Grand Challenges in U.S. Manufacturing
Findings and Recommendations

Sridhar Kota – Executive Director

MForesight: Alliance for Manufacturing Foresight

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Grand Challenge: “Innovate here, Manufacture there” is reaching its logical conclusion: “Innovate there, Manufacture there”

“Innovation moves faster here.” - a former senior Google executive, in a recent interview about China.

Erosion of our industrial commons is limiting our ability to manufacture new advanced technology products

American manufacturing faces both daunting challenges and transformative opportunities.
Manufacturing Prosperity Report

- 9 months of research (data and analysis) on topics related to manufacturing innovation ecosystem, trade, R&D investments, international benchmarking, venture funding, hardware start-ups/scale-ups, technology transfer, etc.

- **Roundtable discussions** on Grand Challenges in U.S Manufacturing were held in Boston, Washington DC, Austin, San Jose, Raleigh, Indianapolis and Detroit

- Convened **over 100 thought leaders** - manufacturing experts, business leaders, academic leaders, state economic development leaders, investors, and policymakers. See Report Appendix

- Spent **over 1000 hours** discussing potential solutions
Three issues discussed at the roundtables

1. **Regaining America’s industrial commons:**
   What foundational capabilities are essential to strong defense supply chains?
   How do we strengthen our national innovation ecosystem?

2. **Create wealth from national R&D investments**
   first-mover advantage in research-intensive advanced technology products

3. **Ensuring financing for “hardware” start-ups and scale-ups**
Grand Challenges

• Tax, trade, and regulation policies could enhance competitiveness of existing industries but do little to enable creation of new industries for national wealth and security

  “if any particular manufacture was necessary, indeed, for the defense of the society it might not always be prudent to depend upon our neighbors for the supply.”


• “flood of counterfeit electronic parts coming into the Defense Department’s supply system...over 1,880 cases of suspected counterfeits”  - 2012 Senate Armed Services Comm. Report

• “for many technologies, the most advanced work is no longer being conducted in the United States.”  - 2012 DoD report, Assuring the U.S. Dept of Defense on Strong STEM Workforce:
Import Penetration in Advanced Technology and Erosion of Foundational Capabilities

Most manufacturing segments use less domestic and more imported content today than they did in 2000

Imported Content of U.S. Manufactured Goods

<table>
<thead>
<tr>
<th>Category</th>
<th>2000 Sales</th>
<th>2015 Sales</th>
<th>Change from 2000 - 2015 in % points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic consumer goods</td>
<td>38</td>
<td>208</td>
<td>-15</td>
</tr>
<tr>
<td>Technology-driven innovative products</td>
<td>55</td>
<td>410</td>
<td>-13</td>
</tr>
<tr>
<td>Vehicles and heavy machinery</td>
<td>55</td>
<td>623</td>
<td>-4</td>
</tr>
<tr>
<td>Locally processed goods</td>
<td>81</td>
<td>460</td>
<td>-8</td>
</tr>
<tr>
<td>Resource-intensive commodities</td>
<td>57</td>
<td>125</td>
<td>10</td>
</tr>
<tr>
<td>All manufacturing</td>
<td>59</td>
<td>1,922</td>
<td>-6</td>
</tr>
</tbody>
</table>

Source: MGI, 2015
Real value added is no higher than in mid-90s

Global Value Add in Manufacturing

The U.S. lost 8 percentage points since 2000

Germany lost only 2 points
Innovate Here, Make There: Creating Knowledge, Not Wealth

Leading the world in R&D is little comfort if we are simply subsidizing it for other countries.
Invent Here, Manufacture There – And Losing faster

By not completing the cycle of innovation within our nation’s borders, we are losing our ability to innovate.
Innovate There, Make There

• 45% of foreign R&D centers in China are from U.S. companies

• The amount may not be worrisome, but the trend should be.
Factors driving manufacturing R&D to China

Source: ConsultancyUK, 2015
Patents and Licenses

Federal labs:
For every $1B of R&D activity, 45 patents issued; $4 million in license revenue

In 2015, $46 billion total spent on R&D by fed gov. 2200 patents; $193 million license revenue

Universities:
168 patents issued
$52 million in license revenue

In 2015, $37 billion spent on R&D in S&E by fed gov. 6200 patents; $1.9 billion license revenue

VCs rarely invest in hardware
Foreign participation in the U.S Venture Capital Market, 2017

China’s investments in U.S. Aerospace Industry
Realities on the ground...

1. Successful emerging technologies (flexible displays, nanotechnology) from federally funded research centers/labs are currently scaled in Asia because they are “best suited for manufacturing at scale”

2. “Once the technology is proven to work, funding dries out in the U.S.” - U.S academic researcher(s)

3. Leading academics are willingly taking results of basic research to China for translational R&D and manufacturing – Tissue Engineering, battery technology, predictive analytics etc.

4. [Link] China finds a new source of cutting-edge military technology: US start-ups

5. [Link] Chinese magnate Shan Xiangshuang created the largest seed fund in Silicon Valley.

6. Multiple Technology Collaborative Institutes from China have signed MOUs to “enhance cooperation” with several leading U.S research universities “to accelerate technology transformation to China” ...target areas incl. biomedical engineering, innovative medicine development, advanced material and manufacturing, ICT and Cleantech.
Market Failures

Private Sector MNCs:

- Driven by short-term financial incentives
- Focus primarily on the current product development through incremental innovation
- Do very little long-term translational R&D needed to mature basic research results into the “next big thing.”

Only government can overcome this market failure and enable the United States to remain globally competitive.

Government has a critical role in investing in manufacturing R&D and beyond.
Not just how much but what we invest in matters

2016 OECD data

**U.S** federal R&D budget: $149 billion
Industrial Production and Technology: $773 million **(0.52%)**
OCED definition: R&D on industrial products and their manufacturing processes.

**Germany**: $36 Billion
Industrial Production and Technology: $4.34 billion **(12%)**
6X the amount U.S spends

**Japan** – 7% of its budget; 3X U.S
**S. Korea** – 30% of its budget; 8X US

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**Trade balance in Goods (2017)**

<table>
<thead>
<tr>
<th>Country</th>
<th>Balance</th>
</tr>
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<tbody>
<tr>
<td>U.S</td>
<td>$ 796 billion deficit</td>
</tr>
<tr>
<td>Germany</td>
<td>$ 290 billion <strong>surplus</strong></td>
</tr>
<tr>
<td>Japan</td>
<td>$ 25 billion <strong>surplus</strong></td>
</tr>
<tr>
<td>S. Korea</td>
<td>$ 95 billion <strong>surplus</strong></td>
</tr>
</tbody>
</table>

Isn’t 5% of total federal R&D a reasonable amount for the U.S to invest in this category?
Creating Demand, not just Supply

- Nascent technologies: technical risk and market uncertainty, requires long-term investment.
- Private sector does not invest in nascent, broadly applicable technologies – market failure.
- Government procurement has accelerated innovation and pilot production in the past.

The U.S led the world in these technologies.

Is the U.S poised to lead the world in these technologies?
Gaps in the U.S. Innovation Pipeline
Meeting the Grand Challenge: Manufacturing Prosperity

Recommendations from the manufacturing community thought leaders:

• Close the gaps in our innovation pipeline
• Create demand, not just supply
• Rebuild industrial commons

More specifically, **4 critical next steps**

1. Invest in translational R&D and manufacturing innovation
2. Invest in maturing Manufacturing Readiness Levels; Leverage govt. procurement.
3. Empower Small and Medium-Sized Manufacturers
4. Grow Domestic Engineering Talent
Overarching strategy:

Manufacturing cuts across multiple disciplines and missions of various federal S&T agencies. That makes all the more compelling reason for a central focal point for manufacturing R&D in the federal government – the key missing element in our R&D ecosystem.
Recommendations

1. Invest in Translational R&D and Manufacturing Innovation:

   a. Invest in translational research centers (university-affiliated but privately run) to translate the results of federally funded academic research into viable products. Licensing of resulting products should be restricted to U.S. production facilities only.

   b. Invest in manufacturing research, process technologies, and systems engineering, to mature MRLs and to overcome market failures

   c. Establish additional Manufacturing USA institutes targeting foundational capabilities.
Recommendations

2. Invest in Manufacturing R&D and promote scale-ups

a. Leverage government procurement:
Promote early adoption by leveraging government (defense) procurement to create lead markets for new products and technologies. Government purchase orders are an effective tool to incentivize private investment.

b. Form investment fund for scale-ups:
Form a number of geographically dispersed manufacturing investment funds, organized as public-private partnerships, that would combine public and private funding to invest in hardware start-ups and domestic scaled production.
3. Empower Small and Medium Sized Manufacturers (SMMs)

a. Institutionalize simple technology **licensing agreements** to facilitate and encourage technology transfer and joint technology development between universities and industry, especially SMMs.

b. Provide loan guarantees to incentivize SMMs to **modernize their capital equipment** and to implement smart manufacturing technologies.

c. Establish **industry fellowships** for engineering and management **retirees** to work with manufacturing start-ups and SMMs.
4. Grow Domestic Engineering and Technical Talent

a. Encourage enrollment of *domestic students in engineering* graduate programs through fellowships.

b. Create a national registry of *apprenticeship and industrial training programs* with the ability to match available programs at SMMs with high school and college students along with funding support for trainees.

c. Educate *engineering technicians* with emphasis on applied engineering skills.
Summary

• “Innovate there and Manufacture there” – a dangerous trend for a developed country

• Being the world’s best in S&T is critical but not sufficient to compete in the global economy.

• Addressing taxes, trade, and regulations may be necessary but not sufficient to create industries of the future.

• Recapturing global leadership in manufacturing and innovation requires **long-term strategic investment** in the industries of the future.

*Other nations are not standing still. The onus is on us.*