



Manufacturing, the Road to Success

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**NIST Road Mapping Workshop on Measurement Science for
Metal-Based Additive Manufacturing
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Why Manufacturing Matters

- Conducts 70% of US R&D, 90% of patents issued
- Close connection between R&D, design, and manufacturing
- Health of industrial commons (know how, process engineering capability, workforce skills, suppliers)
- Manufacturing multiplier (\$1.40 for \$1 of manufacturing output)
- Critical for national security



S&T as Presidential Priority

“Reaffirming America’s role as the global engine of scientific discovery and technological innovation has never been more critical. ...Our renewed commitment to science and technology ... will help us protect our citizens and advance U.S. national security priorities.”

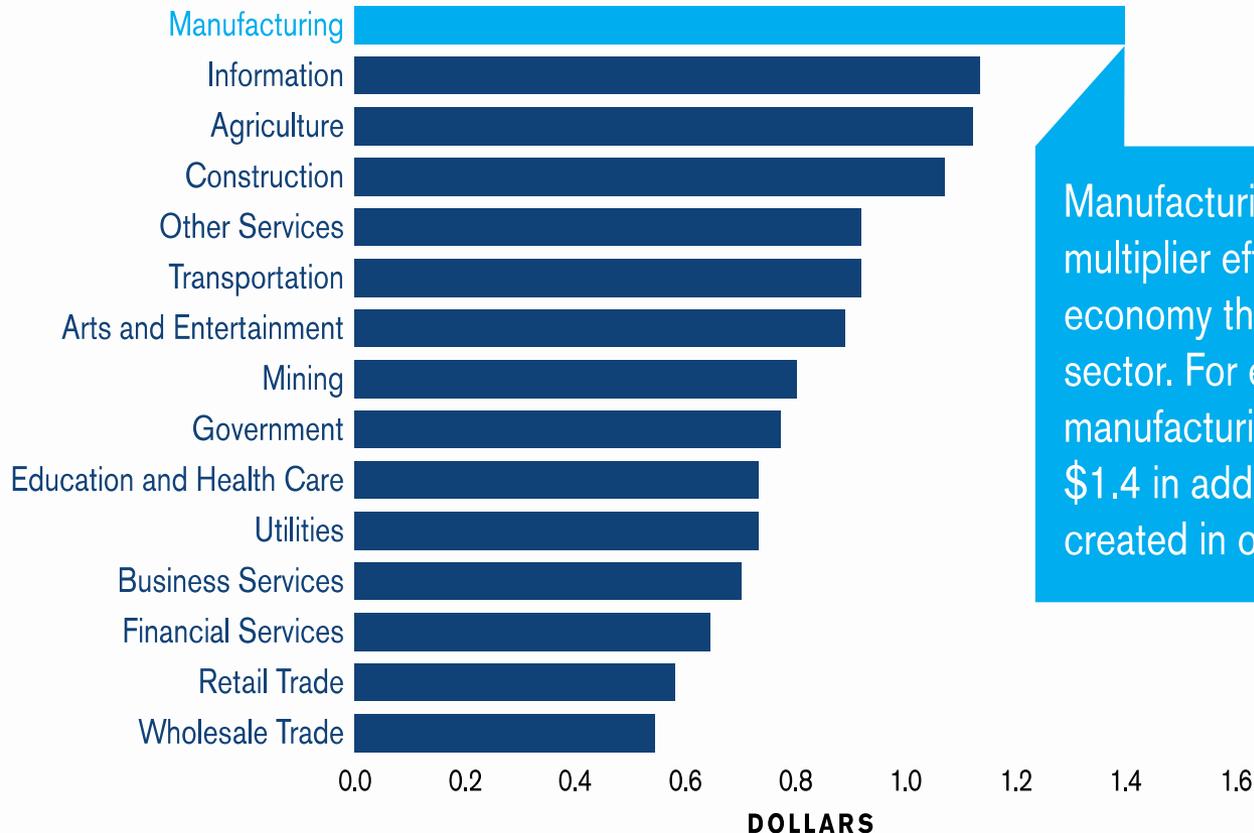


–National Security Strategy, May 2010



Manufacturing Economic Impact

Manufacturing drives jobs throughout the economy, including in services



Manufacturing has a higher multiplier effect on the economy than any other sector. For every \$1 in manufacturing value added, \$1.4 in additional value is created in other sectors.

Source: U.S. Department of Commerce, Bureau of Economic Analysis



A Plant's Economic Impact – supporting services

Manufacturing also has an important jobs impact in the local economy

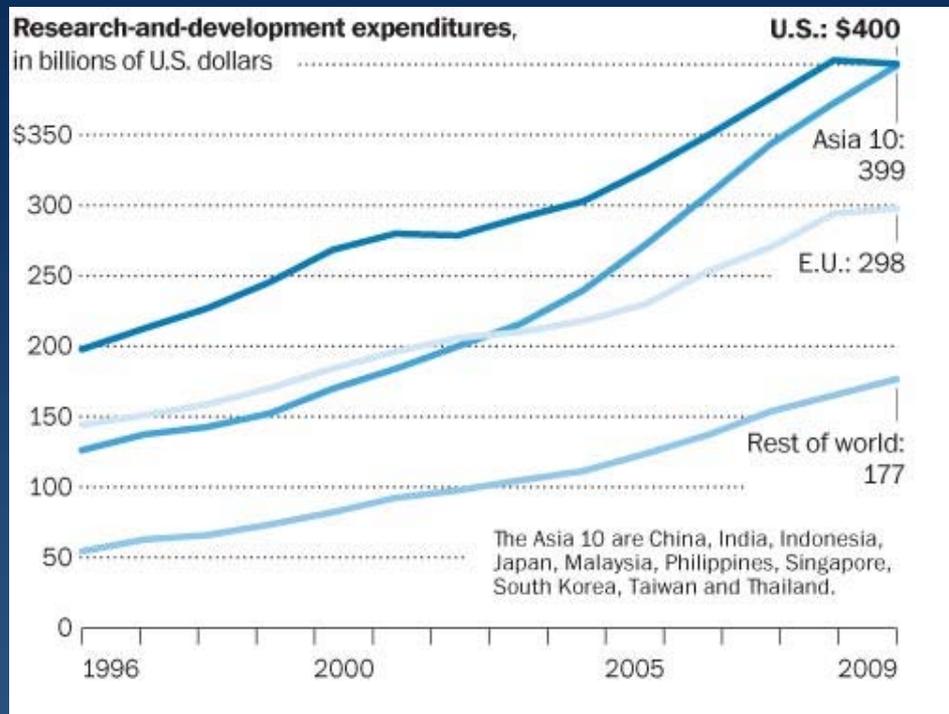


National investment in R&D

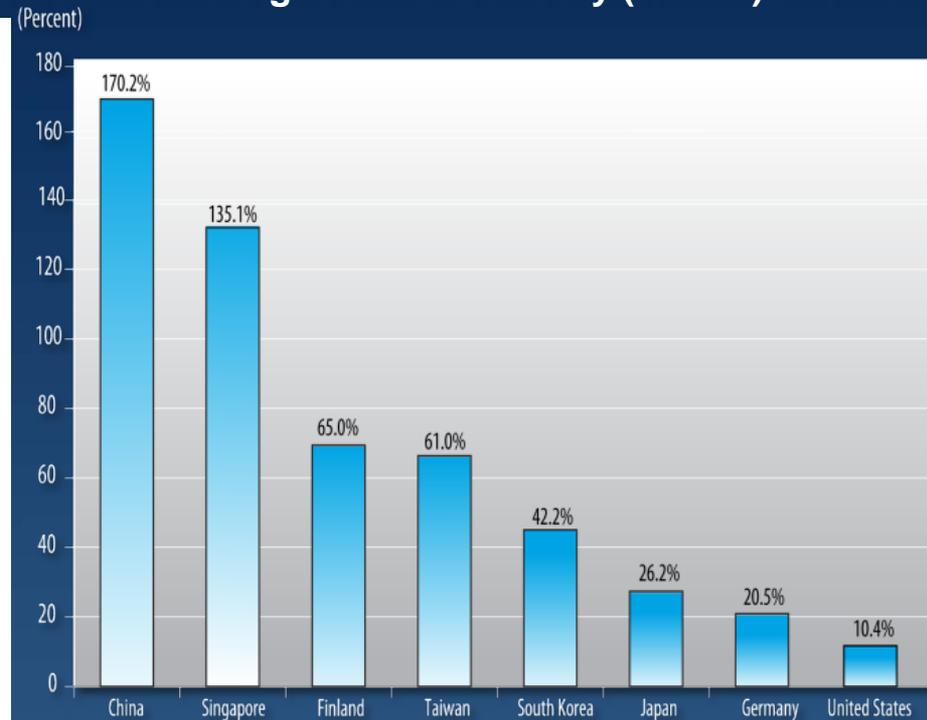
U.S. still out-invests the world...

... but others are catching up

Global R&D investments



Change in R&D Intensity ('95-'08)

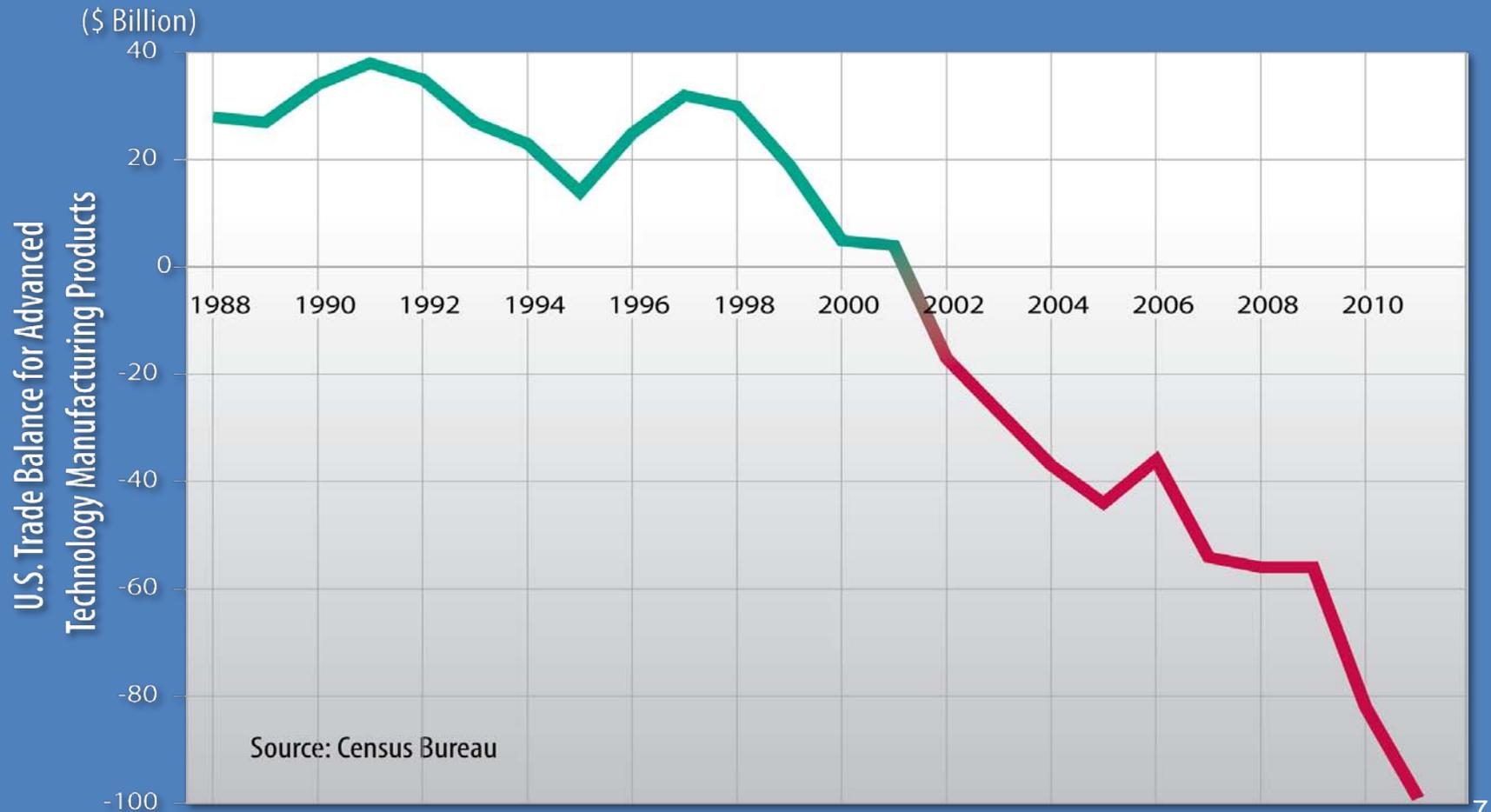


Source: OECD Main Science and Technology Indicators, 2010/1



What is different in the past decade?

U.S. Trade Balance for Advanced Technology Products



Adv. Mfg. Initiative Developments

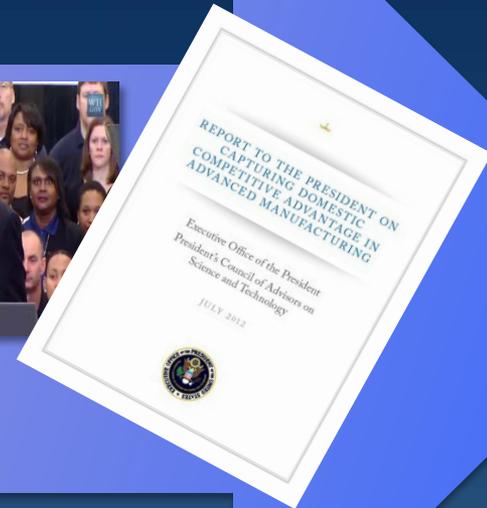
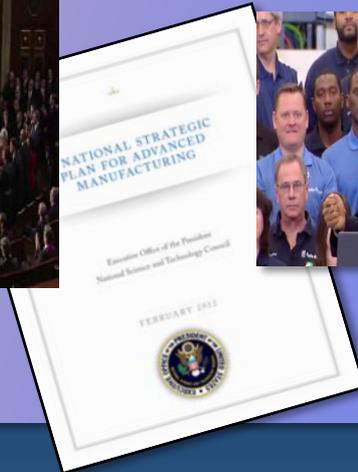
June
2011

Jan
2012

Feb
2012

March
2012

July
2012



National Robotics Initiative (NRI)

The realization of co-robots acting in direct support of individuals and

groups... manufacturing, exploration, discovery, agriculture, security,



NRL



NIH

THEMES

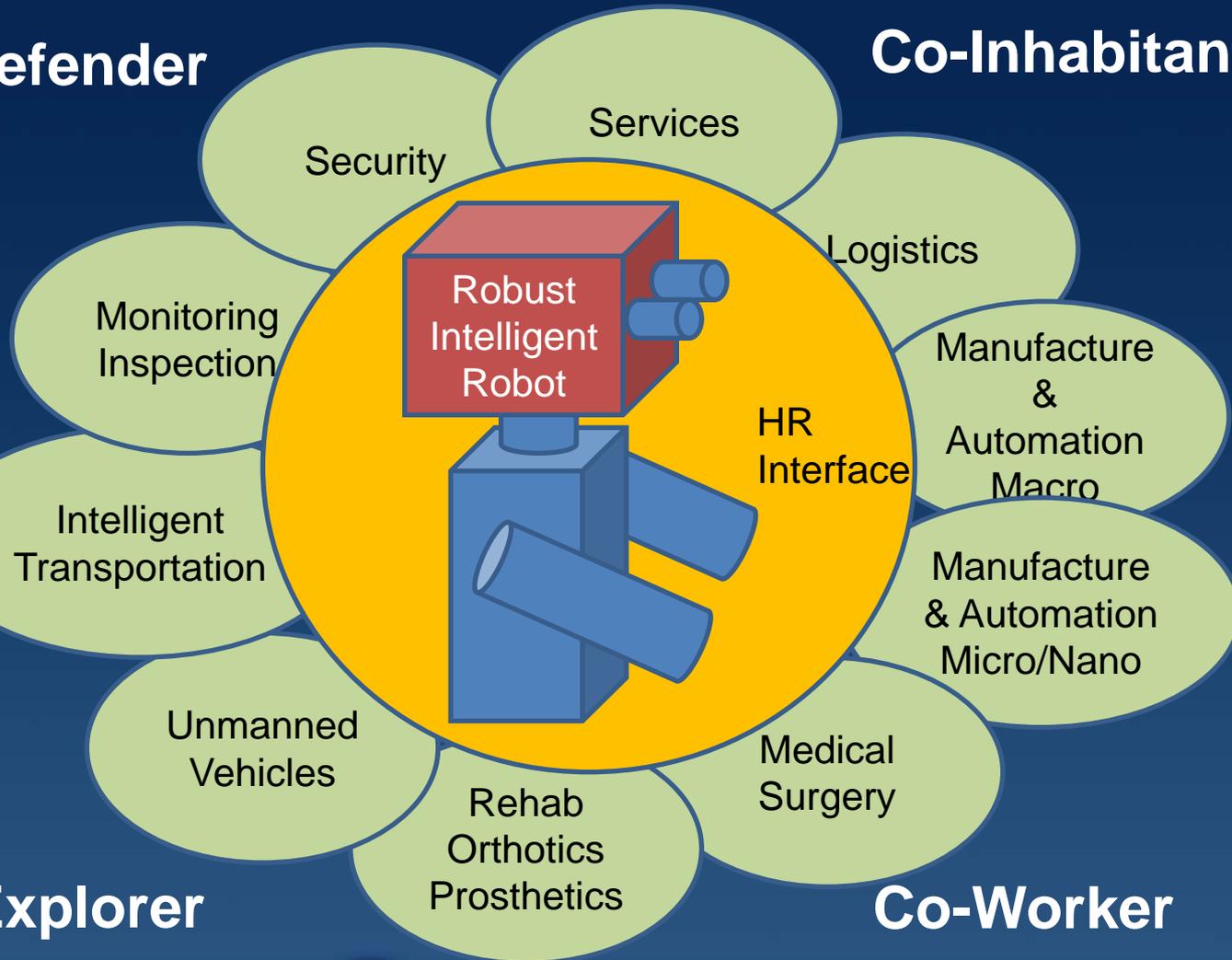
- Fundamental research
- Controls and dynamical systems
- Computational models of human cognition
- Application-inspired topics
- Micro- and nano-robotics, neuro-robotics, humanoid robotics, & networked multi-robot team
- Understanding of the long term social, behavioral and economic implications of co-robots across all areas of human activity
- Use of co-robots for STEM learning



NRI: The Application Space

Co-Defender

Co-Inhabitant

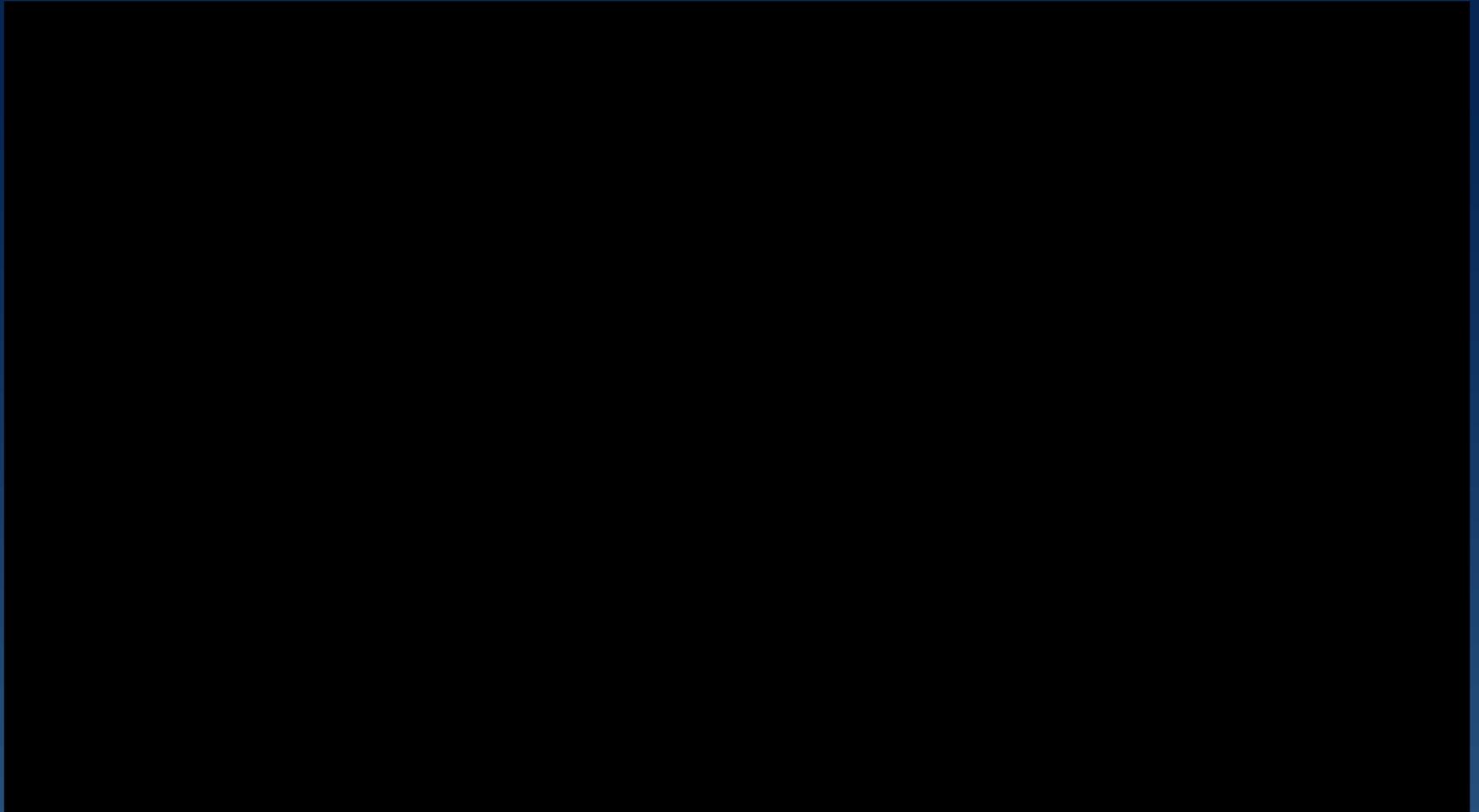


Initiatives

- Multi-agency SBIR
- DURIP
- Prizes & Competitions
- Multi-agency RFP – over 700 proposals received



Interaction with Real Humans



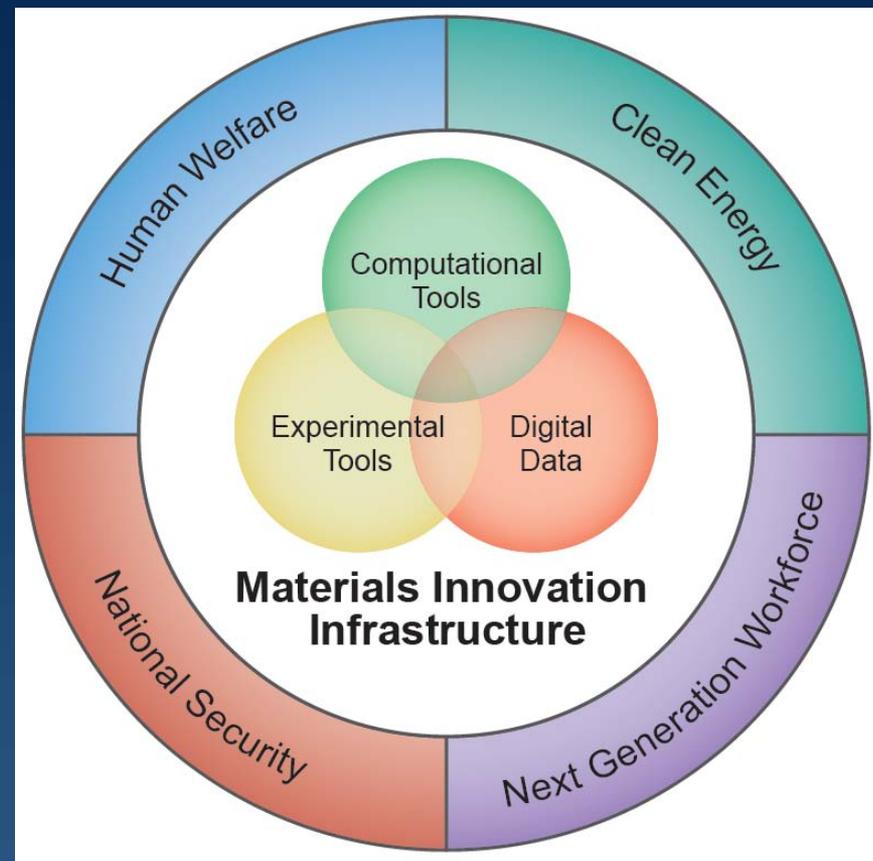
Source DLR, Institute of Robotics and Mechatronics



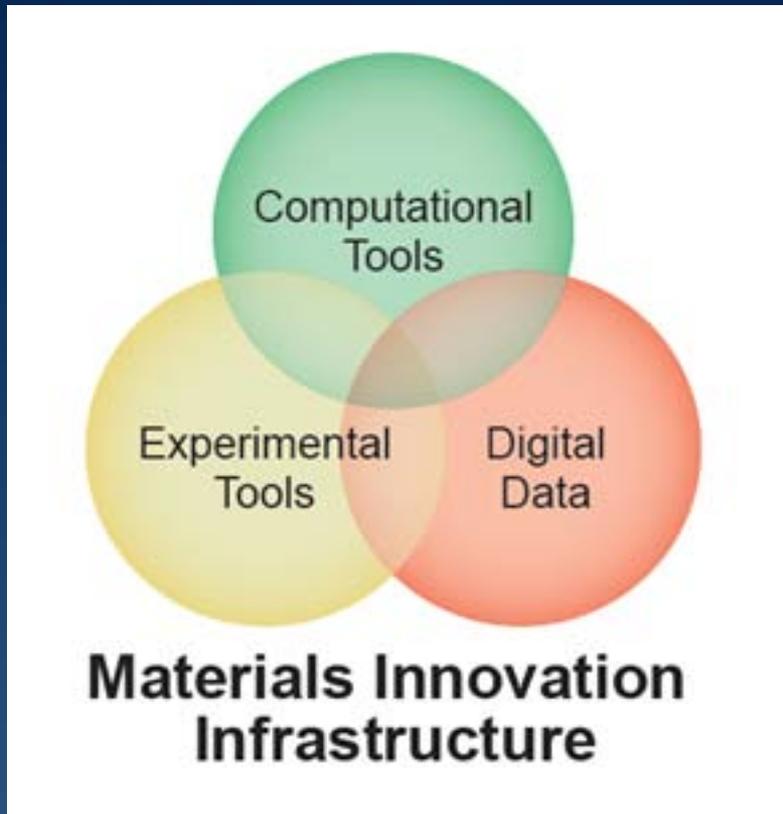
The Materials Genome Initiative

Goal: to decrease the time-to-market for advanced materials by over 50%

- Develop an **innovation infrastructure** for materials deployment
- Achieve **National goals** in energy, security, and human welfare
- Prepare the **next generation workforce**



New Paradigms for Materials Deployment



- Open access to data
- Predictive modeling of materials behavior
- High-throughput experimental tools
- Unified design and manufacturing



Potential Outcomes

- Lightweight alloys

- New alloys for car chassis that will reduce America's dependence on oil



- Protective materials

- Better armor and helmet material to prevent brain injury in soldiers and civilians



- Critical materials substitutes

- Substitutes for critical materials such as rare earth elements which jeopardize the U.S. economy



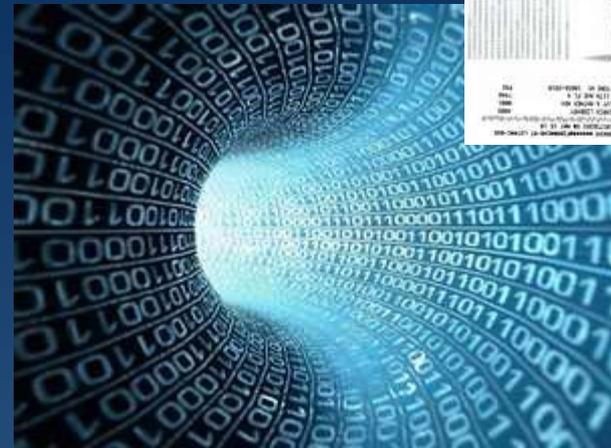
- Battery anodes

- Batteries with dramatically higher energy density for increased lifespan



BIG DATA

- ***“The future of computing is not just big iron. It’s big data.” Tom Kalil, Deputy Director of the White House Office of Science and Technology Policy***
- March 29th – agencies announce \$200 million in additional investments in R&D related to Big Data
- NSF and NIH joint solicitation
- DARPA XDATA program
- DOD “Data to Decision” initiative
- Accelerate “data to knowledge to action.”



National Network for Manufacturing Innovation

\$1 billion FY13 proposal:

“institutes of manufacturing excellence where some of our most advanced engineering schools and our most innovative manufacturers collaborate on new ideas, new technology, new methods, new processes.”

*-President Obama, Rolls-Royce
Crosspointe, Petersburg, VA,
March 9, 2012*

**\$30 million FY12 pilot - DoD
pilot on ManTech - focused
on additive metal,
composites, & direct write
electronics**



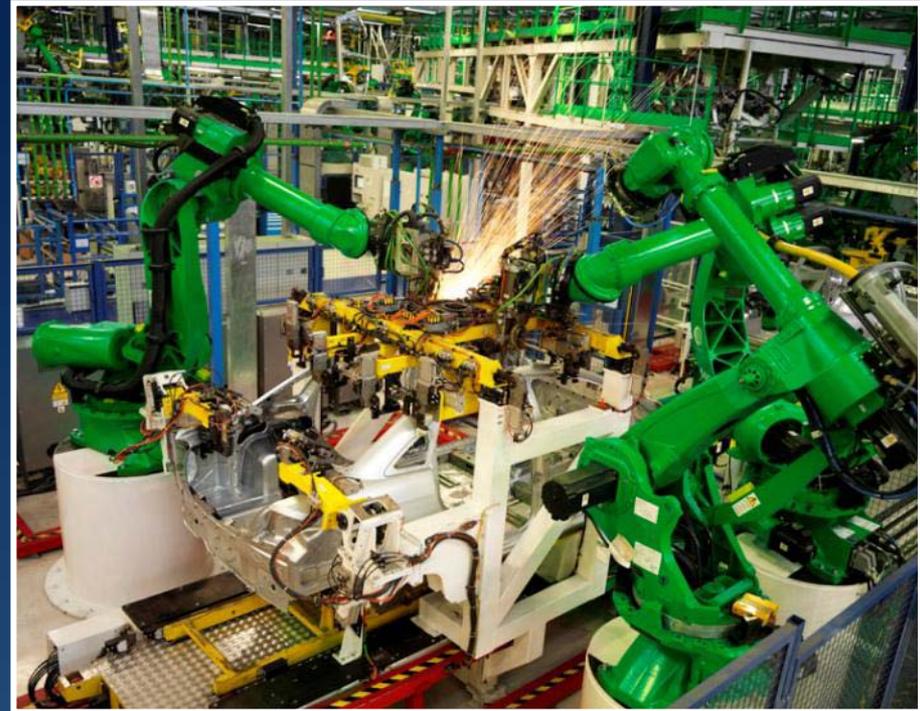
President Obama at Rolls-Royce
Crosspointe, Petersburg, VA, March 9,
2012



The Valley of Death



Basic R&D



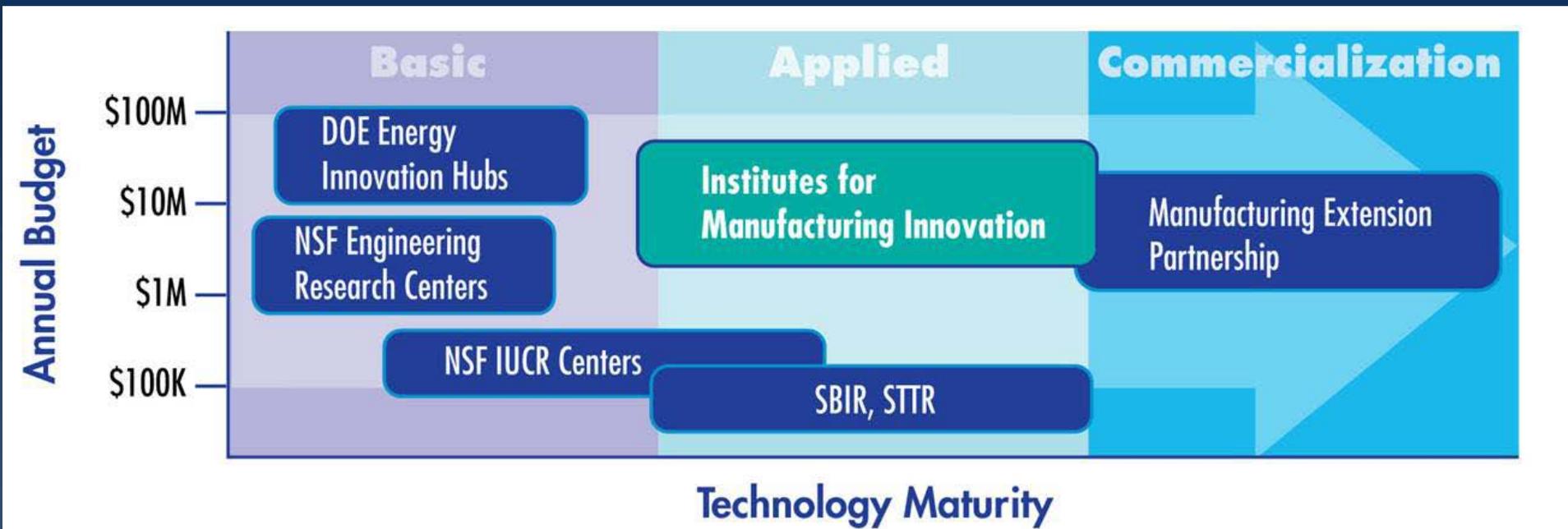
Commercialization



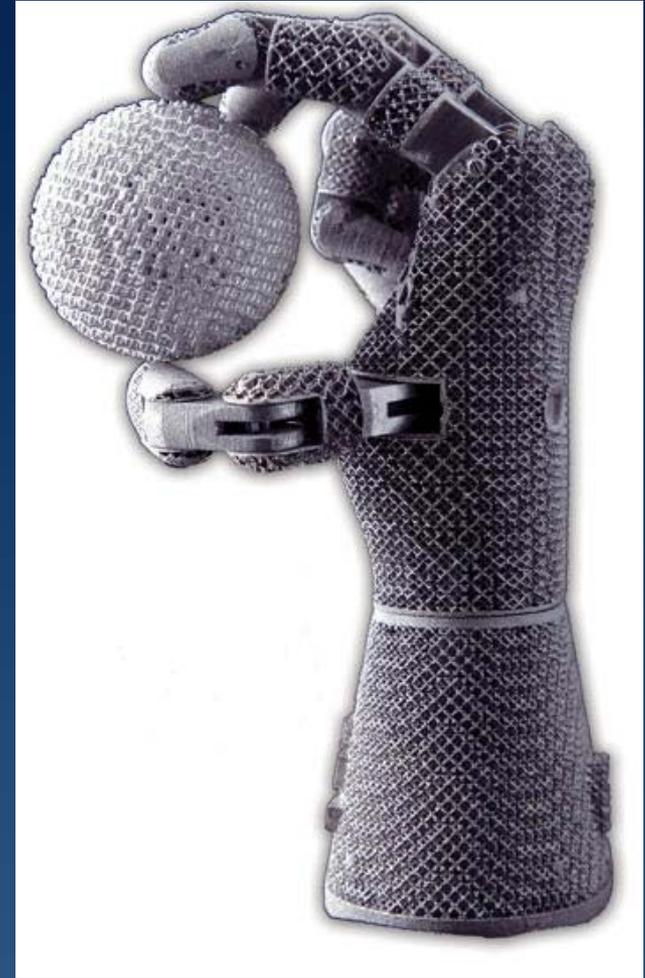
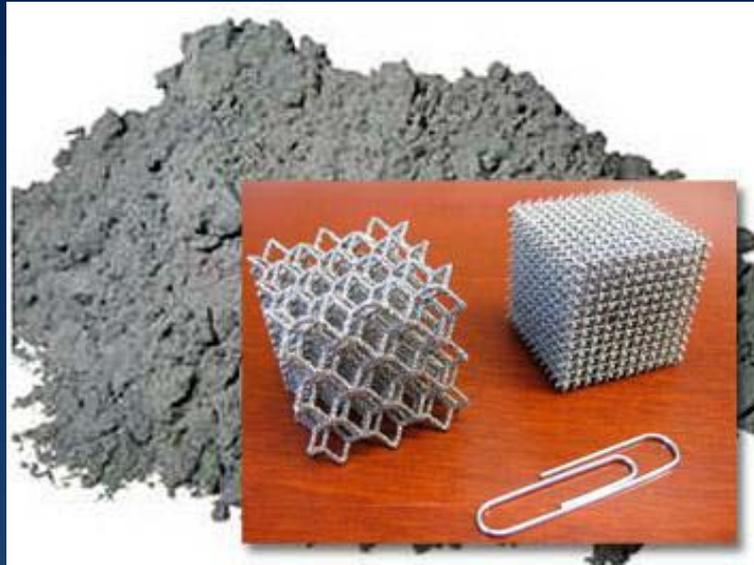
Focus on Scale Up–Missing Middle

Basic science
Largely government funded

Commercialization
private sector owned/funded



2012 Pilot Manufacturing Institute on *Additive Manufacturing*



April 13 May 8 May 16 August 16

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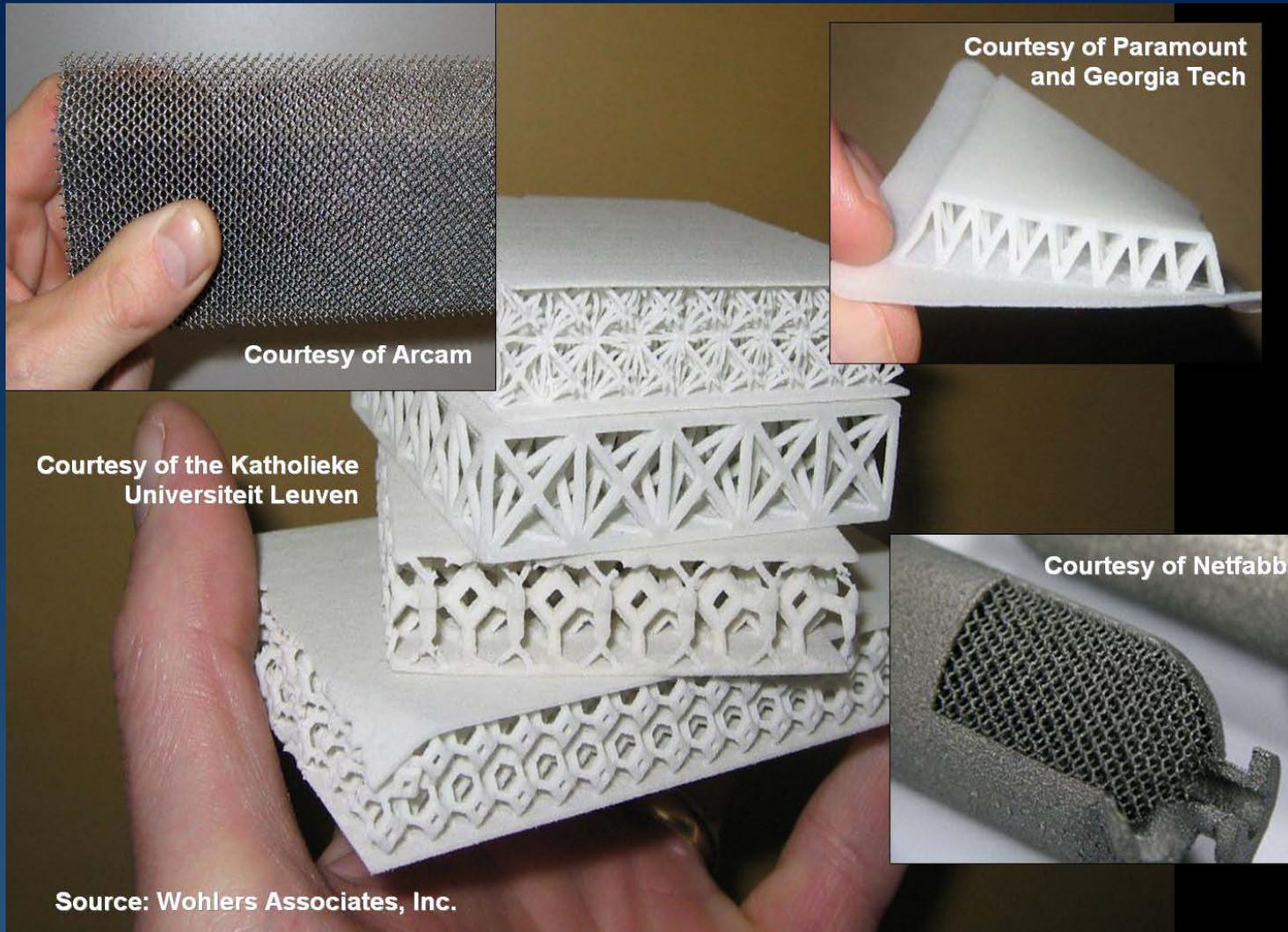
BAA

Industry
Day

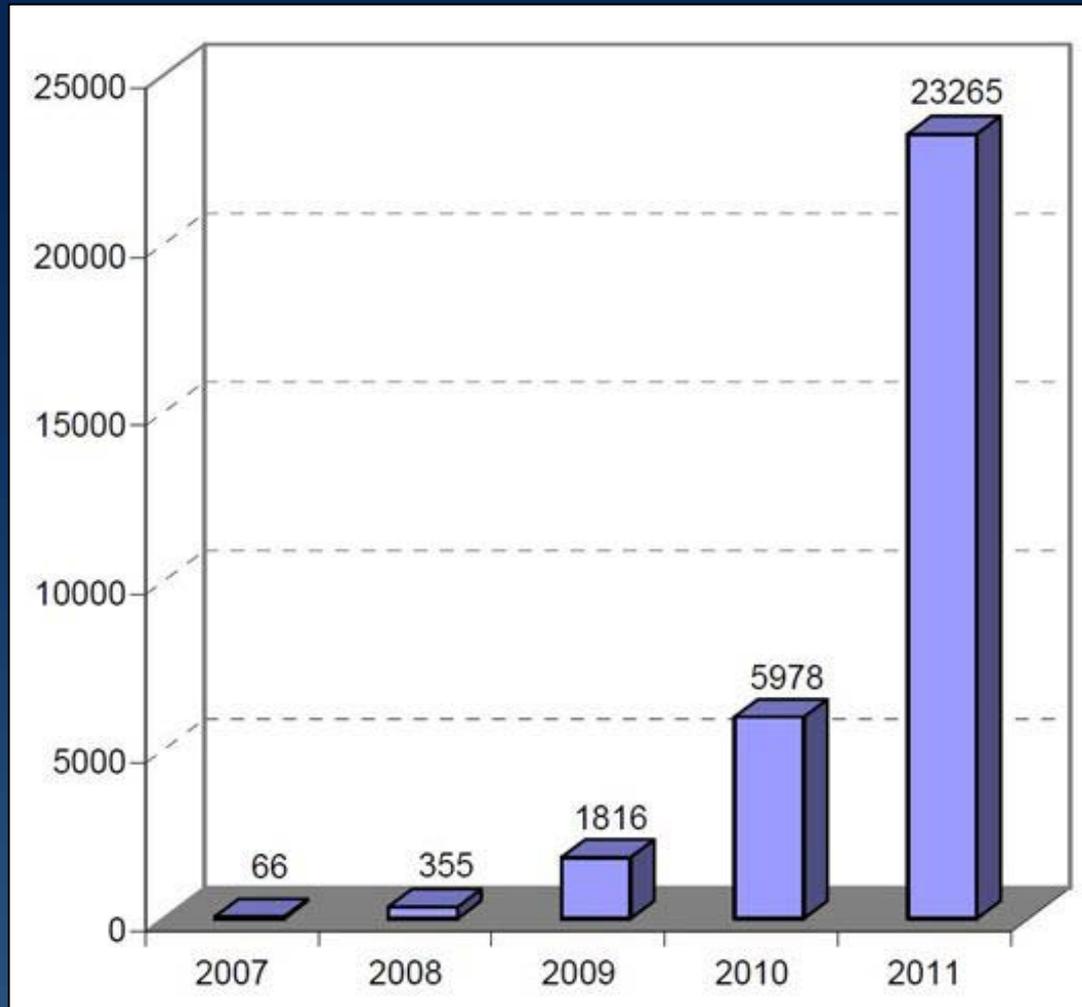
\$30 M



Lightweight / High Strength Structures



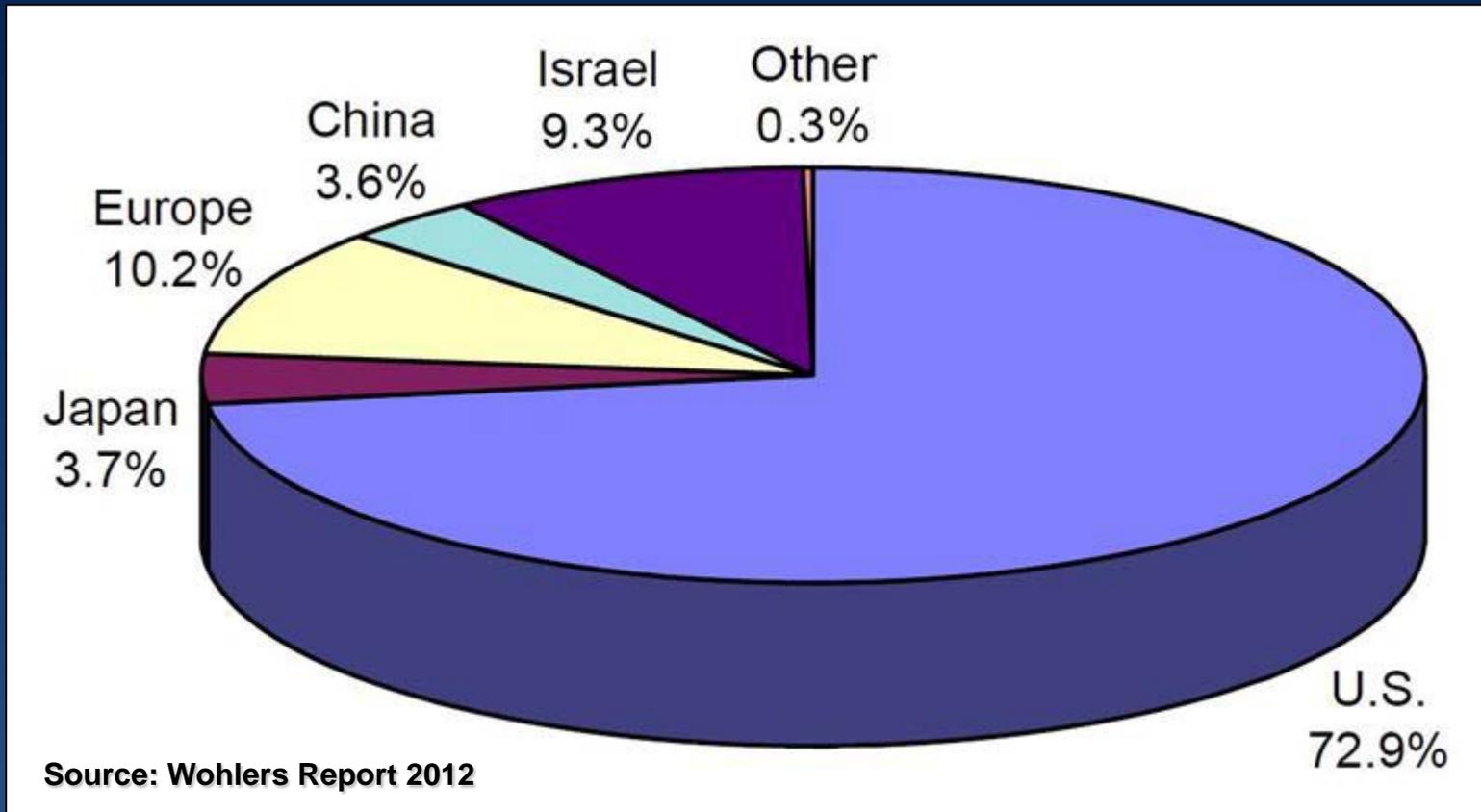
Unit Sales Growth of Personal 3D Printers



Source: Wohlers Report 2012



Number of Industrial AM Systems Sold from Each Geographic Region



Topology Optimization

Let mathematics decide where to locate material



Same strength, half the weight



21st century thingmaker



Images courtesy of Origo



Source: Wohlers Associates, Inc.



STEM Education Potential of 3-D Printing



Encouraging Careers in STEM

- The President's "Educate to Innovate" initiative is leveraging private-sector partners to get students excited about STEM subjects.
 - FIRST students many more times likely to major and pursue careers in science and engineering
- "Technology shifts and increasing investments in **advanced manufacturing** are creating a great demand for STEM-capable students worldwide."
 - *Paula Davis, President, Alcoa Foundation*



White House, November 2009



White House Science Fair, Feb 2012



Global Wellbeing

- Wealth creation
- Sustainability / efficiency
- Enabling SME's
- National well being
- Secured international leadership
- The United States of America
 - Innovation
 - Manufacturing
- The World

“In times of change, learners inherit the earth; while the learned find themselves beautifully equipped to deal with a world that no longer exists.” (Eric Hoffer 1902-1983)





“Think about the America within our reach: A country that leads the world in educating its people. An America that attracts a new generation of high-tech manufacturing and high-paying jobs. A future where we’re in control of our own energy, and our security and prosperity aren’t so tied to unstable parts of the world. An economy built to last, where hard work pays off, and responsibility is rewarded.”

- President Barack Obama
January 24, 2012

