … take into account lessons from US and international best practice

- Understand roles that different manufacturing support organizations play
  - New organizations should be targeted to fill gaps in existing US ecosystem and take advantage of new opportunities.
- Dimensions:
  - Best practice, branding, partnership, existing as well as new companies, field service integration, research infrastructure, training, stable funding, periodic reviews

- "The committee finds that the MEP program provides valuable help to small manufacturers, with the enhancements recommended here, the program will be an increasingly important element in the nation's portfolio of programs to support manufacturing and the jobs it brings."
  - *21st Century Manufacturing: The Role of the Manufacturing Extension Partnership Program (2013, p.5.) http://bit.ly/tech-ext*

Enhancing the MEP:

Main Take Away Points

1. Improve **flexibility and experimentation** for MEP Centers
2. Facilitate **learning of best practices** across MEP Centers
3. Carefully roll out a **more innovation-oriented** program
4. **Improve data collection** of program outcomes
5. Implement regular arms-length **evaluations of suppliers**
6. Draw on **best practices** from foreign programs
7. **Integrate MEP** as a part of **a national manufacturing strategy**

Technology Extension Services

Good Practices … and Debates

Good practices

- Pragmatic approach to technology
- Build client capabilities – beyond problem solving
- Customised, intensive & flexible support
- Expert-led, long-term relationships with business to develop trust
- Program scale and reach – long-term perspective
- Linkages with other service networks, finance, customers

Debates

- Focus on high-growth potential firms rather than blanket support
- Effectiveness of general versus specialized business support
- Regional networking and cluster approaches
- On-line v. face-to-face v. group
- Role of demand-side incentives
- Linking SMEs to research base & commercialization of ideas
- Measurement: What counts?
- Sustaining & justifying public funds
- Integrating extension services into new manufacturing initiatives

Proposition

..an effective set of upgrading, innovation support, and networking mechanisms for small and medium-size firms (SMEs) is one of the foundation measures that nations and regions seeking to improve their economic standing need to have in place.

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