

# **Grand Challenges in U.S. Manufacturing Findings and Recommendations**

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**“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.

American manufacturing faces both daunting challenges and transformative opportunities.

Technological changes play to American strengths: flexibility and adaptability, a large capital market, superior higher education, and world-leading R&D.

# Background

- 6+ months of research on topics related to manufacturing innovation ecosystem, trade, employment, R&D investments – public and private, international benchmarking, venture funding, hardware start-ups and scale-ups, university R&D, technology transfer, sector-specific data 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
- Spent over 1000 hours discussing potential solutions

## THREE ISSUES DISCUSSED AT THE ROUNDTABLES

**1. *Regaining America's industrial commons: foundational capabilities to strengthen defense supply chain? 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***

# The Grand Challenge:

## Leverage Advances in Technology to Ensure Domestic Manufacturing

- Advanced materials, machine intelligence, networked supply chains, etc. create the opportunity to restore U.S. manufacturing
- Targeted public investments in translational research is essential to capture wealth from R&D spending
- Tax, trade, and regulatory policies will encourage manufacturing growth

**BUT**

Loss of the Industrial Commons Hinders Real Progress

# Defense Manufacturing Vulnerabilities

“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.”

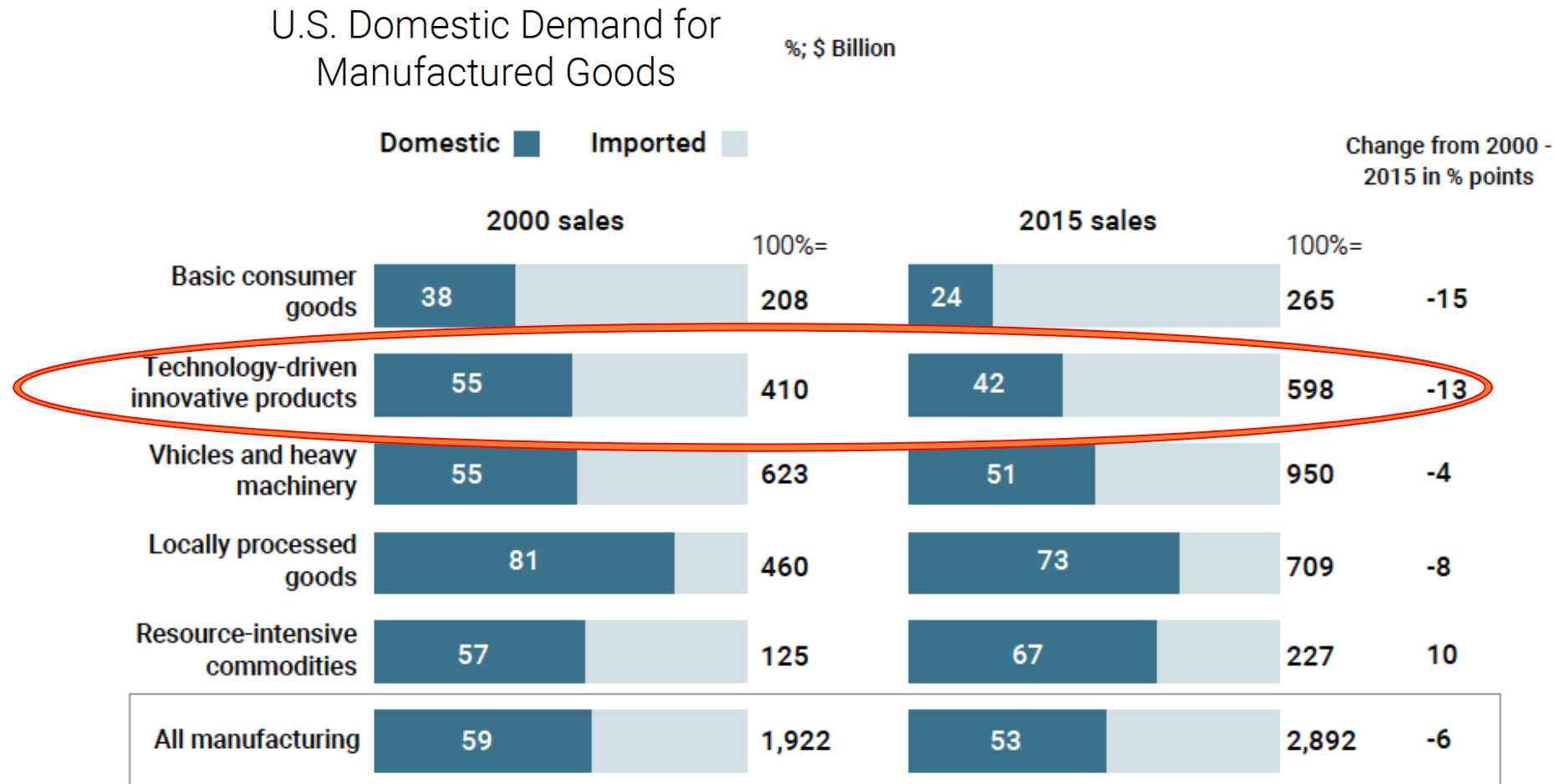
- Adam Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations*, **1776**

- May 2012: SASC report revealed a “flood of counterfeit electronic parts coming into the Defense Department’s supply system.” More than 1,880 cases of suspected counterfeits.
- 2012 DoD report, *Assuring the U.S. Dept of Defense on Strong STEM Workforce*: “for many technologies, the most advanced work is no longer being conducted in the United States.”

Over time, manageable issues are becoming critical problems!

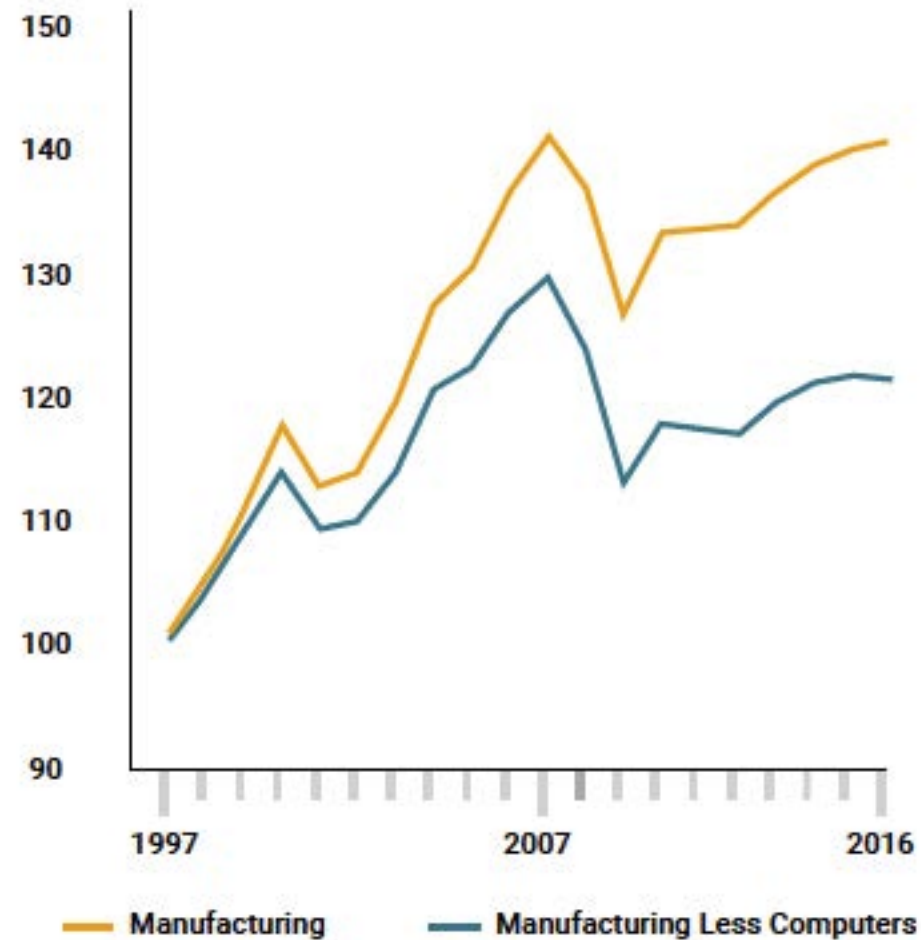
# Import Penetration in Advanced Technology and Erosion of Foundational Capabilities

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



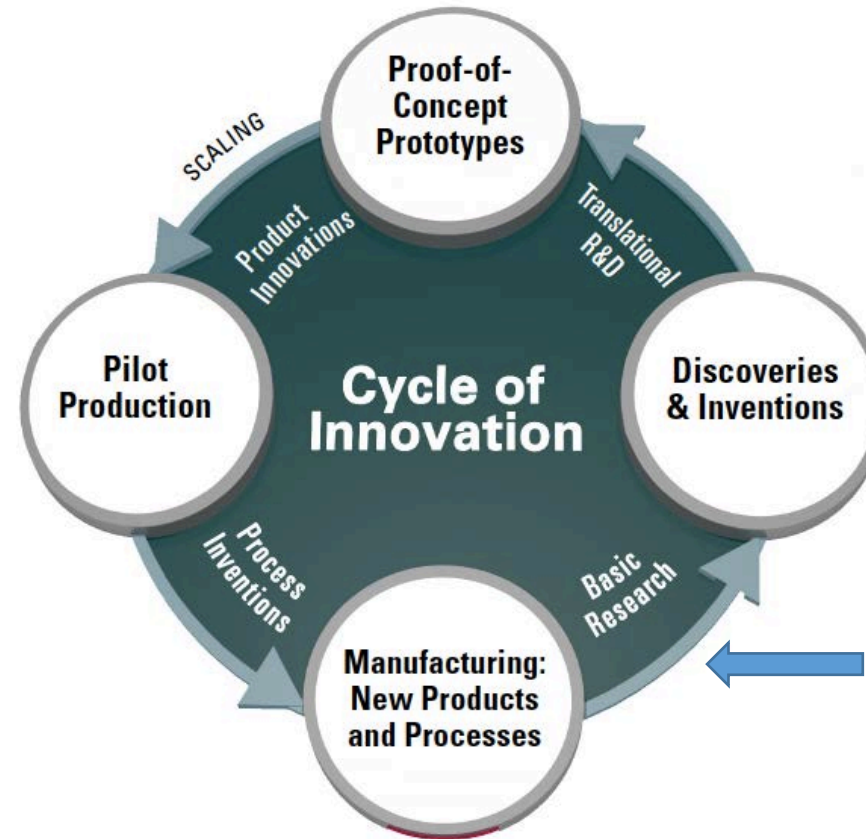
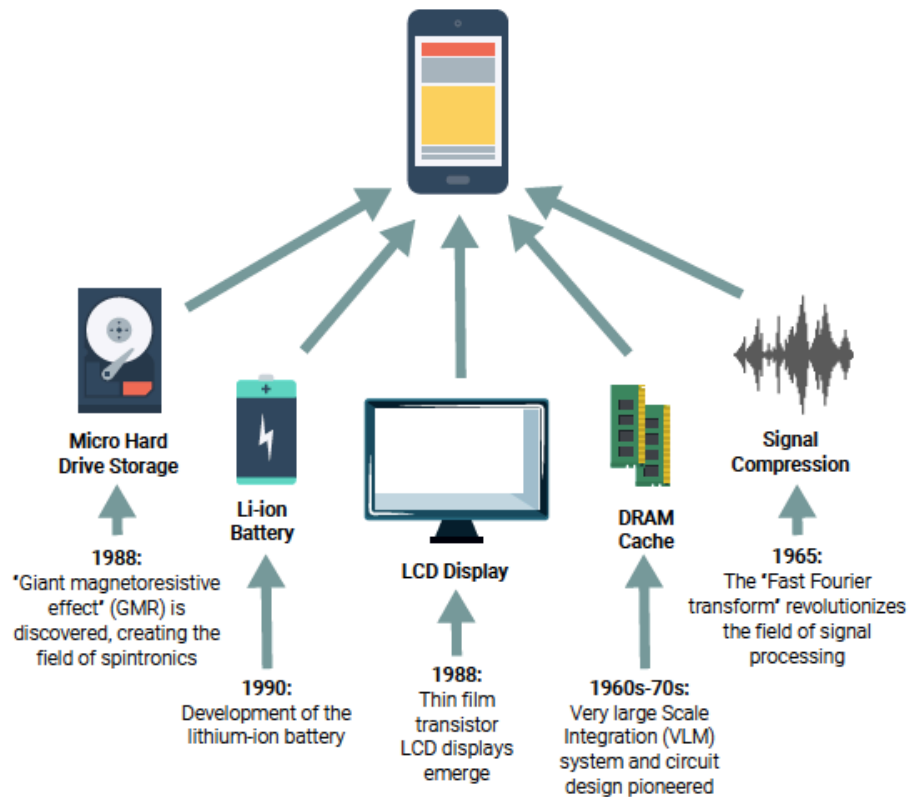
# Real value added is no higher than in a decade ago

(constant dollars indexed to 100)





# Innovate Here, Make There: Creating Knowledge, Not Wealth



Federal S&T investment  
~ \$140 billion annually

↓

Mfg. deficit ~ \$750 billion  
Adv. Tech. Products deficit ~ \$100 billion

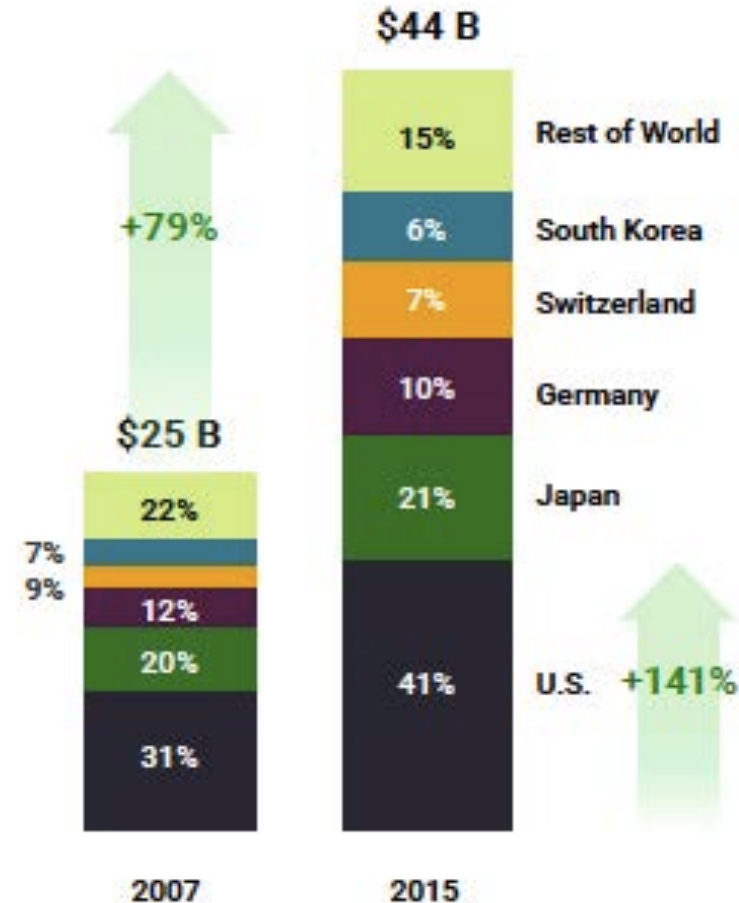
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Manufacturing Innovation Gap

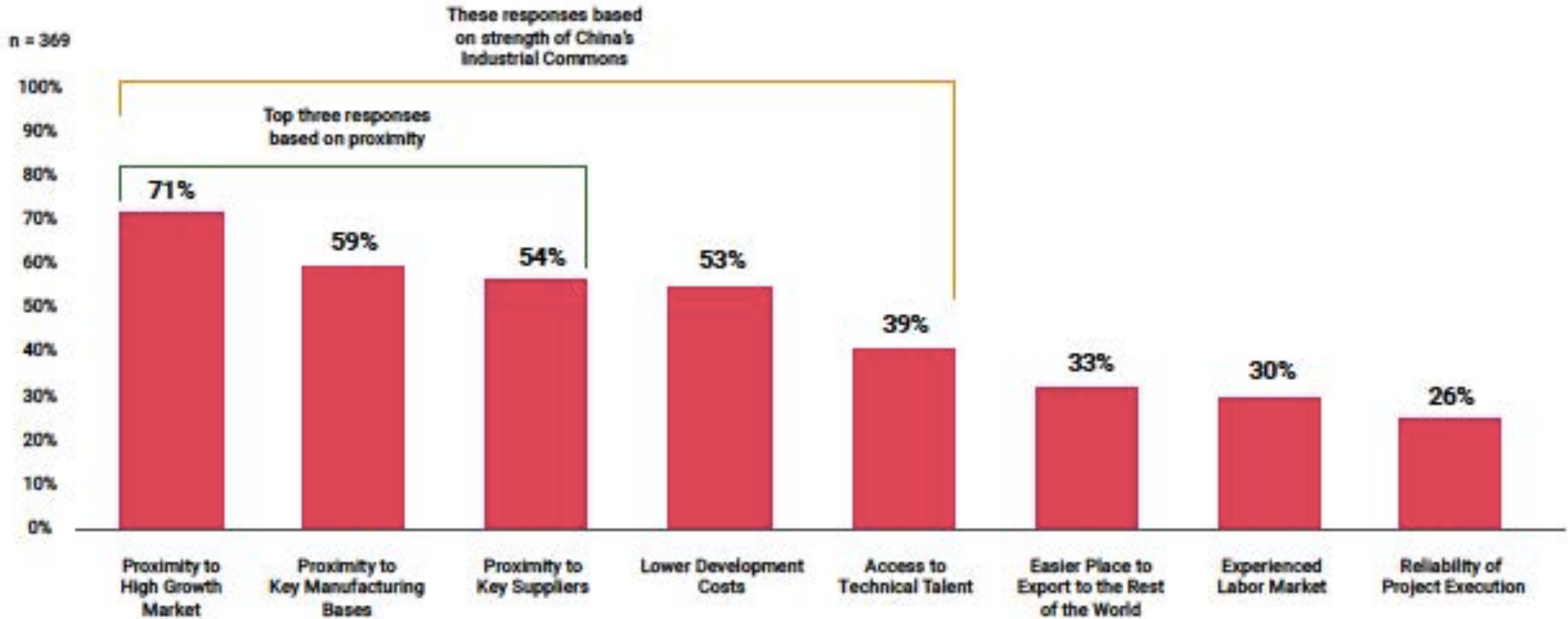
**Losing faster:** Robots, MRI machines, video games, machine tools, computers, cell phones, solar cells, lithium ion batteries, flat-panel displays, drones. nanotechnology, flexible electronics

# Innovate There, Make There

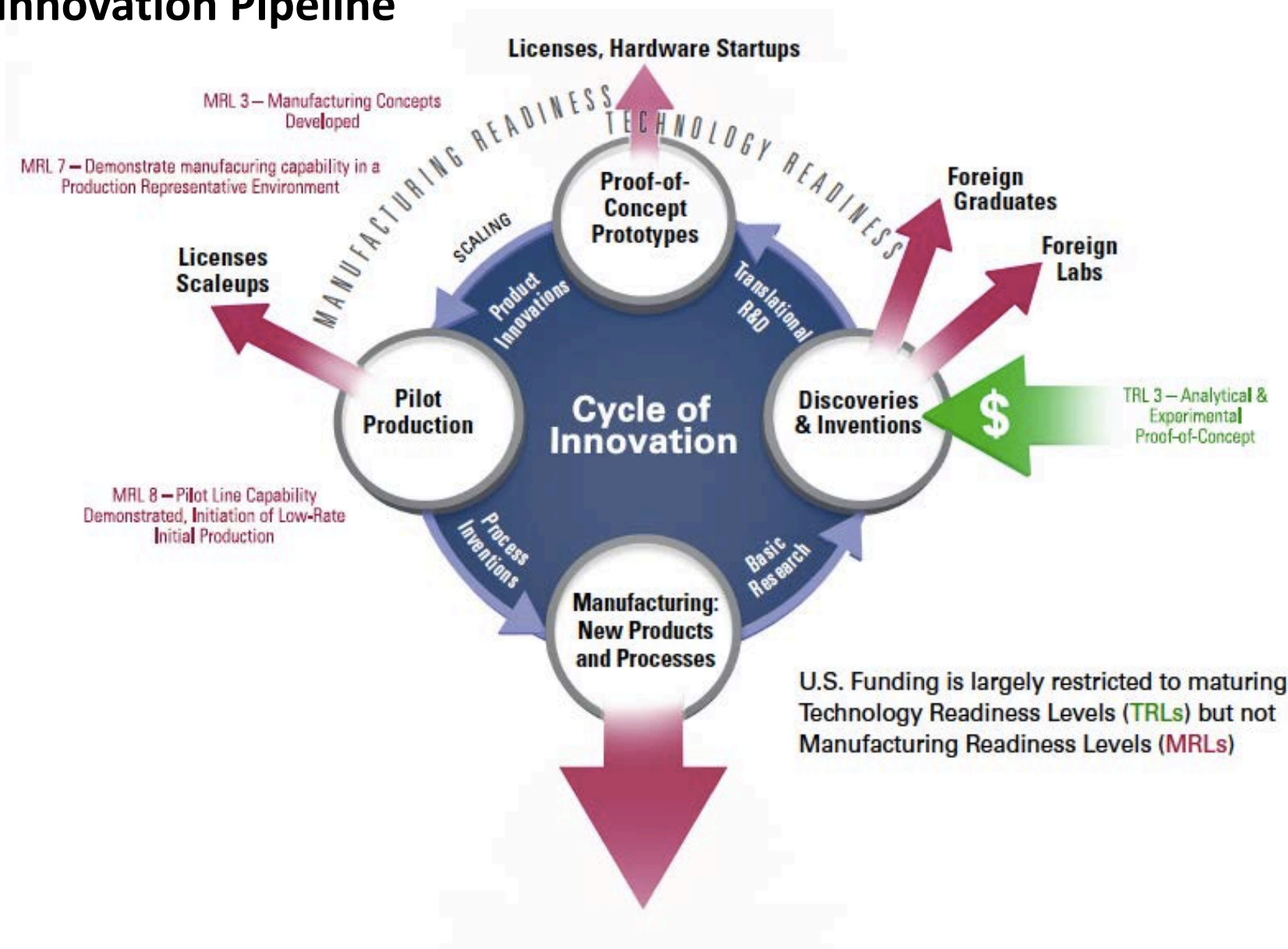
- 45% of foreign R&D centers in China are from U.S. companies
- 70% of R&D units are in IT (83 companies) and Healthcare (17), Consumer Goods (15), Industrial (15), Materials (14)
- The amount may not be worrisome, but the trend should be.



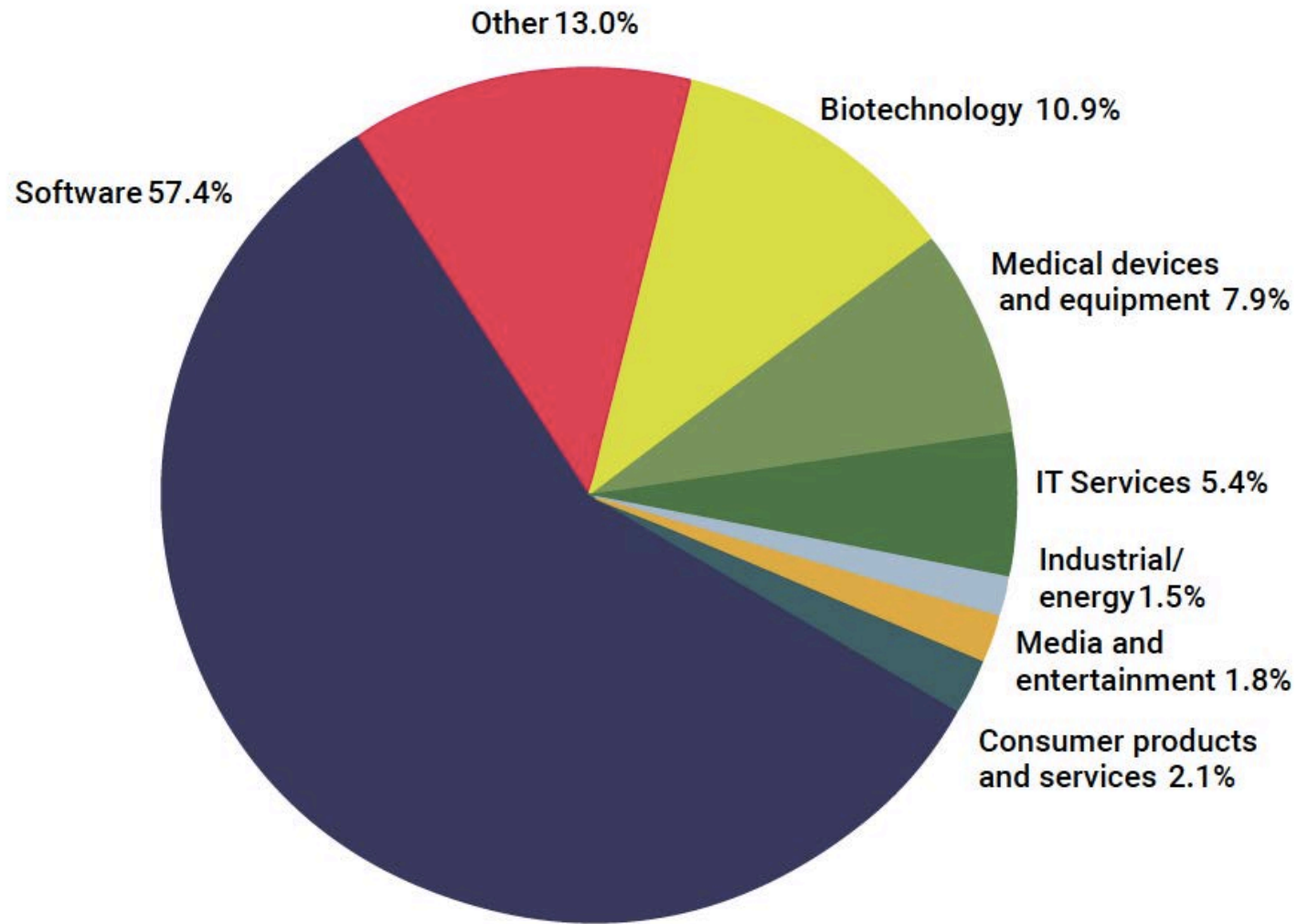
# Why Move R&D to China?



# Gaps in the U.S. Innovation Pipeline



# VCs rarely invest in hardware





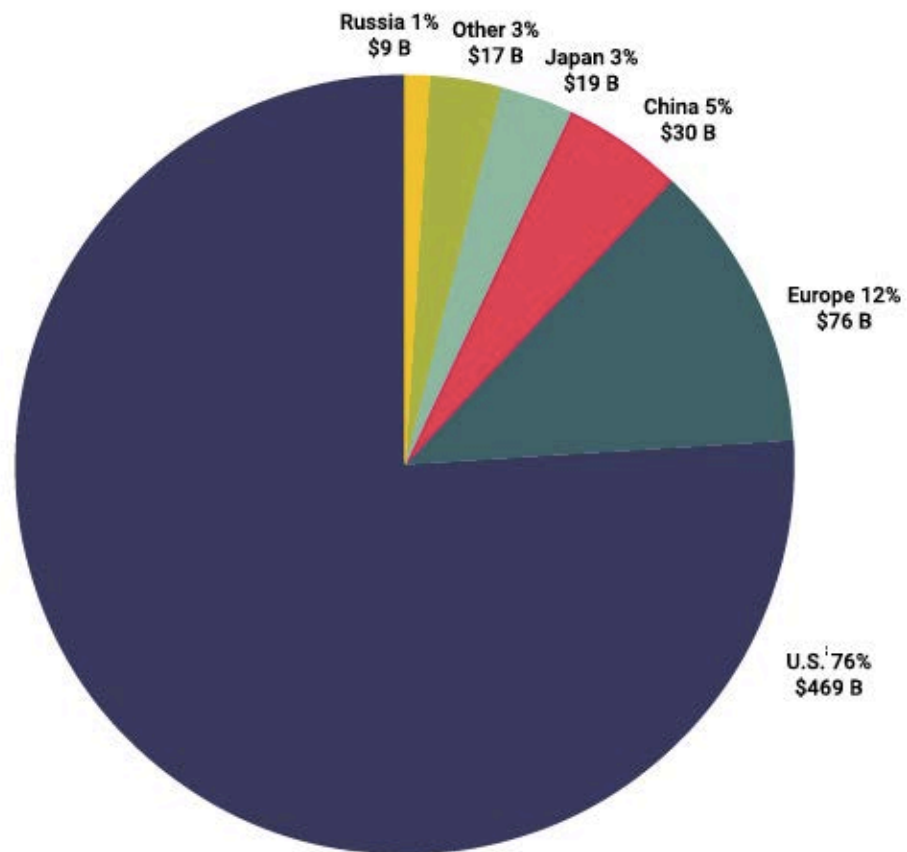


Figure 18: International shares of the U.S. venture capital market, 2010-2016

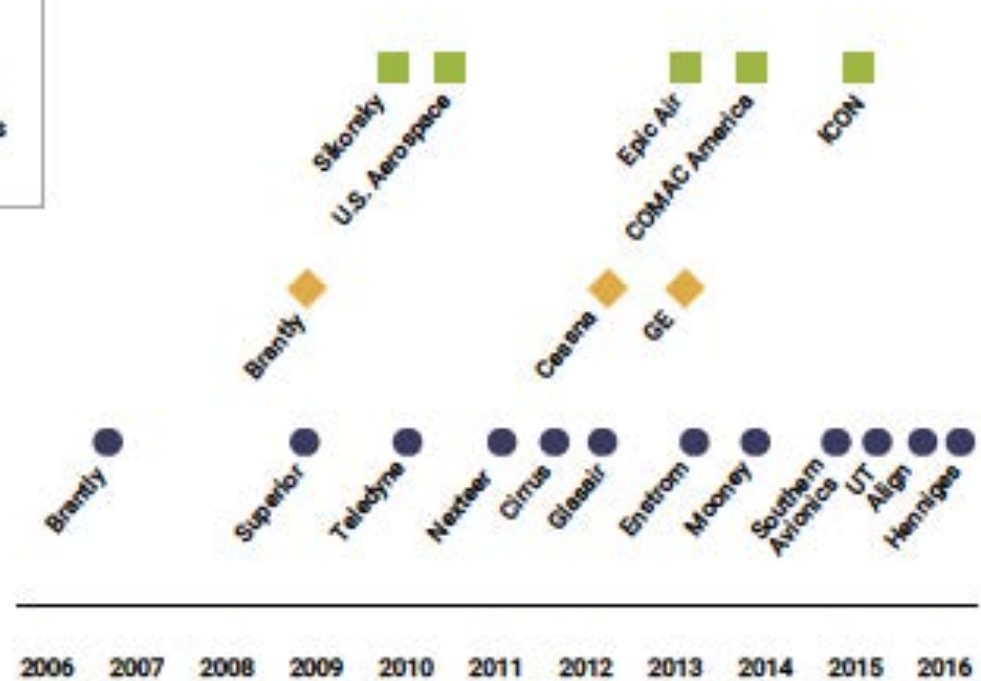
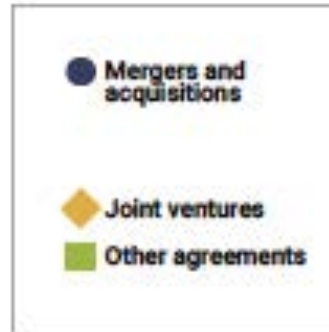
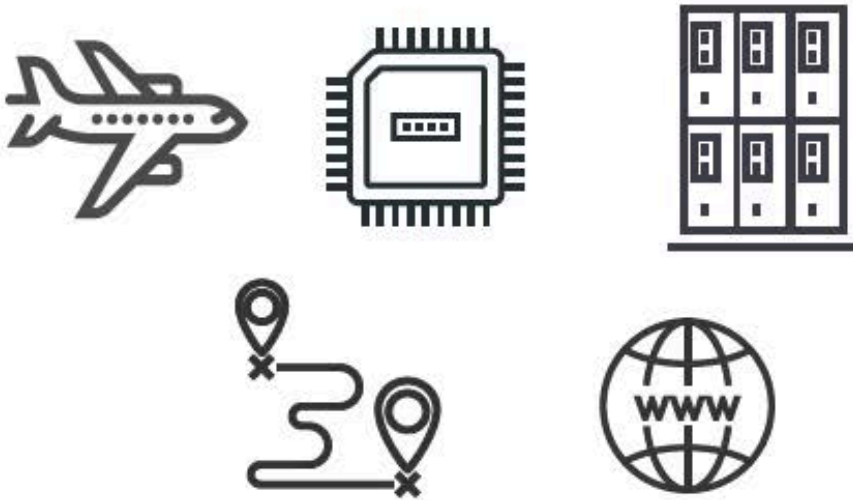


Figure 21: Chinese investments in U.S. aviation (Source: Rand)

# Creating Demand, Not Just Supply

Nascent technologies: technical risk and market uncertainty, requires long-term investment.  
The private sector does not invest in nascent broadly applicable technologies.

The U.S leads the world in these technologies.



Is the U.S poised to lead the world in these technologies?



## Realities on the ground...

1. “Asian firms have acquired most of the critical intellectual property associated with OLED displays from Western sources.”...**"This partnership will allow us to combine AUO's manufacturing strength with the FDC's superior approach ..."**
2. UT-Austin's nanotechnology was licensed by Canon for manufacturing in Japan- proximity to manufacturing know-how
3. “Once the technology is proven to work, funding dries out” - U.S academic researcher (s)
4. Leading academics are willingly taking results of basic research to China for translational R&D and manufacturing – Tissue Engineering, battery technology, predictive analytics etc.
5. [China finds a new source of cutting-edge military technology: US start-ups](#)
6. [Chinese magnate Shan Xiangshuang created the largest seed fund in Silicon Valley.](#)
7. *To enhance the cooperation and [accelerate the technology transformation to Jiangsu province](#), JITRI signed a Memorandum of Understanding (MOU) with University of X, Y and Z ...target areas incl. biomedical engineering, innovative medicine development, advanced material and manufacturing, ICT and Cleantech. Similar deals through other Chinese tech collaborations*



MIT's **Production in Innovation Economy** report (2014) gave **disturbing assessment** of a group of 150 manufacturing startups founded between 1997 and 2008.

*".. 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."*

*"It led to the migration of key skills, technical capabilities, and the ability to fully understand and improve the manufacturing process outside of the country."*

*"Even more importantly, the move overseas was **dragging down the country's future capacity to innovate by gifting other nations with tacit product and process knowledge that had taken years to attain.**"*

"Growth of the economy comes from small companies and businesses— it doesn't come from Fortune 500 companies".

# Market Failures

**Private Sector:** Manufacturers, driven by **short-term** financial incentives, primarily focus on the **current product development** through incremental innovation while **abandoning the long-term** translational R&D needed to mature basic research results into a “next big thing”.

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

## **Public Sector:**

Primarily responsible for **basic research** through funding from various federal agencies and advancing early stage technology development

A key missing element is the investment in translational research and manufacturing technologies

This vacuum we created is attracting investment from foreign sources for hardware start-ups and scale-ups.

# Meeting the Grand Challenge: Manufacturing Prosperity

- Technology & market changes have created opportunities to rebuild U.S. advanced manufacturing ecosystem
- Bold steps are essential - Not another report or a study
- Make investments in manufacturing research, process technologies, and systems eng so that:
  - wealth is created from federal R&D;
  - domestic industry, especially SMMs, implements adv. technologies; and
  - skills & knowledge needed at all levels of industry and the research enterprise are available

Recommendations from the manufacturing community thought leaders:

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

More specifically,

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

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

# Recommendations

1. **Invest in Translational R&D and Manufacturing Innovation:**
  - a. **Invest in non-academic translational research centers** to translate the results of federally funded academic basic 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. Investment 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

# Recommendations

## 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.



# Recommendations

## 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 basic research is critical but not sufficient to compete in the global economy.
- Addressing Taxes, Trade and Regulations are necessary but not sufficient
- 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.***