

Manufacturing and Supply Chain Challenges

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What about the supply chain?

- Major focus now on supply chain resiliency in an atmosphere of supply delays and rising demand
- BUT: *unless fix the underlying manufacturing system, we face ongoing supply chain security and resilience problems over time*
- Story below is on manufacturing, but that is a prerequisite for supply chain fixes

Part I – Manufacturing

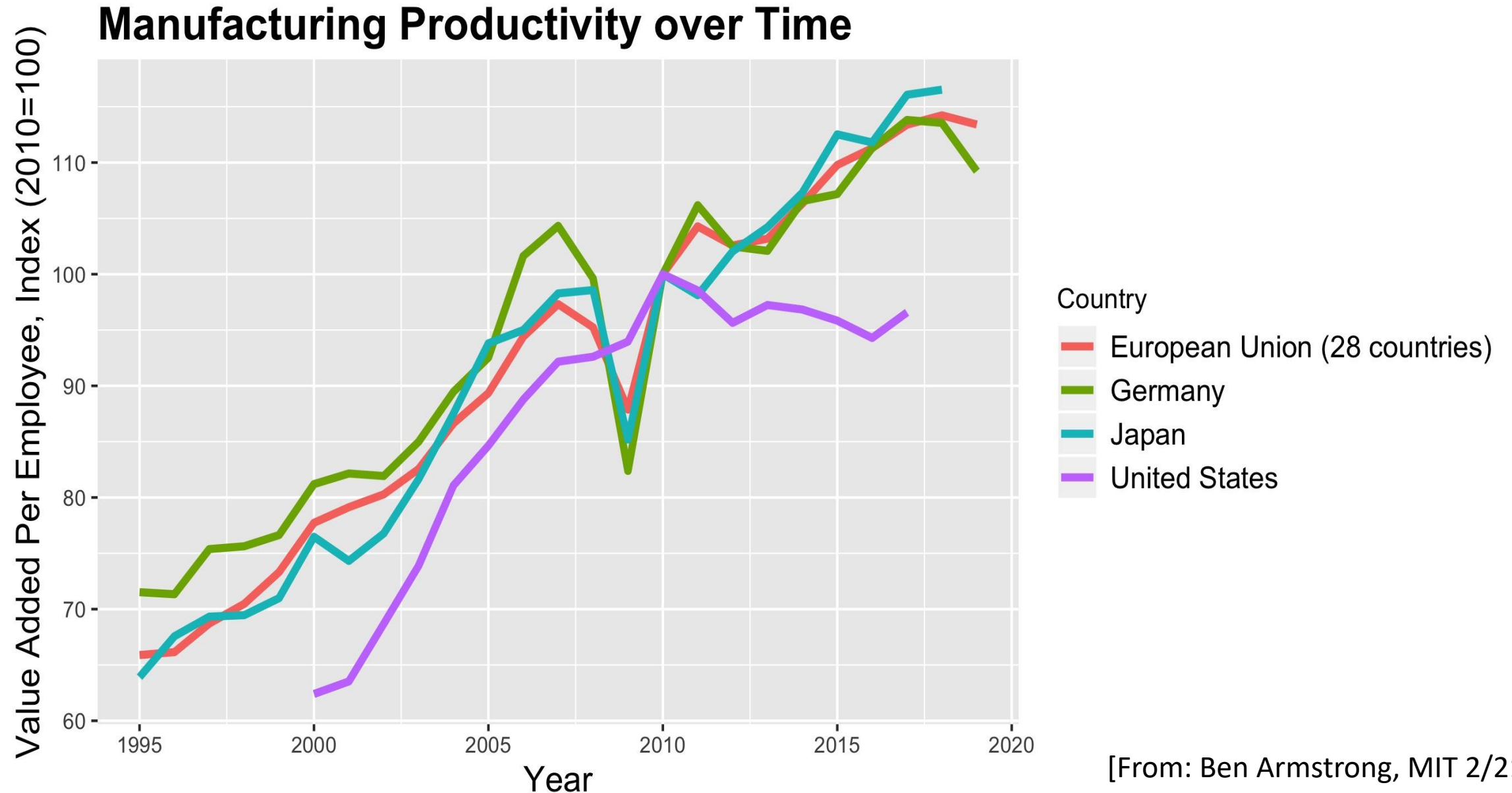
-- What is the US
manufacturing problem?

The Problems Facing US Manufacturing – 4 Findings

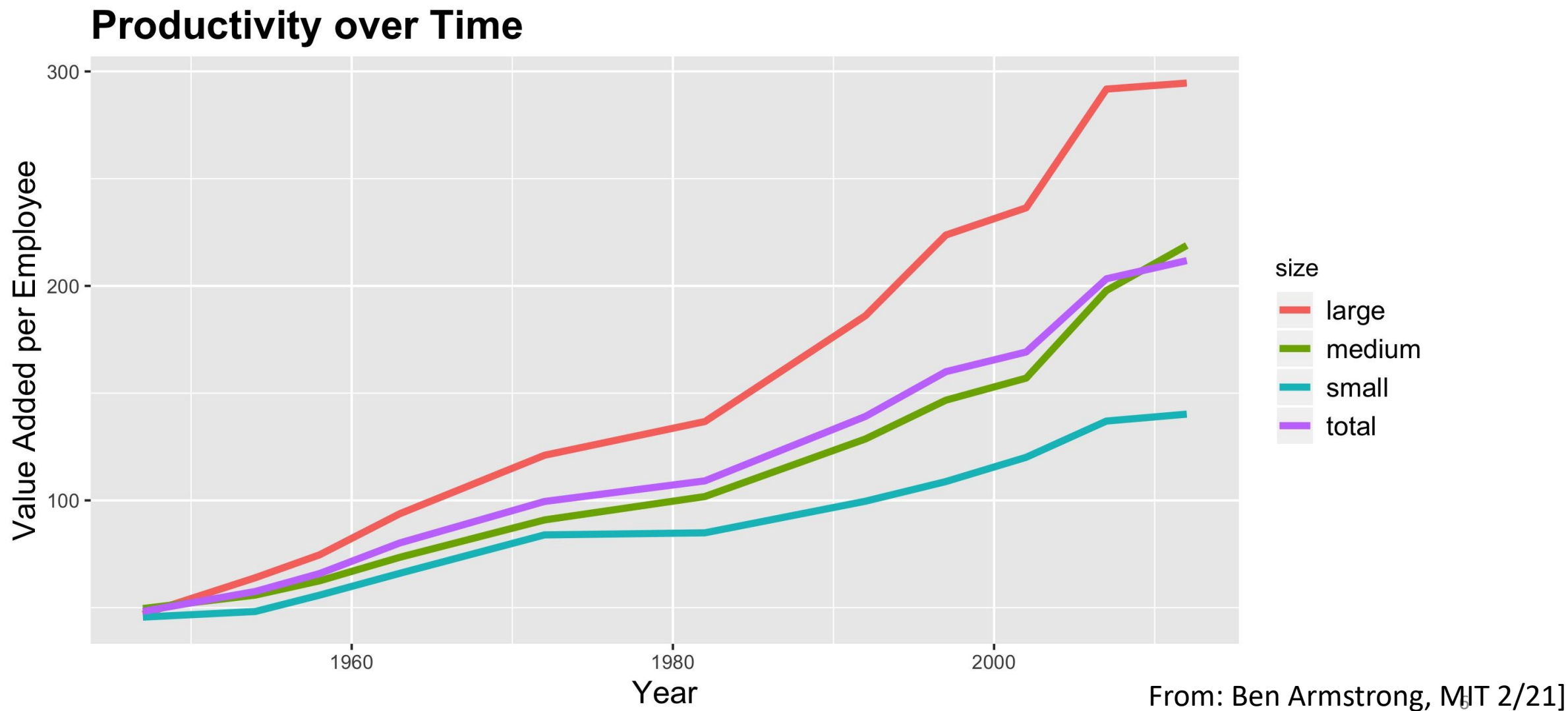
- Finding #1: Signal from Manufacturing Job Loss

- US lost - from 2000 to 2010 – one third of manufacturing jobs
 - **Manufacturing output** in decline in 16 of 19 sectors
 - output only recovered to 2000 levels in 2018
 - **US productivity low:**
 - 1995-2005: 2.5%;
 - 2005-2015: 1% range – historic low
 - **Capital, plant, equipment, IT investment – low**
 - **Major trade deficit: now \$900b in mfg. goods; in adv'd mfg. tech's, jumped from \$130B to \$191B in 2019 from 2020**
- Job loss data: signal that US manufacturing was ***hollowing out and facing international competition – Decline in productivity levels: signal of innovation gap***

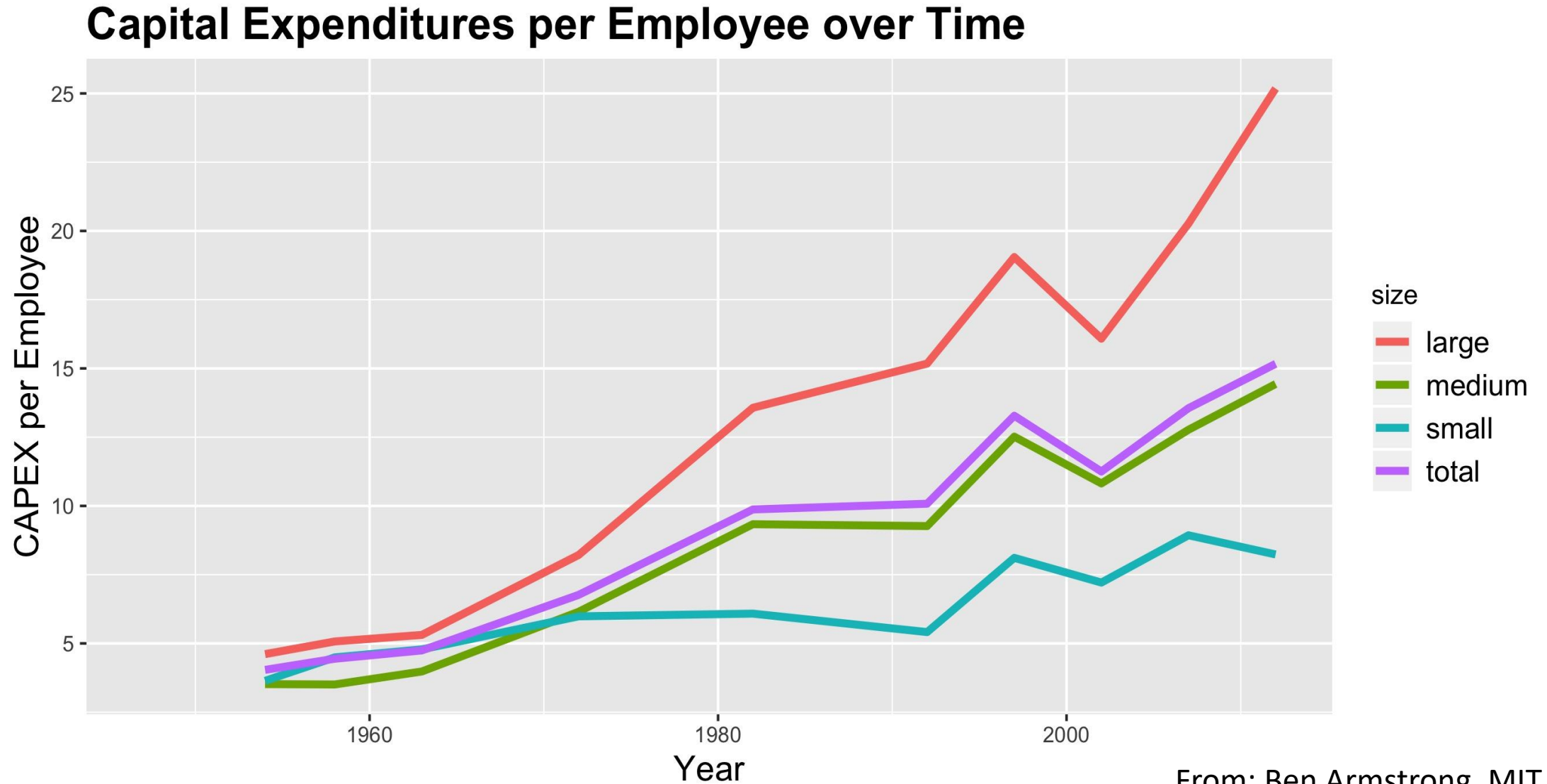
US Manufacturing Productivity Lags Behind Competitor Nations



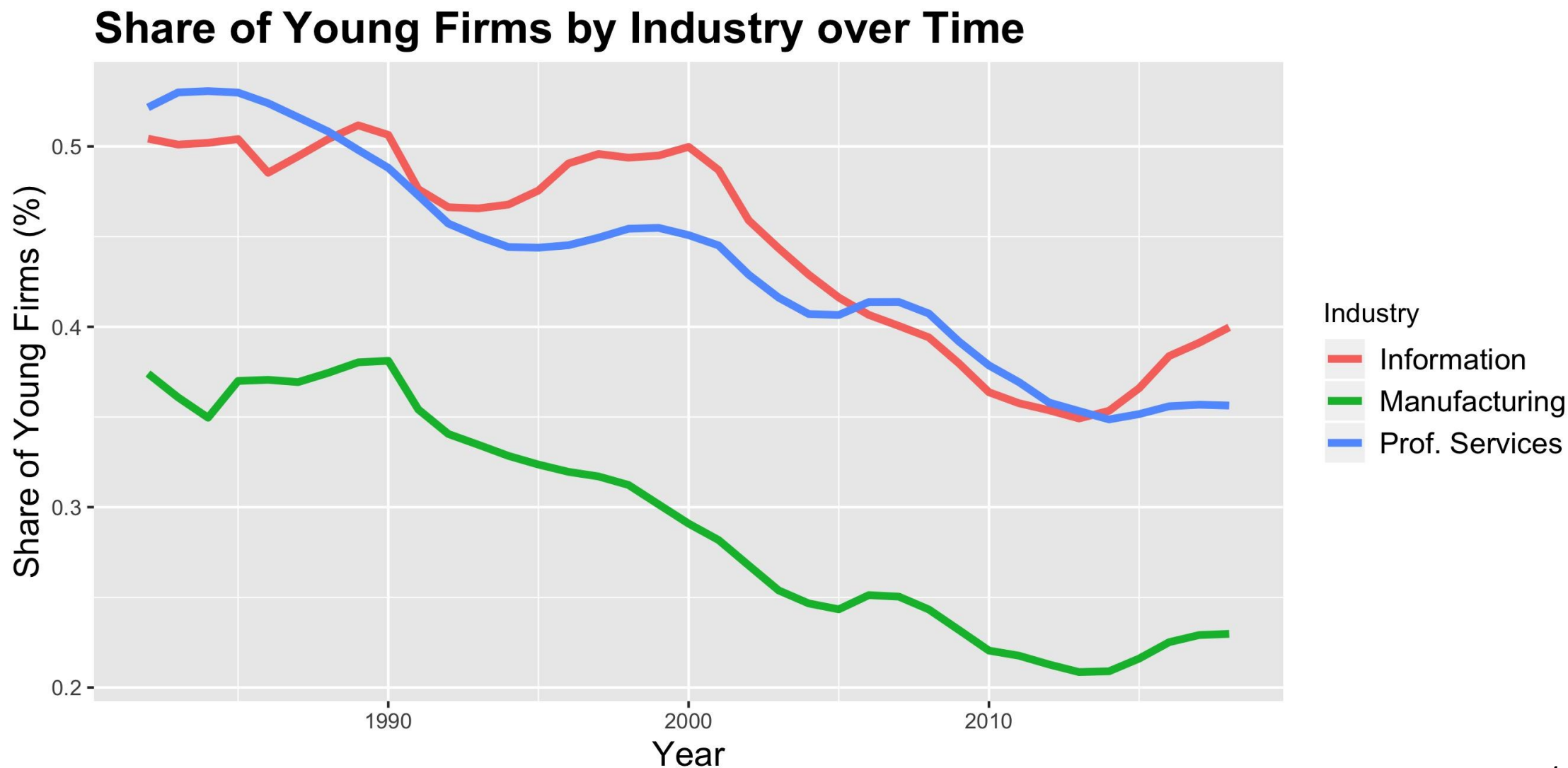
Small and Mid-Sized Mfg. Firms Lag in Productivity:



Productivity-related Capital Investments Stagnate at Small Mfg. Firms:



Nos. of New Entrepreneurial Firms in Decline in Manufacturing:



From: Ben Armstrong, MIT 2/21]

Finding #2: Production must be seen as part of the Innovation System

- Manufacturing not pictured in the US as part of the innovation process
 - US focus is on only R&D: fragmented view
 - Innovation is a system, from early-stage research through manufacturing
- treat production as critical element that must be connected to innovation system
 - or risk innovation erosion

Finding #3: 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 important innovations have to follow production, endangers US core innovation strength – *creates system gap*
- And Innovation is the key growth factor

Finding #4: Lessons from Germany – Illustrate U.S. System Gaps

- US thought that it had to lose manufacturing jobs to low cost producers in Asia because it was high wage.
- But Germany is high wage and high cost – German wages and benefits are 60% higher than the U.S.
- Germany runs a major manufacturing surplus, including a manufacturing surplus with Asian nations
- Germany has a deep ecosystem for their manufacturers, small and large – they aren't "home alone" – shows U.S. gap
- Extensive collaborative R&D shared by industry- gov't- universities around manufacturing technologies and processes – Fraunhofer Institutes
- Shared training system for their workforce – shows U.S. gap
- Ways to link their supply chains for rapid scale up
- Some German practices don't apply, some do

Gaps in the U.S. Production Innovation System = Capabilities Problem

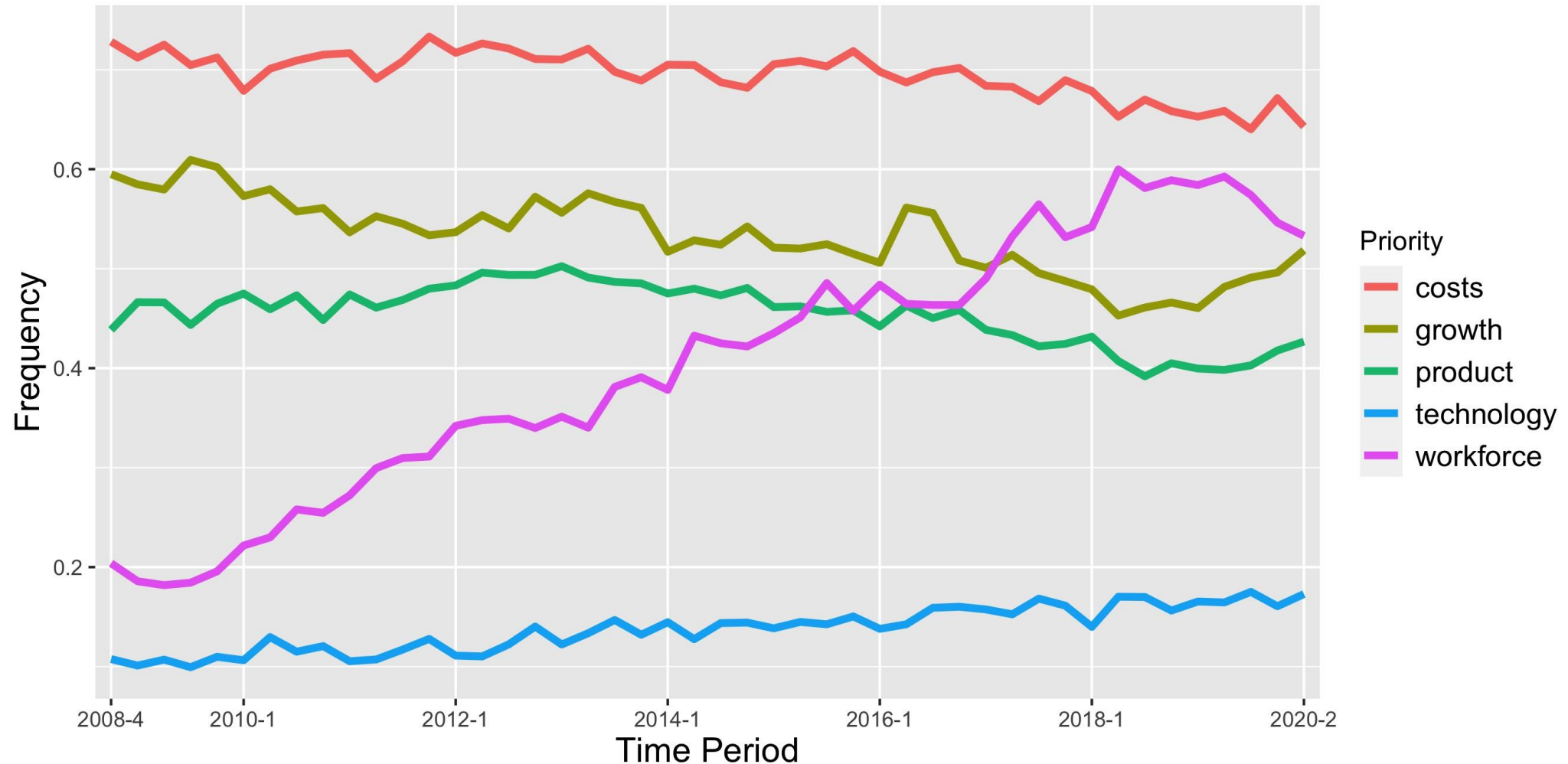
- *Signals of Gaps in Innovation System:*
 - *productivity low,*
 - *supporting ecosystem weak,*
 - *scale up problem,*
 - *delinked innovation and production,*
 - *weak workforce training*
 - = *Social Disruption*
- *Way out? Apply innovation system model?*
- *Core idea: Create new capabilities around system innovation*

And Manufacturing Decline = Social Disruption

- Between 2000 and 2010, U.S. manufacturing employment fell by 5.8 million jobs – 1/3
- Manufacturing – historically important middle class pathway for the high school educated – that was hit hard
- Median income of men with high school educations or less fell by 20% between 1990 and 2013.
- Growing income split between college and non-college educated

Workforce is a rapidly rising priority for Manufacturers

Manufacturing Priorities Over Time



MEP National Survey Data [from Ben Armstrong, MIT 2/21]

Behind it all:
Understanding
the Hourglass --



<---- Resources, Suppliers,
Components, R&D

<--- Production (12m jobs)

<--- Distribution, Sales, Life
Cycle

AND: Value Chains
run throughout

Part II – the Remedy

- Apply the Innovation System to the Problem
- Fill System Gaps, build new capabilities at the national and regional levels
- i.e., “Advanced Manufacturing”

Idea: Scientists/Engineers Say There Are:

New Manufacturing Paradigms

There new advanced manufacturing “Paradigms” –

- **Idea:** raise efficiency, compete with lower cost economies; could lead to restoration of mfg. leadership? – And innovation is its own reward, creates new opportunities -- some examples:

- **“Network centric”/Digital Production**
- **Advanced materials**
- **Nanomanufacturing**
- **Mass Customization**
- **Distribution efficiency**
- **Specific Technologies: Photonics, Advanced Composites, Biofabrication, Power Electronics, etc.**

New Model - Advanced Manufacturing

- **Advanced Manufacturing Partnership (AMP) - idea:**
 - From industry-univ. collaboration – reports in 2012, 2014
 - Need innovation-based efficiency gains to compete with low cost/low wage nations
 - So: Apply innovation capabilities to manufacturing
 - So: New Technologies/Processes/Business Models
- **One key tool: Manufacturing innovation Institutes”**- 16 set up
- Collaborative–industry/univ/gov’t –in a way, Sematech model
 - Tech Dev. around potential new technology paradigms –
 - 3D printing, digital production, robotics, photonics, advanced composites and materials, flexible electronics, cybersecurity, bio fabrication, power electronics, etc.
 - Testbed role
 - Workforce education role
 - Cost shared between: federal gov’t/industry/state gov’t
- *ISSUE: will the Institutes and other mfg. programs like MEP get the support they need from the new Administration?*

Still need work on *remaining system gaps* –

- *Connecting the R&D System to the Institutes*
- *Creating the Network of institutes –*
 - *Have to integrate the various technologies for entirely new production floor systems*
 - *need to deliver packages of workforce ed and advanced technologies for SMMs to use*
- *Workforce training*
- *Scaling-up Startups*
- *Financing – SMMs slow in adopting new production technologies – need low cost equip. financing*
 - *SMMs will only adopt workforce ed when they have the new technologies and equipment on their shop floors*
- *Ending 5 year term limit for federal support*
- *Tracking progress in competitors*

Part III: Conclusion

- **Advanced Manufacturing –**
 - IDEA: Apply the still strong US Innovation System to Manufacturing
 - Manufacturing Institute model evolving
 - Innovation Systems approach
- **Remember:**
 - no manufacturing fix,
 - no supply chain fix