REPORT TO THE PRESIDENT

CAPTURING A DOMESTIC COMPETITIVE ADVANTAGE IN ADVANCED MANUFACTURING

Report of the Advanced Manufacturing Partnership Steering Committee

Annex 6:

Regional Meeting Summaries

Executive Office of the President
President's Council of Advisors on
Science and Technology

JULY 2012

PREFACE

In June 2011, the President established the Advanced Manufacturing Partnership (AMP), which is led by a Steering Committee that operates within the framework of the President's Council of Advisors on Science and Technology. In July 2012, the AMP Steering Committee delivered its report to PCAST, entitled *Capturing Domestic Competitive Advantage in Advanced Manufacturing*. PCAST adopted this report and submitted it to the President. The Steering Committee's report draws on preliminary reports prepared by several "workstreams." These workstream reports have been made available as on-line annexes to the Steering Committee report

IDA SCIENCE AND TECHNOLOGY POLICY INSTITUTE

Summary of Advanced Manufacturing Partnership Regional Meetings

President's Council of Advisors on Science and Technology

Advanced Manufacturing Partnership Steering Committee

Meetings Held: October - December, 2011

Report Date: February 1, 2012

1. Overview

The Advanced Manufacturing Partnership (AMP) is a national effort bringing together the Federal government, industry, universities, and other stakeholders to identify and invest in emerging technologies with the potential to create high-quality domestic manufacturing jobs and enhance the global competitiveness of the United States. AMP responds to recommendations made by the President's Council of Advisors on Science and Technology (PCAST) in its June 2011 report, entitled "Ensuring Leadership in Advanced Manufacturing." AMP is guided by a Steering Committee, which operates within the framework of PCAST and is comprised of leading experts from industry and academia. The AMP Steering Committee (AMP SC) is organized by four workstreams: Technology Development; Policy; Education and Workforce Development; and Shared Facilities and Infrastructure.

In the fall of 2011, the AMP SC hosted four regional outreach meetings around the country and over 1000 members of the public representing diverse stakeholder perspectives participated:

- Atlanta, GA, October 14, 2011 (hosted by the Georgia Institute of Technology)
- Cambridge, MA, November 28, 2011 (hosted by Massachusetts Institute of Technology)
- Berkeley, CA, December 5, 2011 (hosted by University of California - Berkeley and Stanford University)
- Ann Arbor, MI, December 12, 2011 (hosted by the University of Michigan)

The regional meetings had two purposes. The first was to share AMP's approach and activities with industry, university, government, and other stakeholders. The second was to gather the participants' ideas about opportunities for investments and actions that have the potential to transform manufacturing in the United States.

Participants at each of the four regional meetings heard from government and industry panelists, who discussed opportunities and challenges that their communities face in the advanced manufacturing domain. These panel discussions were followed by breakout sessions focused on the themes of the four workstreams. The main points of these breakout sessions are synthesized below. Specific details on each meeting can be found in the Appendix.

AMP Workstreams

Technology Development identifies emerging technologies with transformative potential with the express intent that they be commercialized and deployed in the United States.

Policy makes recommendations to the Administration on economic and innovation policies that can directly or significantly impact the ability to improve research collaboration and the pathway to commercialization in support of U.S. based manufacturing and jobs.

Education and Workforce Development identifies tangible actions that will support a robust supply of talented individuals to provide human capital to companies interested in investing in advanced manufacturing activities in the United States.

Shared Facilities and Infrastructure assesses opportunities to de-risk, speed up, and lower the cost of accelerating technology from research to production through unique capabilities and facilities that serve all U.S. based manufacturers, in particular small- and medium-sized manufacturers.

A. Technology Development Workstream

Each regional meeting approached technology development differently. At the first regional meeting in Atlanta, the participants in the technology development group discussed which advanced manufacturing technologies were critical to develop to enhance U.S. competitiveness in advanced manufacturing and innovation. Participants cast a wide net and identified areas of urgent importance, including energy (old and new sources, efficiency, and innovative technology); microelectronics; informatics (especially in health care); materials (composites, nanomaterials, biomaterials) and technology for forming and shaping materials; supply of strategic materials (including rare earth materials); green technology; and broadly applicable systems (automation, supply chain models, predictive modeling, complex systems, and information management). At subsequent meetings, the discussions were launched from a narrowed list of topics that cut across multiple industries and technology domains. These topics reflect the evolving discussions of the technology development workstream. Over the course of the four regional meetings, the ideas discussed by the participants evolved and were refined resulting in five possible cross-cutting technology domains:

- Advancing sensing, measurement, and process control
- Advanced Materials Design (including nanomaterials, metals, coatings and ceramics)
- Information technologies (including visualization)
- Energy efficient manufacturing
- Nanomanufacturing

B. Policy Workstream

The main themes discussed in the policy workstream breakout sessions included regulatory burdens, intellectual property, export controls, trade policy, and tax policy. While many companies recognize the regulations are important and needed, they contend

that the process is often burdensome and lacks coordination between different Federal and state requirements.

Policies that assist manufacturing firms to transition technologies from research into manufacturing processes were at the heart of the discussions. Enhancing university-industry collaboration is an important step to help SMEs move new ideas into commercialization. To promote university-industry collaboration, effective research and licensing agreements need to be developed. Participants proposed Phase 0 (seed) Small Business Innovative Research awards and funding for incubators were also discussed as possible incentives to connect U.S. manufacturers to innovation programs created by universities.

C. Education and Workforce Development Workstream

Concerns regarding the lack of worker preparation for high-skilled manufacturing jobs in today's workforce dominated the discussion. Partnerships between community and technical colleges, universities, industry, and government were frequently mentioned as being of central importance to training the next generation of workers.

The perceived negative image of manufacturing was also a major theme at each regional meeting. Discussion focused on how to create an image of manufacturing as a stable, socially acceptable career path. Workers and students must be interested and excited about their career prospects to strength the talent pipeline. Participants discussed that repairing this image for all stakeholders, including students, teachers, parents, guidance counselors, essentially all citizens, is critical to maintain and revitalize U.S. manufacturing.

To prepare the workforce, community groups and technical colleges need to work with industry to design programs to prepare curricula to ensure that students are learning important job skills. Industry can collaborate with educational institutions by contributing to class projects, and providing cooperative education and internship and externship opportunities. Industry can also participate in programs that educate teachers and parents.

D. Shared Facilities and Infrastructure Workstream

Similar to the work in the technology development workstream, ideas discussed in the breakout sessions on shared facilities and infrastructure evolved over the four regional meetings. Several major themes were common across all the discussions.

Many representatives from small and medium enterprises (SMEs) expressed that they were not aware of shared facilities at national laboratories or universities. Participants proposed a database of existing shared facilities that has the potential to allow businesses to identify resources they could use to improve their manufacturing processes and products.

Supercomputing centers and centers of excellence where industry could collaborate with universities and develop new technology or prototypes were also listed as potentially useful for businesses. Centers could be physical or digital, depending on regional technology needs. By the fourth regional meeting, at the University of Michigan, the participants further developed the idea of building private-public manufacturing innovation centers and provided valuable input about how such a center could effectively operate. They discussed ideas on governance, operation, and maintenance of the centers; intellectual property rights of users; and workforce training for the centers. Such centers could help to develop a digital manufacturing infrastructure that would provide businesses support for the design and analysis software to enhance their manufacturing capabilities. Such centers would need to be narrow enough to serve the needs of a particular industry, but broad enough to encourage different aspects of production that cut across industries.

E. Next Steps

The AMP Steering Committee is using the valuable input from regional meetings, the AMP website, and ongoing discussions with stakeholders to generate recommendations for its final report which will be released in spring 2012.

Appendix: Advanced Manufacturing Technology Regional Meeting Agendas and Summaries

Georgia Institute of Technology, October 14, 2011

Time	Event	Speakers/Participants
9:00 am	Welcome	*G.P. "Bud" Peterson* President, Georgia Institute of Technology
		Joseph J. Ensor Vice President and General Manager for Engineering, Manufacturing and Logistics/Electronic Systems Sector, Northrop Grumman Corp.
		Jason Miller Special Assistant to the President for Manufacturing Policy
9:30 am	Overview of Workstreams	*Carrie Houtman* Senior Public Policy Manager, The Dow Chemical Company
		Ben Wang Incoming Executive Director, Manufacturing Research Center; Georgia Institute of Technology/FSU
9:40 am	Government Panel Presentations	*David Hart* (Moderator) Assistant Director for Innovation Policy, Office of Science and Technology Policy
		Neal Orringer Director of Manufacturing and Industrial Base Policy, Department of Defense
		Leo Christodoulou Program Manager, Industrial Technologies Program, Department of Energy
		Michael F. Molnar Chief Manufacturing Officer, National Institute of Standards and Technology
		Steven H. McKnight Director, Civil, Mechanical, and Manufacturing Innovation Division (CMMI) of the Directorate for Engineering, National Science Foundation
10:50 am	Breakout Session Instructions	*Steve Cross* Executive Vice President for Research, Georgia Institute of Technology
11:00 am	Break	
11:15 am	Breakout Session 1	**Technology Development**
		Education and Workforce Development
		Shared Facilities and Infrastructure
		Policy
12:00 pm	Lunch	
12:15 pm	Breakout Session 2	**Technology Development**
		Education and Workforce Development
		Shared Facilities and Infrastructure
		Policy
1:00 pm	Break	
1:15 pm	Breakout Session Outbriefs	
1:50 pm	Next Steps	*Jason Miller* Special Assistant to the President for Manufacturing Policy
2:30 pm	Panel Discussion: Industry Prospective on the AMP Workstreams	*John Zegers* (Facilitator) Director, Georgia Center of Innovation for Manufacturing
		Panelists:
		Walt Stadnisky President, Roper Pumps
		Burl M. Finkelstein Kason Industries
		Donald L. Deptowicz PCC Airfoils, LLC
		David Stern

Meeting Summary: Georgia Institute of Technology, Atlanta, GA October 14, 2011

Introductory Session

Speakers were G.P. "Bud" Peterson, President of Georgia Institute of Technology; Joseph Ensor, Vice President of Northrop Grumman; and Jason Miller, Special Assistant to the President for Manufacturing Policy. They emphasized the following points:

- Innovation in manufacturing requires a strong manufacturing base, and a strong manufacturing base requires collaboration between the research and industry communities and a robust supply of skilled technical workers.
- Companies are willing to invest to create jobs, but they need to see long-term payoff.
- The goal of the AMP is to accelerate technology development and lower the risk in moving from laboratory to factory to market

Federal Government Panel

Panelists from the government were Leo Christodoulou, Department of Energy (DOE); Steven McKnight, National Science Foundation (NSF); Neal Orringer, Department of Defense (DOD); and Michael Molnar, National Institute of Standards and Technology (NIST). They described initiatives and grant mechanisms aimed at promoting collaborative technology research and technology transfer to industry. Some of the main points included:

- DOE's Innovative Manufacturing Initiative is investing in the next generation processes as well as in the next generation of materials.
- Advanced manufacturing at NSF includes fundamental and cross-cutting research, as well as attention to education and human capital development
- DOD funds the development of high-technology products with long lifetimes. To guarantee the supply chain, DOD monitors and co-invests in the development, purchasing, and maintenance of these high-tech products.
- NIST has many programs that focus on advanced manufacturing, and partners with industry and universities through programs such as the Manufacturing Extension Partnership (MEP) and some shared facilities.

Breakout Sessions Reports

The participants divided into groups, which each discussed the workstream topics of (1) advanced technology development, (2) shared infrastructure and facilities, (3) policy, and (4) education and workforce development. The groups reconvened to offer summaries, including the points described in the following subsections.

Advanced Manufacturing Technology Development

Areas seen as having urgent importance included energy (old and new sources, efficiency, innovative technology); microelectronics; informatics (especially in health care); materials (composites, nanomaterials, and biomaterials) and technology for forming and shaping materials); supply of strategic materials (including rare earth materials); green technology; and broadly applicable systems (automation, supply chain models, predictive modeling, complex systems, and information management.

Shared Facilities and Infrastructure

Participants agreed on the value of shared facilities allowing industry access to costly specialized equipment, but recognized problematic issues such as improving access by small- and medium-sized companies and safeguarding intellectual property. A fundamental need is for a system that lets industry know what facilities are available and what their potential value is in specific manufacturing contexts.

Policy

The burden of regulatory compliance (including domestic regulations and export controls) is an overwhelming issue for many industries, which frankly see Federal regulation as an adversarial bureaucracy. Participants also saw a need for more Federal support of university-industry collaboration; the German model was frequently mentioned in this context.

Education and Workforce Development

Many industries have begun working with schools and community colleges to promote technical education and bolster manufacturing as a career choice. Intervention must be early in students' school careers to be effective. Much of this work is local and needs to be shared and coordinated on a national scale.

Massachusetts Institute of Technology, November 28, 2011

Time	Event Name	Speakers/Participants
10:00 am	Welcome and Overview	*Susan Hockfield* President of MIT
		The Honorable *Deval Patrick* Governor of Massachusetts
		Video: *Andrew Liveris* Chairman and CEO, The Dow Chemical Company
10:20 am	Federal Government Panel	*Susan Hockfield* (Moderator)
		Subra Suresh Director of the National Science Foundation
		Patrick Gallagher Under Secretary of Commerce for Standards and Technology, NIST Director
		Ken Gabriel Deputy Director, Defense Advanced Research Projects Agency
		Henry Kelly Acting Assistant Secretary, Office of Energy Efficiency and Renewable Energy
11:30 am	Overview of AMP	**White House Perspective:**
		Jason Miller Special Assistant to the President for Manufacturing Policy
		Summary of AMP Workstreams:
		Carrie Houtman Senior Public Policy Manager, The Dow Chemical Company
		Ben Wang Chief Manufacturing Officer, Georgia Institute of Technology
11:45 am	Breakout Session Instructions	*Martin Schmidt* Associate Provost and Professor of Electrical Engineering, MIT
11:50 am	Break	
12:10 pm	Lunch Breakout Sessions	**Policy:**
		Eric Nakajima (Facilitator) Senior Innovation Advisor, Massachusetts Executive Office of Housing and Economic Development
		Education, Training and Recruitment: *Nancy Snyder* (Facilitator) President and CEO of Commonwealth Corporation
		Networks and Shared Facilities: *Patrick Larkin* (Facilitator) Director of the John Adams Innovation Institute at the Massachusetts Technology Collaborative
		University and Industry Collaborations: *Olivier de Weck* (Facilitator) Associate Professor of Aeronautics and Astronautics and Engineering Systems, MIT; Executive Director, MIT Production in the Innovation Economy (PIE) Study
		Technology: *Ahmed Busnaina* (Facilitator) William Lincoln Smith Professor and Director of the National Science Foundation Nanoscale Science and Engineering Center (NSEC) for High-Rate Nanomanufacturing at Northeastern University
		Energy/Sustainability/Green Manufacturing: *Timothy Gutowski* (Facilitator) Professor of Mechanical Engineering, MIT

1:10 pm	Break

Massachusetts Institute of Technology, November 28, 2011 (continued)

Time	Event	Speakers/Participants
1:15 pm	Regional Panel 1: Advanced Manufacturing Success Stories	*Karen Mills* (Moderator) Administrator of the U.S. Small Business Administration G*uy Broadbent* President and CEO, Xcellerex, Inc. *Jill Becker* CEO, Cambridge NanoTech *Michael Casper* Founder, President and CEO, UltraSource, Inc. *Joanna Dowling* Director, The Custom Group *Bill Emhiser* President, Maine Manufacturing
2:15 pm	Regional Panel 2: University Activities and Partnerships	*Suzanne Berger* (Moderator) MIT's Raphael Dorman-Helen Starbuck Professor of Political Science and Co-chair of the Production in the Innovation Economy (PIE) project *Mark Trusheim* Bio-manufacturing Executive in Residence, UMASS Dartmouth *Bernhardt Trout* Professor of Chemical Engineering at MIT and Director, Novartis-MIT Center for Continuous Manufacturing *Dean Fuleihan* University of Albany, College of Nanoscale Science and Engineering, Executive Vice President for Strategic Partnerships *Andre Sharon* Professor, Mechanical Engineering at Boston University and Executive Director, Fraunhofer USA Center for Manufacturing Innovation
3:15 pm	Break	
3:30 pm	Regional Panel 3: Regional Government and Policy	*David Hart* (Moderator) Assistant Director of Innovation Policy, Office of Science and Technology Policy *Gregory Bialecki* Secretary of Housing and Economic Development, MA *Lawrence Miller* Secretary, Agency of Commerce and Community Development, VT George Bald Commissioner, Department of Resources and Economic Development, NH *Aaron R. Fichtner* Assistant Commissioner, Labor Planning and Analysis, New Jersey Department of Labor and Workforce Development
4:30 pm	Regional Panel 4: Regional Manufacturing Challenges and Opportunities	*Gururaj (Desh) Deshpande* (Moderator) Chairman of Sparta Group LLC *Marc Giroux* SVP Manufacturing Technology and Engineering, Chief Engineer at Corning *Luis Izquierdo* Vice President of Corporate Operations at Raytheon *Geoff MacKay* President and CEO of Organogenesis *Raymond Stata* Co-Founder of Analog Devices *Daniel Armbrust* President and CEO of SEMATECH

5:40 pm	Closing Remarks	*Susan Hockfield*

Meeting Summary: Massachusetts Institute of Technology, Cambridge, MA November 28, 2011

Introductory Session

Speakers at the opening session were Susan Hockfield, President of MIT and co-chair, AMP Steering Committee; Deval Patrick, Governor of Massachusetts; and Andrew Liveris, Dow Chemical Co and co-chair, AMP Steering Committee, who joined by video. They raised the following points:

- Manufacturing is "central to our national identity," but it "has truly eroded." The erosion of manufacturing threatens the nation's ability to innovate.
- In fall 2010 MIT created a Production in the Innovation Economy (PIE) program that will provide an evidentiary base for policies that link production and innovation
- The Governor announced that Massachusetts is establishing an Advanced Manufacturing Collaborative to "amplify the AMP."
- In the view of many, manufacturing is still dirty, dangerous, low-paying work. A central mission of the new Collaborative is to convey that modern manufacturing drives innovation and offers skilled, high-paying jobs.

Federal Government Panel

Panelists were Subra Suresh, director of NSF; Patrick Gallagher, director of NIST; Ken Gabriel, deputy director of DARPA; and Henry Kelly, acting assistant secretary of DOE. Some of their points:

- Advanced manufacturing is both an enabler of existing products and a source of new products.
- Advanced manufacturing requires a sustained whole-of-government effort. The agencies on this panel will work together to this end.
- While the NSF focuses on basic research, it has long supported manufacturing research, especially through its Engineering Research Centers. New programs, such as Innovation Corps, will enhance NSF's impact on advanced manufacturing
- Regional, long-term public-private partnerships are essential to manufacturing, and NIST, along with the rest of the federal government, wants to facilitate them.
- DARPA's advanced manufacturing programs have as their central focus reducing the time from design to production of manufacturing innovations.
- Advanced manufacturing is at the core of innovation in clean energy technology, making industrial processes more energy efficient and cutting the costs of clean energy products.

Breakout Sessions

Participants divided into six groups to discuss the workstream topics. They reconvened to offer the following points:

- Three primary barriers to investment in US advanced manufacturing, especially for SMEs, are tax/innovation policy, regulatory policy, and trade policy.
- The R&D tax credit should be made permanent.
- We need policies that reward companies for taking technology and business risks.
- The image of manufacturing as "dirty, dangerous, and degrading" is outdated and must be corrected through public education.
- Educational institutions must work with industry to train the future workforce.
- Sharing of infrastructure, facilities and public-private "product accelerators" that help bridge the gap between research/design and production should be supported.
- University/industry collaborations through pre-competitive partnerships, apprenticeships, fee-for-service projects, visiting professorships, and other means are important.
- Cross-cutting technologies, including energy efficiency, modeling and simulation, and advanced sensing and measurement, are required for advanced manufacturing.
- Emerging technologies are vital to US economic development include nanomanufacturing/advanced materials, robotics, custom manufacturing.
- Developing sustainable/green manufacturing depends most prominently on policy.

Regional Panel 1: Advanced Manufacturing Success Stories

Members of this panel were leaders of successful small businesses, most of which make platforms, tools, or systems for advanced manufacturers. All said they could grow faster if they could find more trained staff. Several discussants noted the lack of student interest in science and engineering, especially at community colleges. One noted that some guidance counselors advise students against careers in manufacturing.

Regional Panel 2: University Activities and Partnerships

Members of this panel agreed that universities were good at innovating, but poor at supporting young firms. "We need to make problems of scale-up as interesting to students as those of start-ups," stated one member. The federal government has not been a strong in applied research for advanced manufacturing. The lack of prototyping centers was identified as a key "gap" between research and production.

Regional Panel 3: Regional Government and Policy

This panel featured workforce and economic development leaders from Massachusetts, Vermont, and New Jersey, who noted both the poor image of manufacturing and the low classroom demand for advanced manufacturing-related topics. States need "deeper partnerships" with the federal government, including more flexibility in how they use federal

funding and “room to fail once in a while.” At a fiscal level, states need more predictability and better access to data.

Regional Panel 4: Regional Manufacturing Challenges and Opportunities

This panel featured representatives of medium-sized and large manufacturers who agreed that manufacturing in a high-tech environment requires close coupling of R&D and customer. U.S. firms cannot be competitive if they are isolationist. For instance, Organogenesis, which manufactures regenerative medicine products, designed its new manufacturing plant so that all functions could be together in the U.S.

Closing quote from Susan Hockfield: “The greatest real thrill that life offers is to create something useful. Too often we fail to recognize and pay tribute to the creative spirit.” – Alfred P. Sloan, Jr.

University of California, Berkeley / Stanford University, December 5, 2011

Time	Event	Speakers/Participants
8:30 am	Welcome	*S. Shankar Sastry* Dean, College of Engineering, UC Berkeley – Sibley Auditorium, BEC
8:35 am	Opening Remarks and Workstream Overview	*Robert J. Birgeneau* (Workstream Lead) Chancellor, UC Berkeley; AMP Steering Committee *Friedrich B. Prinz* Chairman, Mechanical Engineering Department, Stanford University *Krishna Mikkilineni* Senior Vice President, Honeywell; AMP Workstream Lead *Tom Kalil* Deputy Director for Policy, Office of Science and Technology Policy
9:00 am	Government Panel and Presentations	*Arati Prabhakar* (Moderator) Chair, EERE Advisory Council, U.S. Department of Energy Government Panelists: *David Brinkley* Department of Defense *Leo Christodoulou* Director, Industrial Technologies, Department of Energy *Patrick Gallagher* Director, National Institute of Standards and Technology *Bruce M. Kramer* Senior Advisor, National Science Foundation *Thomas Lee* Director, Microsystems Tech Office, Defense Advanced Research Projects Agency
9:50 am	Introduction to Breakout Session Topics Materials Genome Working Meeting (parallel session)	*Krishna Mikkilineni* (Moderator) Senior Vice President, Honeywell; AMP Workstream Lead Industry Panelists: *Will Coleman* Partner, Mohr Davidow Ventures *Matthew Ganz* Vice President, Boeing *Kurt Petersen* Chief Engineer, Profusa *Dan Jones* Director, Intuitive Surgical *Omkaram Nalamasu* CTO, Applied Materials *Darlene J.S. Solomon* CTO, Agilent Technologies
10:45 am	Breakout Sessions	Clean Energy Cyber-Physical Systems Medical Devices Small-Medium Enterprises Sustainable Manufacturing Synthetic Biology
Noon	Lunch	
1:00 pm	Topline Reports from Breakout Sessions	

1:45 pm	Next Steps	Speaker TBD

University of California, Berkeley, and Stanford University, Berkeley, CA December 5, 2011

Introductory Session

S. Shankar Sastry, Dean of the UC Berkeley College of Engineering, was joined by Robert Birgeneau, Chancellor of UC Berkeley and AMP Steering Committee; Friedrich B. Prinz, Chairman, Mechanical Engineering Department, Stanford; Krishna Mikkilineni, Honeywell and AMP Workstream Lead; and Tom Kalil, Deputy Director for Policy, OSTP, who joined by video. They raised the following points:

- The nation is on the verge of a new industrial revolution, powered by innovative technologies.
- A goal of the AMP is to establish manufacturing as a platform to revitalize the economy and create more jobs.
- To remain competitive, the nation must re-couple its design and production functions, align manufacturing with policy, and excite today's students.
- The meeting should make concrete proposals, including "some manufacturing moon shots that can motivate and inspire."

Federal Government Panel

Arati Prabhakar (DOE) moderated a federal government panel consisting of Leo Christodoulou (DOE); Patrick Gallagher (NIST); Thomas Lee (DARPA); David Brinkley (DOD); and Bruce Kramer (NSF). Key points included:

- Manufacturing is increasingly about systems: interoperability, supply chains, and information sharing. "Separation is okay; segregation not."
- Create more hubs, networks, clusters, and "shoulder rubbing."
- Physical or virtual hubs and shared facilities/infrastructure enable SMEs to reduce costs and increase access to expensive tooling, characterization facilities, and other platform technologies.
- Fundamental advances in synthetic biology are likely to disrupt manufacturing.
- A sound strategy is to invest in research on process technology that has a wide range of applications itself or leads to products with a wide range of applications.
- The future of manufacturing may be about "satisfying the long tail problem," making a larger number of products in smaller quantities.
- Revitalized manufacturing depends on updating its image as a career and strengthening the workforce—from technicians to PhDs.

Industry Panel

Krishna Mikkilineni (Honeywell) moderated an industry panel consisting of Kurt Petersen (Profusa); Darlene Solomon (Agilent Technologies); Omkaram Nalamasu, (Applied Materials); Will Coleman (Mohr Davidow Ventures); Dan Jones (Intuitive Surgical); and Matthew Ganz (Boeing). The following points were made:

- Synthetic biology is "on the cusp" of designing cells, engineering biological systems, transforming manufacturing, and powering economic growth.
- As companies scale technologically, they will require capital starting with venture capital, to a mix of private equity, corporate funding, partners, and debt financing. Obtaining this continuum of funding can be challenging for companies, especially small companies, so government support through grants and public-private partnerships is also needed.
- Products in some industries, such as aircraft, are too complex for co-location, so "mastering decentralized teamwork is core."
- In China and Singapore, scientists and engineers are "rock stars." This should be a model for the United States, where there is a "huge bias" against manufacturing careers.

Breakout Sessions Reports:

The participants divided into six groups, which discussed (1) clean energy, (2) cyber-physical systems, (3) medical technology and devices, (4) sustainable manufacturing, (5) SMEs, and (6) synthetic biology. A parallel session addressed the materials genome. The participants reconvened to offer summaries, including these points:

- Leveraging existing shared facilities, such as national laboratories, and creating new ones are needed to help startups scale their technologies and financing.
- Access to prototyping and virtualization tools can speed technology development.
- Hub/cluster models that co-locate SMEs, universities, community colleges, corporate laboratories, institutes, business incubators, and financing should be promoted.
- Workforce development must include settings where students "get their hands dirty" and learn about life-cycle design; industry must "pull" and clarify its educational needs.
- Outreach and communication are essential to update image of manufacturing.
- The introduction of synthetic biology will spur GMO(genetically modified organisms)-like debates, which need to be discussed early.
- Prompt development of standards and clear, coordinated tax and regulatory policies can open doors to collaboration.
- Many of the groups discussed the need for immigration reform and making the R&D tax credit permanent.

S. Shankar Sastry closed the meeting by recognizing the "passion" of the attendees and urging participants to "stay engaged."

University of Michigan, December 12, 2011

Time	Event	Speakers/Participants
8:30 am	Welcome and Overview	*Stephen R. Forrest* Vice President for Research, University of Michigan
		Mary Sue Coleman President, University of Michigan
		Theresa G. Kotanchek Vice President, Sustainable Technologies and Innovation Sourcing, Dow Chemical Company
		Rosina Bierbaum Professor, University of Michigan School of Natural Resources and the Environment, and Member, President's Council of Advisors on Science and Technology
9:15 am	Overview of AMP Workstreams	*S. Jack Hu*
		J. Reid
		Polly Anderson Professor of Manufacturing Technology, University of Michigan, College of Engineering
		Carrie Houtman Senior Policy Analyst, Dow Chemical Company
9:25 am	Government Panel and Presentations	*Chuck Thorpe* Assistant Director, Advanced Manufacturing and Robotics, Office of Science and Technology Policy
		Michael Molnar Chief Manufacturing Officer, Department of Commerce, National Institute of Standards and Technology
		Neal Orringer Director of Manufacturing, Manufacturing and Industrial Base Policy, Department of Defense
		Leo Christodoulou Program Manager, Advanced Manufacturing Office, Department of Energy
		Steven H. McKnight Director, Division of Civil, Mechanical, and Manufacturing Innovation, Directorate for Engineering, National Science Foundation
10:25 am	Panel Discussion: Industry Perspective on Advanced Manufacturing	*Richard Jarman* (Moderator) President, National Center for Manufacturing Sciences
		James P. Tetreault Vice President, North America Manufacturing, Ford Motor Company
		Dawn White President/CTO, Accio Energy
		John Winzeler President, Winzeler Gear
		Sujeet Chand Chief Technology Officer, Rockwell Automation
		Douglas Dinon Site Leader, Advanced Manufacturing Technology Center in Michigan, General Electric Global Research
11:30 am	Breakout Session Instructions	*S. Jack Hu*
11:35 pm	Lunch	

University of Michigan, December 12, 2011 (continued)

Time	Event	Speakers/Participants
12:15 pm	Breakout Sessions	**Education and Workforce Development:** *Albert Shih* (U-M) and *Carrie Houtman* (Dow)—Facilitators **Policy:** *Marvin Parnes* (U-M) and *Ed Rozynski* (Stryker)—Facilitators **Shared Infrastructure and Facilities:** *Don Chaffin* (U-M) and *Karen Huber* (Caterpillar)—Facilitators **Technology Development:** *Euisik Yoon* (U-M) and *Theresa G. Kotanchek* (Dow)—Facilitators **Materials Genome Initiative:** *John Allison* (U-M)—Facilitator
1:45 pm	Break	
2:00 pm	Breakout Session Outbriefs	
2:40 pm	Next Steps	*Chuck Thorpe*

University of Michigan, Ann Arbor, MI
December 12, 2011

Introductory Remarks

Stephen R. Forrest, Vice President for Research, University of Michigan, moderated an introductory session by Mary Sue Coleman, President, University of Michigan; Theresa Kotanchek, Vice President, Sustainable Technologies and Innovation Sourcing, Dow Chemical Company; Rosina Bierbaum, Professor, University of Michigan School of Natural Resources and the Environment, and Member, PCAST; and Chuck Thorpe, Assistant Director for Advanced Manufacturing and Robotics, OSTP. Some highlights included:

- Michigan has suffered from the decline in manufacturing, but the state is well positioned for a manufacturing resurgence, partly because of its tradition of collaboration.
- Streamlining the path to market requires better models for public-private partnerships (PPPs), such as hubs and clusters.
- Essential to preparation of a skilled workforce are shop courses, positive guidance counseling, and a return to a culture that values working with the hands.

Federal Government Panel

Chuck Thorpe (OSTP) moderated a panel consisting of Michael Molnar (NIST); Neal Orringer (DOD); Leo Christodoulou (DOE); and Steven McKnight (NSF). Some highlights included:

- Advanced manufacturing is ranked "first and foremost at NIST," where all laboratories and most test beds are shared facilities. Funding of $25 million is specifically allocated to advanced manufacturing in response to PCAST.
- Public-private partnerships (PPPs) should be led by industry and university, not government.
- The White House named Department of Commerce Secretary John Bryson and National Economic Council Director Gene Sperling as co-chairs of the White House Office of Manufacturing Policy. The Office of Manufacturing Policy is part of the National Economic Council in the White House and works across Federal government agencies to coordinate the execution of manufacturing programs and the development of manufacturing policy.
- DOD is responsible for about 80% of government manufacturing expenditures. Its main goals are to maximize productivity and drive down costs and delivery times.
- DOE recently created the Advanced Manufacturing Office (AMO), which invests in pervasive, broadly applicable manufacturing processes and next-generation materials. Through partnerships, the AMO will help to develop and deploy new technologies.
- NSF targets PPPs through the Grant Opportunities for Academic Liaison with Industry (GOALI), Engineering Research Centers (ERC), Industry-University Cooperative Research Centers (I/UCRC), and the Innovation Corps (i-Corps) programs. These NSF grants encourage academics to collaborate with industry and, in some cases, to gain industry experience.

Industry Perspective on Advanced Manufacturing

Richard Jarman (National Center for Manufacturing Sciences) moderated a panel of Sujeet Chand (Rockwell Automation); James P. Tetreault (Ford Motor Company); Dawn White (Accio Energy); John Winzeler (Winzeler Gear); and Douglas Dinon (General Electric Global Research). Some key points included:

- Innovation occurs in PPPs, which bring together talent, investment, and infrastructure. Manufacturing issues should not be divided into concerns of SMEs vs. small firms; "it's really an ecosystem" of PPPs. For General Electric, "the public-private partnership is our approach going forward."
- The supply chain model offers "huge opportunities" to optimize end-to-end processes.
- Lack of expertise in something as basic as joining dissimilar materials for automobile applications "should concern us;" These skills are often obtained abroad. Several other countries have national technical education curricula; by age 16, "skills are extraordinarily high."
- A small firm making plastic gears succeeds through "true strategic partnerships" with a university, small and large firms, outreach to high school counselors, and community involvement.
- Some small firms gain great benefits from national laboratories, but access is difficult.
- Suspend tax on repatriating overseas cash, incentivize to rebuild infrastructure. Make R&D tax credit permanent and offer tax credit for training scientists and engineers.

Breakout Sessions Reports

The participants divided into five groups, which discussed the four workstream topics plus the Materials Genome Initiative. They reconvened to offer suggestions, including the following:

- Ensure that regulations are not barriers to entry for small and medium firms.
- Consider policy measures such as a domestic manufacturing deduction, an R&D tax credit for research done off-site (for example, working with a university), and a tax credit for new factories or for fighting intellectual property theft.
- Use master agreements, not ad hoc bargaining, for university-industry intellectual property rights discussions.
- In technology development, emphasize the importance of adhesives, joining, and fastening technologies, as well as non-destructive evaluation, sustainable manufacturing, and additive manufacturing.
- Advance the optimization of the supply chain across several suppliers, not just between one supplier and one customer.
- In sharing facilities, use physical hubs, digital hubs, and open source databases. The main purpose of these hubs and databases is to connect small and medium firms with resources, partners, and the community.
- In education, better align the image of manufacturing with interests of young people; better align academic output with the needs of industry; reduce barriers to using veterans' skills, for example, by translating military occupational classes to civil categories.

Next Steps

- Chuck Thorpe of the Office of Science and Technology Policy concluded the meeting with a call for participation, and a sketch of future objectives. The AMP has now been discussed by well over 1,000 participants at the four regional meetings.
- The continuing involvement of those participants is needed to prioritize action plans and generate recommendations in spring 2012.
- After the report comes the real work of "action and evangelism," The goal is to spread the word, developing action plans, and forming new partnerships.