



# *Advanced Manufacturing – New Policy Approaches*

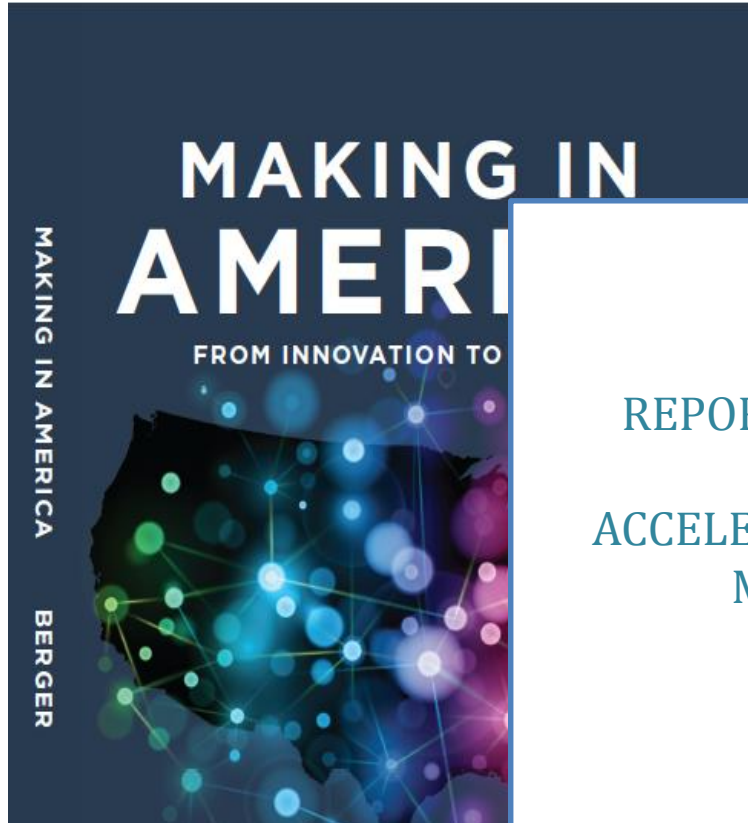


*Production and Supply Chain  
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Management” Conference*

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*What's the  
Advanced  
Mfg  
Context? --  
- Recent  
Reports...*

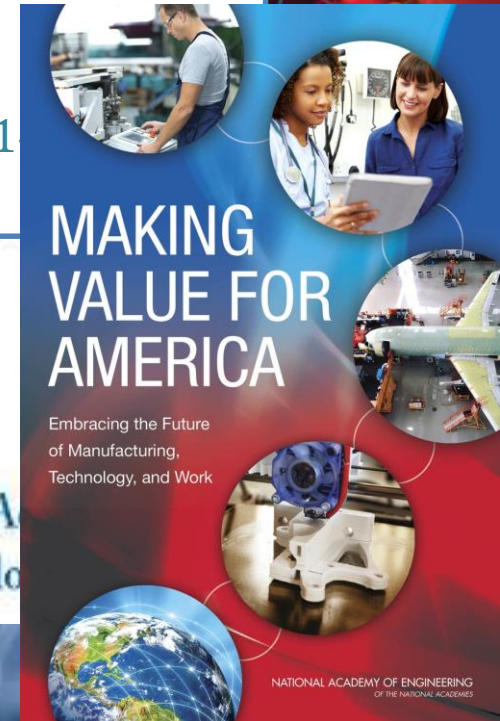


REPORT TO THE PRESIDENT  
ACCELERATING U.S. ADVANCED  
MANUFACTURING

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The President's Council of Advisors  
on Science and Technology



SCIENCE  
Advanced Mfg  
Policies and  
Paradigms  
Dec. 6 2013  
By  
Policy Section

# *The Manufacturing Problem:*

- 1) Manufacturing is not Agriculture
- 2) Our Manufacturing Firms are Increasingly: “*Home Alone*”
- 3) Small, mid-sized and start-up firms – most of U.S.  
manufacturing - can’t get financing to “Scale-Up”  
innovative production
- 4) Strong innovation capability = strong production capability
  - Emerging advanced technology fields
- 5) What Germany can teach us: strong ecosystem
- 6) Jobs – How manufacturing sector affects U.S. services sector
- 7) Manufacturing is part of the innovation system

## *A New Manufacturing Innovation Model?*

- Elements: Manufacturing Institutes,
- Cross-Gov’t/Industry/Univ’s Collaboration,
- Technology Strategies, training, financing, etc.
- A new collaborative university role



# *Point One: Manufacturing is not Agriculture*

- For a long time we thought manufacturing was agriculture.
  - In 1900 half of population farming; now less than 2% farming
  - Producing more than ever, so enormous “productivity gains” in agriculture
- But the reports tell us this manufacturing is not agriculture
- We lost 5.8 million manufacturing jobs from 2000 to 2010
  - We thought manufacturing **output** was holding firm, but it wasn’t - on reexamination we’re finding it was in decline (in 16 of 19 sectors)
  - So we ***didn’t get the productivity gains we thought***
  - **Capital and plant investment rate down in 2000s**
- Job loss data tells us manufacturing sector is hollowing out



## *Point Two: Home Alone*

- The reports tell us for the past three decades we have been thinning out our manufacturing ecosystem
  - We used to have firms and supply chains that were very vertically integrated
  - We hit on a financial model of emphasizing quarterly returns, which led us to reduce risk by making our firms focus on “core competency” and go “asset light”
  - So the shared assets of training, bringing best practices to suppliers, thinned out
  - The companies in our system are now much more ***“home alone”***



# *Point Three: The Scale Up Problem*

- We have 3 manufacturing sectors:
  - **1) Our big multinationals** – they are global, they can get production efficiencies by producing in lower cost countries and they must be in all the global markets
    - They're OK, although they are increasingly producing abroad

## **+ Two More Vulnerable Sectors:**

- **2) Main Street firms** – they do most of our manufacturing, there are 300,000 small and mid-size firms
- They **have trouble getting production scale up funding**, they're thinly capitalized, must be risk adverse to survive, and don't do R&D (although they can be very innovative about process)
- **3) Our entrepreneurial startups that make something** –
  - they do well until they have to **scale up for production** of their product – they **lack financing for scale- up** here – Venture firms don't fund this – send startups to contract mfgs.in Asia
  - So they turn to contract manufacturers abroad



# *Point Four: The Tie between Innovation and Production*

- US had: *innovate here/produce here* – got full spectrum of gains
- Then US did: *innovate here/produce there*
- But - for most products need to tie innovation closely to initial production
  - Need dense feedback loops as you do product design- initial production requires very creative engineering and design – it's part of innovation
  - So if you shift production capability, in many cases innovation capability has to follow it
  - Result: *Produce there = Innovate there*
- Innovation is U.S. strong suit –what it does best
- But if many of our important innovations have to follow production, then endangering our innovation strength
- And Innovation is the key factor in growth



# *Point Four, con't*

- Are there new advanced manufacturing “Paradigms” that could lead to restoration of mfg. leadership?
- **Energy Efficiency** – energy is “waste”
- **“Network centric”**
  - mix of advanced IT, RFID, sensors in every stage and element, new decision making from “big data” analytics, **advanced robotics, supercomputing w/adv'd simulation & modeling**
- **Advanced materials**
  - “materials genome” – ability with supercomputing to design all possible materials with designer features
  - Biomaterials, bio fabrication, syntehtic biology
  - Lightweighting everything
- **Nanomanufacturing**
  - fabrication at the nano-scale
- **Mass Customization**
  - Production of one at cost of mass production (ex.: 3D printing /additive mfg, etc.)
- **Distribution efficiency**
  - IT advances that yield distribution efficiency (ie, supply chain)



# *Point Four, con't:* DOE 3D Printed

Shelby Cobra at ONL - concept to printed, 6 weeks; 500 parts/24 hours

Used - [BAAM](#) ("Big Area Additive Manufacturing") machine -- can print parts [500 to 1,000](#) times faster than current industrial 3D printers



## *Point Five: what Germany can teach us*

- We thought that we had to lose manufacturing jobs to low cost producers in Asia because we are high wage.
- But Germany is high wage and high cost – German wages and benefits are 66% higher than the U.S.
- They run a major manufacturing surplus, including a manufacturing surplus with China
- They have a deep ecosystem for their manufacturers, small and large – they aren't "home alone"
- Extensive collaborative R&D shared by industry- gov't- universities around manufacturing technologies and processes
- Shared training system for their workforce
- Ways to link their supply chains for rapid scale
- Some German practices don't apply, some do



# Point Six - Behind it all: Understanding the Hourglass --



<---- Resources, Suppliers,  
Components,  
Innovation

<--- Production (12m jobs)

<--- Distribution, Sales, Life  
Cycle



# *Point Seven: Production must be seen as part of the Innovation System*

- Manufacturing not pictured as part of the innovation process
  - Focus on only R&D: fragmented view
  - Innovation is a system, from early-stage research through production
- Production is the major enabler of “increasing returns” in an economy – it is a scale-able factor
  - a foundational societal wealth creator.
- treat production as critical element that must be connected to innovation system or risk innovation erosion



# *Problem Summary: Seven Points...*

- Manufacturing is part of Innovation System
- Manufacturing is not Agriculture
- U.S. Manufacturing Firms are Increasingly “Home Alone”
- The Scale-Up problem for small, mid-sized, and start-up firms – most of U.S. manufacturing production strong
- Close linkage between innovation/production
- New production paradigms?
- Germany: strong mfg. ecosystem
- Jobs – tie tradeable goods to tradeable services for scalable growth
- manufacturing sector affects services



# Is Advanced Manufacturing a *New Innovation Model?*

- **BACKGROUND**: R&D and Talent are the two direct innovation factors
- “Innovation organization” is the *third* direct innovation factor –way talent and R&D come together
- So: how the federal R&D system organized is critical
- ***5 Periods of federal innovation organization:***
  - Postwar, Sputnik, Competitiveness, Energy, Manufacturing
- Fundamental divide in design of US R&D agencies
  - **“Connected” model in wartime period**
  - **“Disconnected” postwar model**
  - **Then: Reconnect process in some areas**



# *DOD Builds a Parallel Universe along side the Vannevar[Bush] model...*

- Most of US R&D on basic research/pipeline model -- but there is a parallel universe:
  - Dept. of Defense (DOD) rebuilt the ***connected*** model of WW2 for the Cold War
  - Launched: aviation, nuclear, electronics, space, computing, internet – ***major innovation waves of the 20<sup>th</sup> century***
  - DOD: Pervasive role at all stages of the pipeline - from R to D to prototype to demonstration to creating initial market
    - **POINT: Sputnik is first of a series of external pressures that force change in U.S. innovation system**



# *How far down the innovation pipeline does the Federal Government role go?*



## **THE INNOVATION PIPELINE:**

**Research-> Dev-> Prototype-> Demo-> Testbed-> Production-> Market**

NSF, DOE OS, NIH,  
etc.:



DOD:



*DOD has a “Connected System”*

# *The last manufacturing crisis - 1980s Competitiveness Period:*

- *The Bayh Dole Act*
  - Universities own federal research results
    - Pushed university researchers pipeline to technology development and company creation.
- *The Manufacturing Extension Partnership (MEP)*
  - bring the latest manufacturing technologies and processes to small manufacturers.
- *The Small Business Innovation Research (SBIR) program*
  - R&D grants to small and start-up companies



# *80s Competitiveness Period, Con't:*

- *The Advanced Technology Program (ATP)*
  - high-risk R&D undertaken by industry.
- *Sematech*
  - U.S. semiconductor industry
  - Advanced manufacturing challenge – organize suppliers
  - DARPA matched industry Sematech funding until 1996
- *So: gov't role moved further down the pipeline*



Then: 2012 & 2014 Advanced Mfg.  
*Partnership – 4 Basic Recommendations:*

- *Transformative Technologies – Technology Strategies Linked to R&D*
- *Implementing Manufacturing Institutes and networking them*
- *Demand-Driven Workforce Solutions*
- *Technology Scale-Up/Policy*



# *New Period? Advanced Manufacturing*

- **Advanced Manufacturing Partnership (AMP) - idea:**
  - need innovation-based efficiency gains to compete with low cost/low wage nations
  - Apply innovation capabilities to manufacturing
  - So: New Technologies/Processes/Business Models
- **“Advanced Manufacturing Institutes”- 15 now planned**
  - Collaborative–industry/univ/gov’t –in a way, Sematech model
  - Testbed role / Workforce education role
  - 3D printing, power electronics, lightweighting metals/materials, digital manufacturing, “smart” mfg., photonics, composites, advanced fiber, etc.
- **Creating an Adv’d Manufacturing System:**
  - Technology Strategies around adv’d mfg. technologies
  - Industry-Univ-Gov’t. - collaborative advice – advisory panel
  - Integrated adv’d mfg R&D across agencies–feed-in to Instit’s
  - Scale-up financing fund - \$10 b



# *Linking Policy to the 7 Problem Points*

- Lesson from “home alone” – restore the ecosystem:
  - Manufacturing Institutes – like Germany’s Fraunhofers?
- Lesson from “innovation/production connection” - reconnect:
  - Use the federal R&D system in adv’d mfg
  - Technology strategies for adv’d mfg paradigms
    - Collaborative – industry-univ.-gov’t
    - Focus on cross-sector technologies
  - Tie in R&D system to strategies, link to institutes
- Lesson re Workforce: need training for adv’d mfg
  - community college role, adv’d engineering
- Lesson re Production Scale up
  - Gap in financing system – needs review



# *Lessons from AMP For University Role in Policy*



- Universities co-led the AMP process with industry CEO's and leaders
- Joint industry-univ. committee for innovation policy analysis - new
  - Developing “Technology Strategies” in three tech areas together was particularly instructive - forced collaboration and new thinking
- Manufacturing Institutes are a new model for technology evaluation and stand-up
  - Fraunhofer model
  - Ties industry/universities together in longer innov. chain
  - Joins the sectors not simply in research but in later stage development