Investing in U.S Innovation Ecosystem

Sridhar Kota

Executive Director, MFOresight: Alliance for Manufacturing Foresight
Herrick Professor of Engineering, University of Michigan

NSF EDSE Workshop – Purdue University, Oct 07, 2019
About MForesight

MForesight.org

A federally-funded (NSF and NIST), independent national consortium (think-and-do tank) on emerging technologies and advanced manufacturing with a singular focus on enhancing U.S manufacturing competitiveness
MForeSight Leadership Council

Convene diverse stakeholders
- Conduct “game-changing ideas” events, deep-dive workshops and expert interviews.
- Access to over 40,000 subject matter experts

Develop Actionable Recommendations
- R&D Priorities
- Implementation challenges
- Related policies

Disseminate
- Serve as a continuous source of intelligence to Federal agencies, Capitol Hill, the White House, Private sector, and Academia

Over 2000 participants from 38 states (2017-18), ~60,000 report downloads
Accelerating Technology & Manufacturing Innovation

- Metamaterials Manufacturing
- Biomaterials Manufacturing: Regenerative Medicine
- Manufacturing High Entropy Alloys
- From Making to Manufacturing
- Manufacturing Prosperity
- Education and Skills Building
- Next Generation Supply Chains
- Cybersecurity for Manufacturers

**Ideas worth scaling**

**Challenges worth addressing**

- Basic Research
- Translational R&D
- Applied R&D
- Full Volume Manufacturing
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U.S. Technological Innovation in *hardware*

- Scientific Discovery
- Engineering Invention
- Technological Innovation

**Industrial Commons**
- engineering skills, production know-how, infrastructure and supply chains
Contrary to popular reports of a strengthening manufacturing sector, ... 

Robots and automation had almost nothing to do with job losses

Between 2006 and 2016, some of the largest reductions in output were in advanced industries:

- pharmaceuticals 3.1 percent,
- industrial machinery 2.9 percent,
- communications equip 2.5 percent
- computers & peripherals 2.3 percent.

Imports increased in all of these industries.

6 million job lost; 65,000 mfg facilities shut down between 2001 and 2010

Source: Bureau of Labor Statistics

![Dramatic Decline in Manufacturing Productivity Growth](image)
Invent Here, Make There: Creating Knowledge, Not *National* Wealth

Federal government invests ~$150 billion a year in S&T

~$900 billion in mfg trade deficit; over $100 deficit in Advanced Technology Products + major challenges in national security

Underlying research funded by the federal govt.

*Leading the world in R&D is little comfort if we are simply subsidizing it for other countries*
Production in Innovation Economy Study

• Studied growth trajectories of 150 manufacturing startup firms based on MIT technology and founded between 1997 and 2008

• None of these companies were able to scale in the U.S due to lack of funding, and know-how. All scaled in foreign countries; 70% of them scaled in China

“.. when these firms were ready to take a giant step up to large-scale processes, the search for additional capital as well as scalable production capabilities drove many firms to relocate their production abroad.”
Innovate There, Manufacture There

Factors driving manufacturing R&D to China

“Innovation happens faster here” – a former Google exec referring to China

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

Source: ConsultancyUK, 2015
U.S. Investments in Engineering in the last two decades

1991-99: Federal support of chemical, electrical, and mechanical engineering declined by 25 percent, 30 percent, and 55 percent, respectively. Meanwhile, funding for biological and medical sciences rose more than 20 percent.

2001-11: 4.3% reduction in engineering

2011 NSF Science and Engineering Index

STEM Field of Focus
($3,440 M)

- Science, $1,993.83 41%
- Engineering, $1,023.34, 30%
- Math, $15.07, <1%
- Engineering, $883.29, 26%
- Agency Specific, $883.29, 26%

# of Investments = 252

2011 NSF Science and Engineering Index
Its not how much we invest, but what we invest in

U.S; $150 billion S&T budget: Of which, ~770 million invested in Industrial Production and Technology

Germany: $36 Billion $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

Source: OECD data 2015 Engineering and Mfg R&D

Is 5% a reasonable investment for the U.S.?
Round Table discussions to address the Grand Challenge

Grand Challenge: “Invent here, Manufacture there” has reached its logical conclusion: “Innovate there, Manufacture there”

Convened 7 roundtables across the nation with over 100 thought leaders who spent over 1200 hours discussing potential solutions. How to: 1. Rebuild America’s industrial commons; 2. Create national wealth from federal R&D investments. 3. Ensure financing for “hardware” start-ups and scale-ups

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Closing the Gaps in the U.S. Innovation Pipeline

Establish Translational Research Centers (TRCs) at Universities

Fund pilot production and Leverage Defense Procurement

Empower small & Med sized companies

Create public-private investment fund to support scale-ups

4X domestic graduate fellowships in engineering

Federal investment

Fund R&D in Engineering and Manufacturing (MRLs)

Establish a National Manufacturing Foundation
06.18.19

Peters Announces Proposal to Establish a National Institute of Manufacturing, Make Manufacturing Policy a Major National Focus

Marco Rubio: We need to invest in America again

Rubio Report Outlines Future of “American Investment”
Promising Trends

Manufacturing is increasingly *digital, democratized and distributed* and it plays to American strengths.

According to a recent survey, 37 percent of millennials perceive manufacturing as a high-technology career choice, notably higher than both the Generation X (27 percent) and Baby Boomers (23 percent).

Foreign MNCs continue to invest in manufacturing facilities in the U.S.

Investments in Battery and Electric vehicle manufacturing in the U.S.
This Workshop

How can EDSE research make sustained impact on diverse application domains, such as manufacturing, transportation, and smart and connected communities?

Manufacturing – M&S tools (probabilistic reasoning), application-specific design tools, modeling and performance prediction of metamaterials, data analytics, Design for Manufacturing, design of manufacturing machines

What are the new opportunities for EDSE research created by emerging technologies and the changing workplace and society?

Smart Manufacturing (Industry 4.0);
Impact of AI and automation – much hype

How can the EDSE research community maximize the societal impact ....?

Role of Universities in empowering small and medium sized manufacturers
Working with local MEP, Purdue Univ. faculty and students helped Jeco Plastics, Plainsfield, Indiana with Modeling and Simulation tools which led to a multi-million dollar contract from a global Automotive OEM for large plastic pallets which used to made in China until 2011.
Benefits:

1. **Students gain real-world experience** by applying knowledge gained in the classroom to a real-world setting and by demonstrating value to a local SMM.

2. **SMMs gain necessary and deep insights** into opportunities and challenges with implementing computational tools on company-specific products and processes.

3. **By engaging with local industry, faculty can** enrich classroom instruction and research with practical examples

4. **Universities add significant value** to the local community and SMMs
Other examples:

Systems engineering design and education

Smart manufacturing
   Assessment
   Data analytics
   Virtual and augmented reality opportunities
   Design for Additive Manufacturing

Design tool for emerging technologies

   Metamaterials
   Batteries and electric vehicles
   etc.
Summary

*From Offshoring Production to Offshoring Innovation*
- *A Dangerous Trend for a Developed Country*

Invest in innovation ecosystem to rebuild our capacity to innovate (hardware)

Science is not engineering.

Engineering theory v. Engineering Success

Rethink engineering research and engineering education in ways that maximizes societal impact – provides a return on investment to taxpayers who are funding our research

How do we define basic research in engineering that has academic rigor and is also practical?