How Digitalization Is Transforming Modern Manufacturing and Implications for Iowa

Iowa Innovation Council

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- The world's leading science and technology policy think tank.
- Supports policies driving global, innovation-based economic growth.
- Focuses on a host of issues at the intersection of technology innovation and public policy across several sectors:
  - Innovation and competitiveness
  - IT and data
  - Telecommunications
  - Trade and globalization
  - Life sciences, agricultural biotech, and energy

ITIF Mfg. Reports

Today's Presentation

1 Manufacturing Digitalization and Why It Matters

2 Policy Considerations

Increasingly Digitalized Global Economy

- Digital economy accounts for 25% of global GDP.
- Value of international data flows has surpassed value of international merchandise trade.
- 50% of all value created in the global economy will be created digitally over the next decade.

Sources: Accenture, “Digital Disruption: The Growth Multiplier”; McKinsey Global Institute, “Digital Globalization: The New Era of Global Flows”

Digitalization Transforming Manufacturing

- "Smart manufacturing": The application of information and communications technologies to manufacturing processes.

  Key enabling technologies: Sensors, IoT, wireless comms, cloud computing, AI/big data analytics, CAD/CAE software, robotics.

- Digital services now account for 25% of manufacturing inputs.

- By 2020, 60% of leading manufacturers will depend on digital platforms to support 30% of their overall revenue.

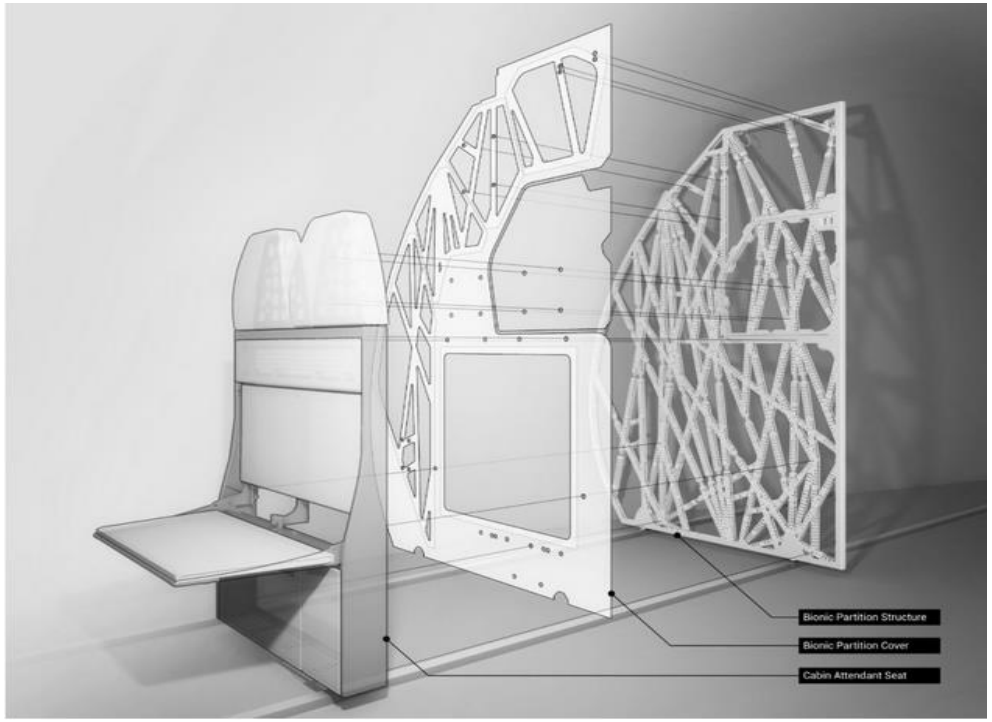
Source: Sherry Stephenson, "The Linkage Between Services and Manufacturing in the U.S. Economy"; IDC, "IDC FutureScape: Worldwide IT Industry 2018 Predictions"

“Digitally Enabled” at Each Step of Manufacturing

1. Product Design
2. Fabrication and Assembly
3. Factory Operation
4. Supply Chain Integration
5. Product Use and Consumption

Product Design

- Modern CAD software leverages generative design techniques to herald a new era of how products get designed.

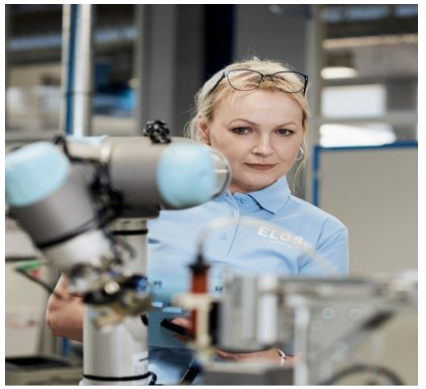


Fabrication and Assembly: 3D Printing & Robotics

- 3D printing expected to impact up to 42% of production in U.S. aerospace, automotive, and medical devices sectors.

- 2 million industrial robots at work in the world's factories; responsible for 10% U.S. GDP growth over last 15 years.

- Human-robot collaborations are 85% more productive than either humans or robots working on their own.

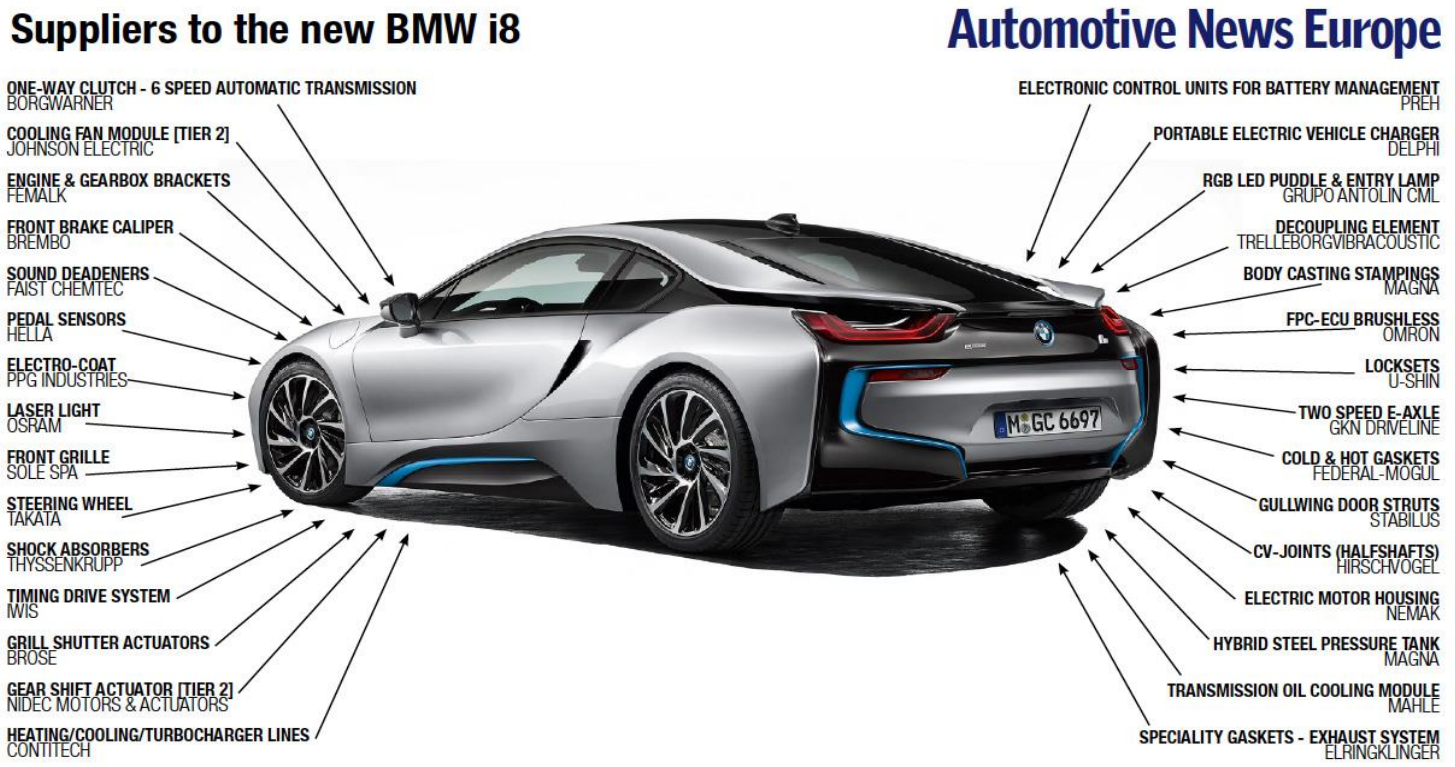


Factory Operations

- Sensor-enabling equipment generates a comprehensive, real-time view of the status of machines, work cells, and systems.

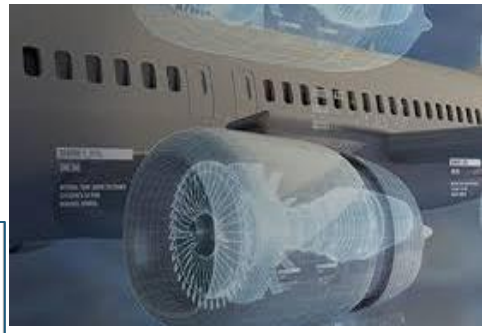
Supply Chain Management and Integration

- Real-time visibility into every machine making every component across supply chains.



Digitally Enabled Product Use and Consumption

- Digitalization enables new business models such as product servification, mass customization, low-cost variability, and evergreen design.
  - E.g., Rolls Royce's "Power by the Hour" model.
  - John Deere tractors with variable engine horsepower.
- Value-added services increasingly driving revenue growth for manufacturers.



Source: Harvard Business Review, "How Smart, Connected Products Are Transforming Companies"

Rold

Roldsmartfab

Roldappliance **Rold**lighting **Rold**industrial

RoLD

All the data and factory alerts in real-time and ready-to-use

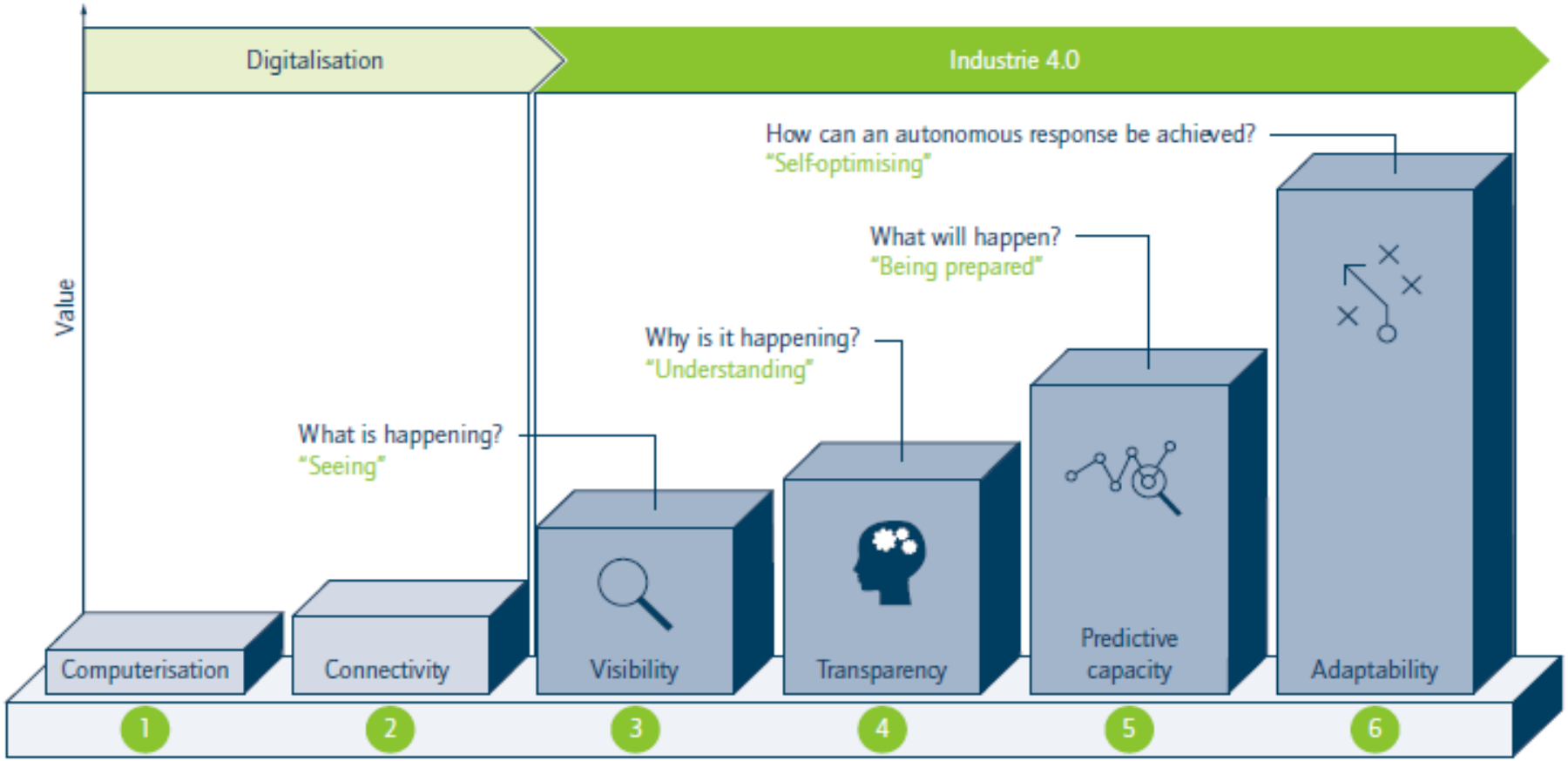
Real-Time Notification to the Operator

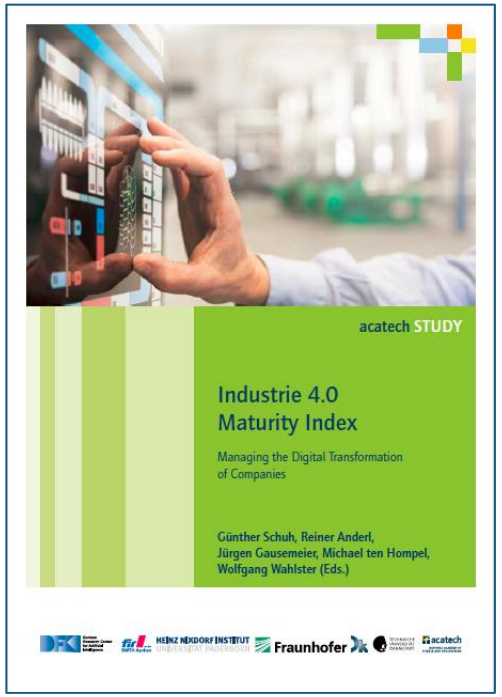
Timely Problem Solving

Instant Feedback to the Manager

Roldappliance Roldlighting Roldindustrial ROLD

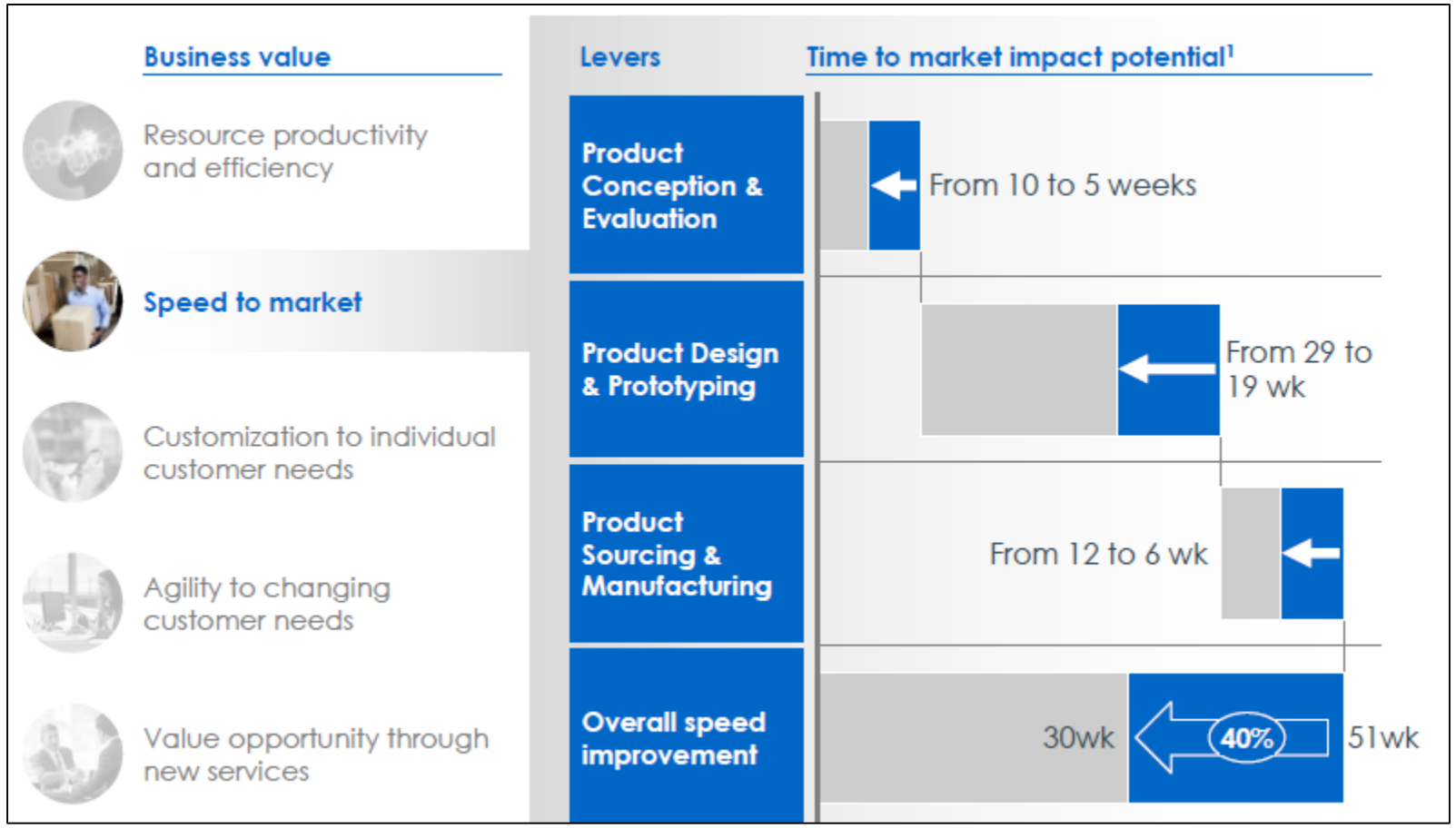
The Manufacturing Digitalization Maturity Journey





Source: Acatech (German National Academy of Science and Engineering) "Industrie 4.0 Maturity Index"

Accelerating Innovation and Speed to Market



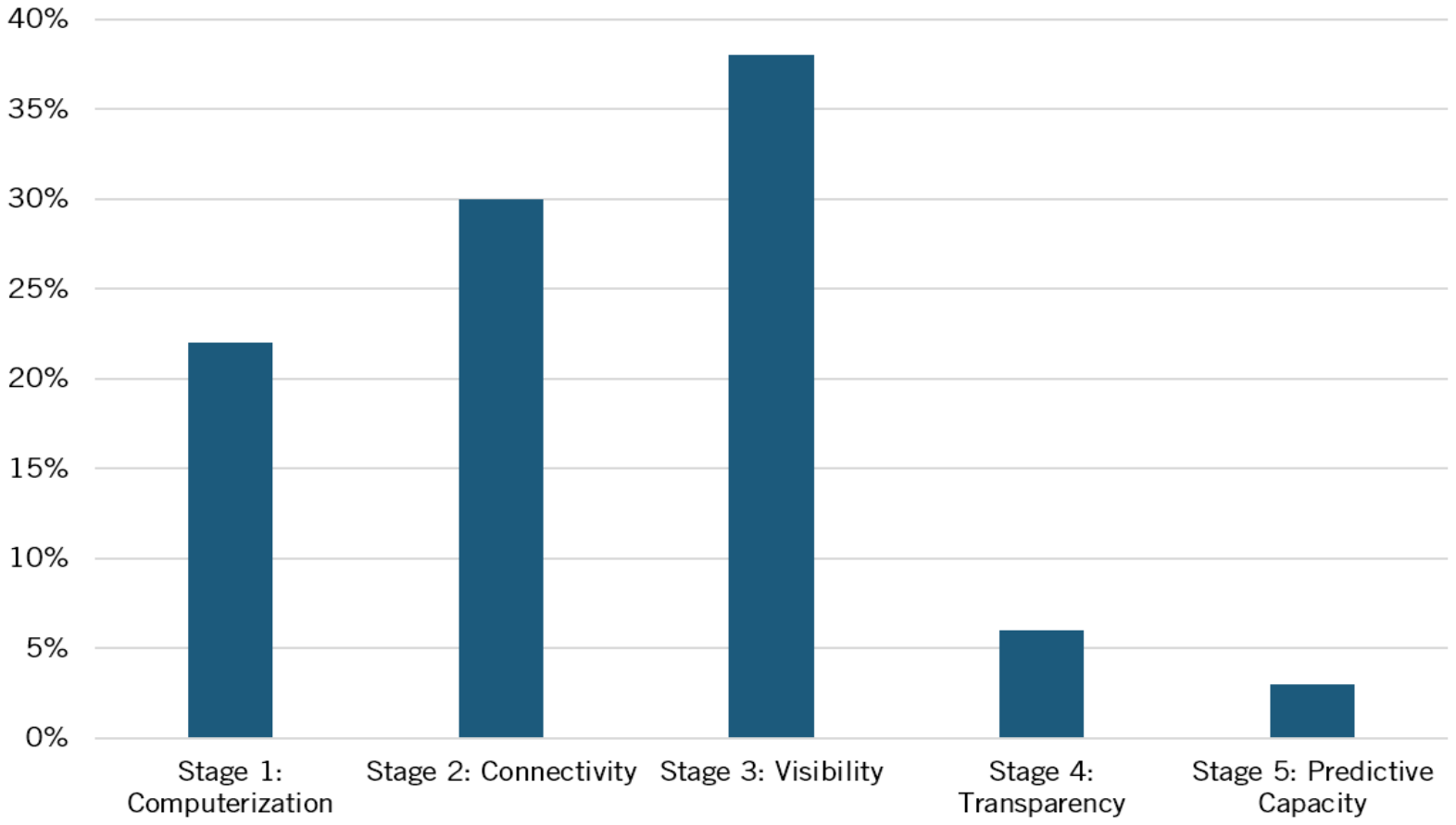
Courtesy: Caralynn Collens, MxD and McKinsey & Company, Spring 2018

Economic/Productivity Impacts From Manufacturing Digitalization

- Industrial Internet of Things applications expected to add $10 trillion to the global economy over the next decade.
- Digitalization expected to boost factory productivity up to 25%.
- Could add 1-1.5% to annual productivity growth.

Sources: McKinsey Global Instiute, "The Internet of Things: Mapping the Value Beyond the Hype"
GE, "Industrial Internet: Pushing the Boundaries of Minds and Machines"

Yet Most Manufacturers in Early Stages of the Manufacturing Digitalization Journey



Source: ITIF/MAPI, "The Manufacturing Evolution: How AI Will Transform Manufacturing & The Workforce of the Future"

Why Has Digital Manufacturing Progress Been So Slow?

Supply

- Technology not yet fully mature.
- Fragmented providers/lack of interoperable standards.

Demand

- Underinvestment in capital equipment.
- Lagging employee skills and competencies.
- SMEs unclear how to proceed/understand value proposition.

Source: Stephen Ezell, ITIF, "U.S. Manufacturing Digitalization – Extent of Adoption and Recommendations for Increasing Penetration"

Today's Presentation

1 Manufacturing Digitalization and Why It Matters

2 Policy Considerations

Manufacturing Digitalization: Extent of Adoption and Recommendations for Increasing Penetration in Korea and the U.S.

BY STEPHEN J. EZELL, ROBERT D. ATKINSON, DR. INCHUL KIM, AND JEAHAN CHO | AUGUST 2018

Manufacturing digitalization promises to transform how products are designed, fabricated, used, and serviced, but more needs to be done to facilitate the uptake of digital technologies by manufacturers in the United States, Korea, and beyond.

Whether it's called "Industry 4.0," as in Europe, the "Industrial Internet of Things (IIoT)," as in the United States, or simply "smart manufacturing," information and communication technology (ICT) is in the midst of reshaping modern manufacturing.[1] This digitalization of manufacturing will transform virtually every facet of modern manufacturing, from how products are researched, designed, fabricated and produced, distributed, and consumed to how manufacturing supply chains integrate and factory floors operate.[2] But it's still early days in the smart manufacturing revolution: for instance, 77 percent of small U.S. manufacturers still lack plans to implement Internet of Things applications over the next three years. This report examines the extent of smart manufacturing adoption by U.S. manufacturers and offers policy recommendations to increase smart manufacturing penetration in the United States, Korea, and beyond.

Smart manufacturing enables manufacturers to converge the physical and digital worlds, combining sophisticated hardware with innovative software, sensors, connectivity, and massive amounts of data and analytics to produce smarter products, more efficient processes, and more closely linked customers, suppliers, and manufacturers.[3] The digitalization of modern manufacturing holds the potential not only to restore once-robust manufacturing productivity growth, but also to reshape the landscape of global manufacturing, bolstering the competitiveness of the most innovative and most rapidly technology-adopting companies while eroding the advantage of enterprises—and nations

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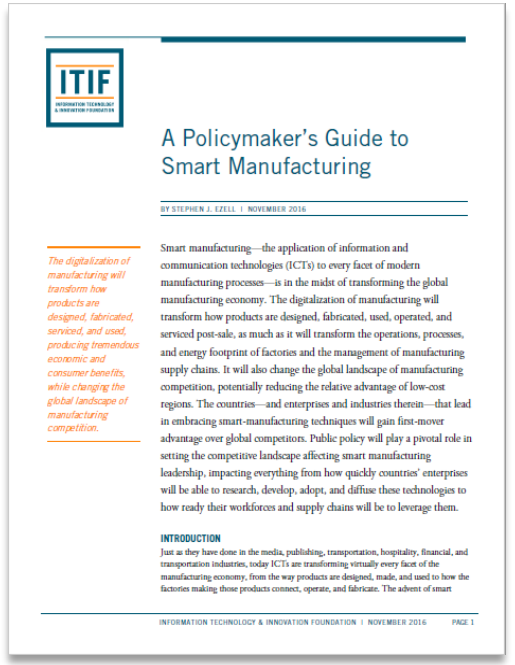

A Policymaker's Guide to Smart Manufacturing

BY STEPHEN J. EZELL | NOVEMBER 2016

The digitalization of manufacturing will transform how products are designed, fabricated, serviced, and used, producing tremendous economic and consumer benefits, while changing the global landscape of manufacturing competition.

Smart manufacturing—the application of information and communication technologies (ICTs) to every facet of modern manufacturing processes—is in the midst of transforming the global manufacturing economy. The digitalization of manufacturing will transform how products are designed, fabricated, used, operated, and serviced post-sale, as much as it will transform the operations, processes, and energy footprint of factories and the management of manufacturing supply chains. It will also change the global landscape of manufacturing competition, potentially reducing the relative advantage of low-cost regions. The countries—and enterprises and industries therein—that lead in embracing smart-manufacturing techniques will gain first-mover advantage over global competitors. Public policy will play a pivotal role in setting the competitive landscape affecting smart manufacturing leadership, impacting everything from how quickly countries' enterprises will be able to research, develop, adopt, and diffuse these technologies to how ready their workforces and supply chains will be to leverage them.

INTRODUCTION

Just as they have done in the media, publishing, transportation, hospitality, financial, and transportation industries, today ICTs are transforming virtually every facet of the manufacturing economy, from the way products are designed, made, and used to how the factories making those products connect, operate, and fabricate. The advent of smart

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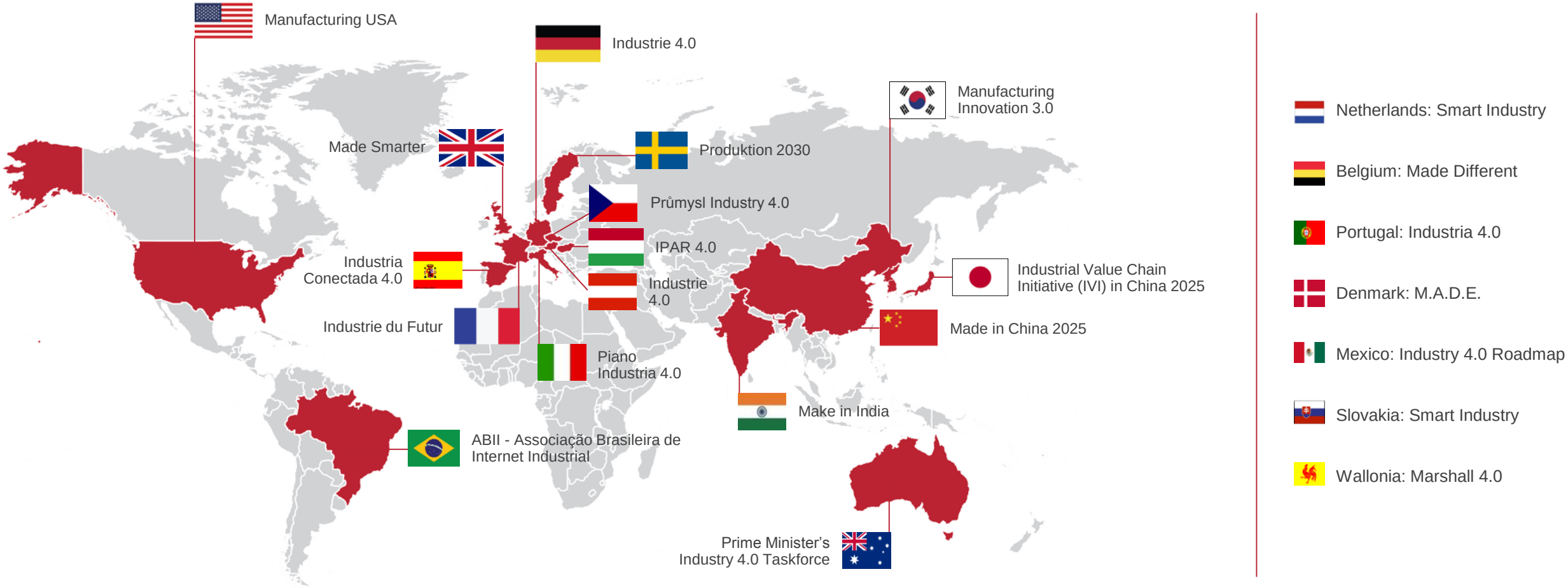
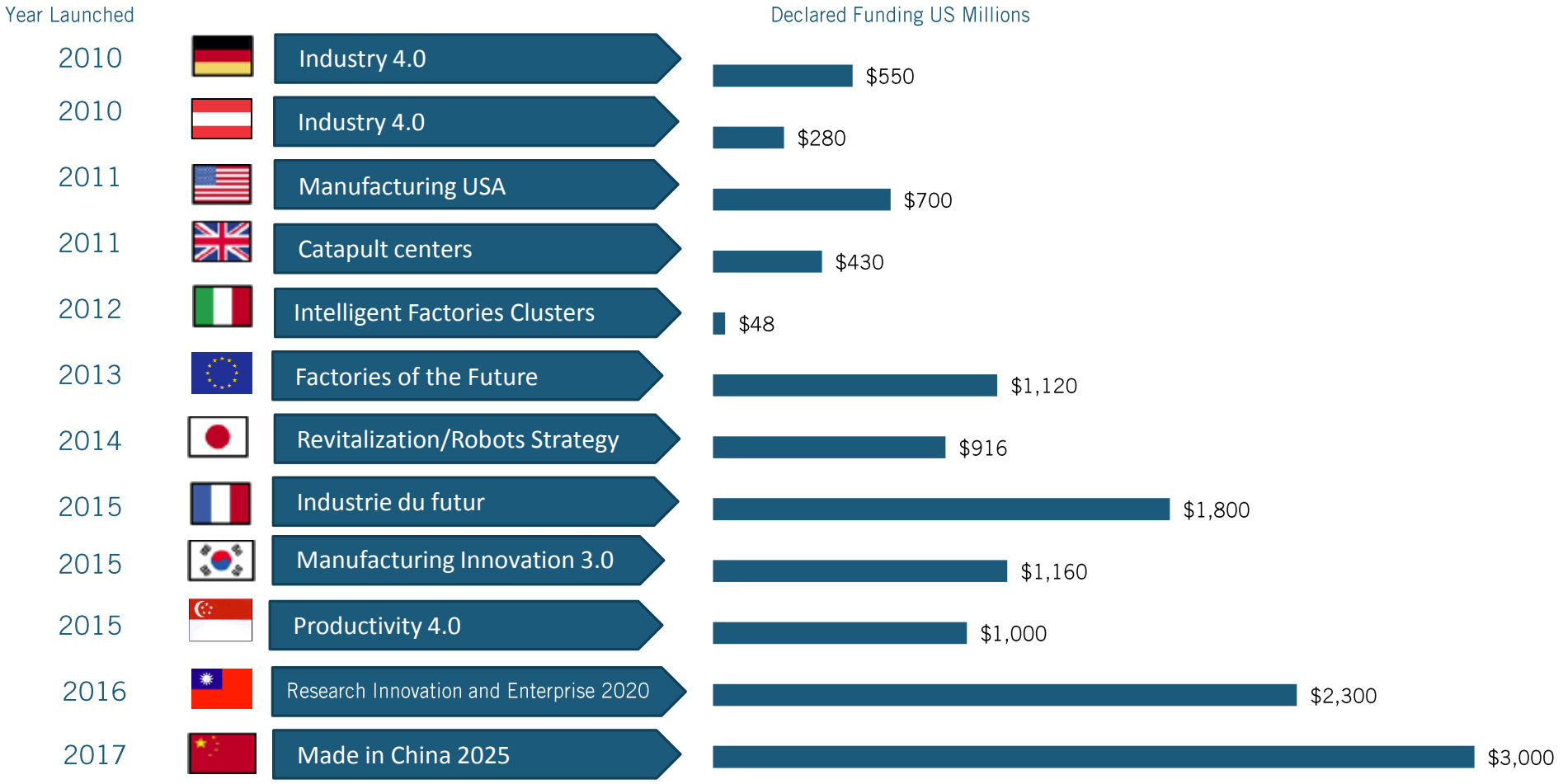
Manufacturing Digitalization Becoming a Priority Worldwide



Courtesy: Dave Vasko, Rockwell Automation

Countries Aggressively Implementing Policies to Achieve Digital Manufacturing Leadership



Source: Roland Berger; ITIF Analysis

Top 5 Things Countries' "Industry 4.0" Policies Are Doing

1. **Recognizing that effective public/private partnerships are critical if countries, or U.S. states, are to take advantage of the digital manufacturing revolution.**
2. Developing "Digital Manufacturing Maturity Indices" and providing "Self-Benchmarking Assessment Tools" (including cybersecurity) for SMEs.
3. Inventorying and describing discrete, specific manufacturing digitalization use cases and processes. (E.g., Germany has documented over 300 specific use cases/sample instantiations of SME manufacturing digitalization).
4. Launching "pilot fabs" that demonstrate smart manufacturing techniques on active production lines. (Germany/Austria/Japan/Korea/U.S./Iowa)
5. Providing financial support ($ and tax credits) for manufacturing digitalization and helping industry address manufacturing workforce challenges.

Iowa Already Taking Many Proactive Steps

- ✓ Articulating an advanced manufacturing strategy for the state.
- ✓ Launching a Digital Manufacturing Deployment Facility.
- ✓ Developing a customized manufacturing digitalization readiness assessment instrument for Iowa's manufacturers.
- ✓ Coordinating a statewide additive manufacturing awareness strategy.
- ✓ Facilitating networking and peer-to-peer learning among Iowa companies.

Manufacturing Digitalization Policy Considerations

- Complement goal of raising Iowa's manufacturing GSP output to $32B by 2022 with goal of increasing sector's productivity by a comparable percent.
- Launch a robotics/artificial intelligence awareness initiative with similar magnitude as additive manufacturing awareness initiative.
- Develop and socialize sector-specific use cases and success stories from companies that have been through the mfg. digitalization journey.
- Match investment Iowa SMEs make to become Tier 3 MxD members ($500).
- Include in biennial CIRAS survey questions on Iowa manufacturers' adoption of key digital manufacturing applications.

Manufacturing Digitalization Policy Considerations

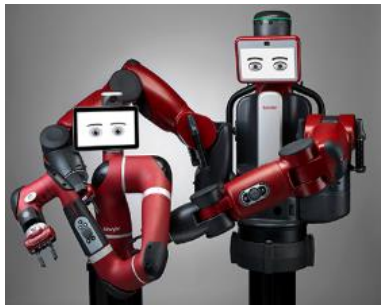
- Consider establishing a 401(k) program for Iowa SME manufacturers.
  - E.g., CT program allows manufacturers to set aside up to $1M in tax-deferred accounts with funds only withdrawable to support expenditures for workforce training, R&D, or capital equipment investments.
- Consider creating an "SME Manufacturing Digitalization Fund"
  - Repayable grants/loans to encourage upfront investment in digital technologies.

Manufacturing Digitalization Policy Considerations

- Consider implementing innovation vouchers for small businesses.
  - Grants provided to SMEs enabling them to purchase new capital equipment, or the expertise needed to develop a new product or process.
  - Connecticut, New Mexico, Rhode Island, Tennessee using vouchers.
  - In most states, a matched program where companies cover 50% of costs but can apply for a voucher of up to $50,000
  - Studies in countries like Austria/Holland have found 80% additionality.

Manufacturing Digitalization Policy Considerations

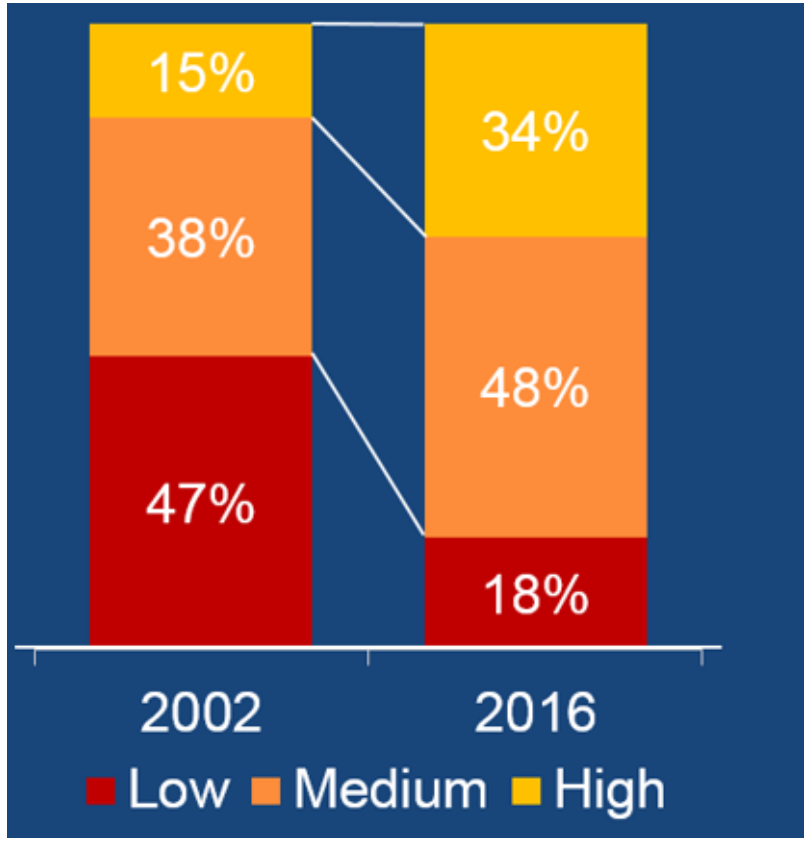
- South Dakota MEP's **Automation Lab** in Sioux Falls mitigates risk in acquiring new technologies by housing on-site cobots and providing a beta test environment for specific applications.
- **This year, SD's MEP began a state-wide roadshow going into the field to demonstrate how rural manufacturers could effectively deploy cobots.**
- In April, NCDMM, America Makes, and Catalyst Connection launched AMNOW, which seeks to insert additive manufacturing technology into the U.S. Army supply chains.
- **Funds are available to train SMEs involved in Army supply chains on additive manufacturing implementations.**



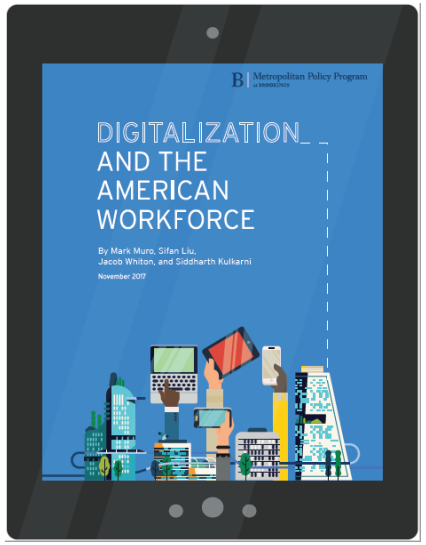
Sources: South Dakota Manufacturing and Technology Connections, https://www.sdmanufacturing.com/services/automation/; NCDMM and Catalyst Connection Announce AMNOW Program to Support Additive Manufacturing Technology Insertion into the U.S. Army Supply Chain

Manufacturing Jobs Increasingly Demand Digital Skills

Employment in Advanced Manufacturing by Digital Skill Level



"82% of U.S. manufacturing jobs require a medium to high digital skill level today."

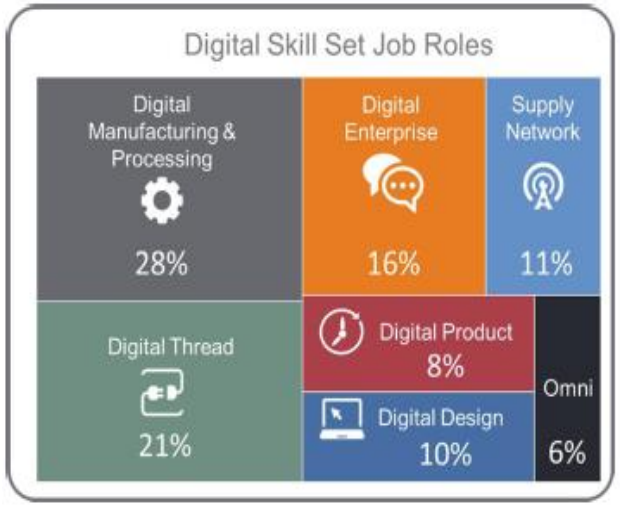


Source: Mark Muro, Sifan Liu, Jacob Whiton, and Siddharth Kulkarni, Brookings Metropolitan Policy Program, "Digitalization and the American Workforce"

Public/Private Initiatives Tackling Mfg. Skills Challenges

- SME's "Tooling U" MOOC provides 500+ manufacturing technology classes online.
- MxD's "Digital Manufacturing and Design Roles Taxonomy" identifies 165 distinct digital manufacturing and design roles. (Taxonomy 2.0 on cybersecurity coming.)
- For AI, the Microsoft AI Business School offers education for executives while a Professional Program offers certifications in data science and AI apps development.

TOOLINGU | sme



Source: MxD and Manpower Group, "The Digital Workforce Succession in Manufacturing"

Digital Manufacturing Workforce Ideas

- Task Iowa community colleges with developing a comprehensive digital manufacturing curriculum through two-year degree programs.
- E.g., Motlow State Automation and Robotics Training Center (ARTCm) in Tennessee.
  - Facility includes six teaching labs with industrial robots from major vendors.
  - Offers robotics industry-recognized training credentials/certificates and robotics degrees programs such as Mechatronics degrees with a concentration in robotics.
  - Collaborative effort co-funded by TN gov., local industry, and philanthropic supporters.

Sources: ITIF, "How to Reform Worker-Training and Adjustment Assistance Policies for an Era of Technological Change"
The College System of Tennessee, "Motlow State Automation & Robotics Training Center now open for business"

Digital Manufacturing Workforce Ideas

- Consider waiving tuition for students at state universities studying STEM subjects with a manufacturing focus (E.g., Illinois.)

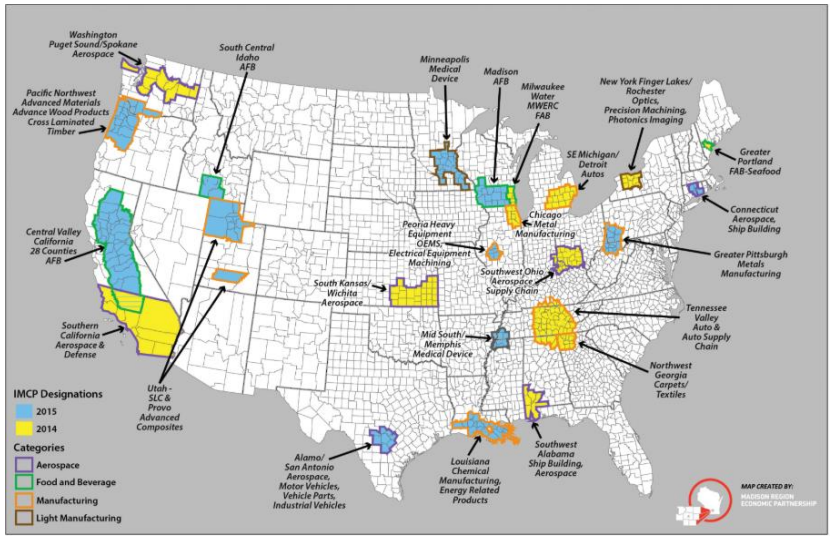
- Ohio has created mobile training units providing on-site training, reimbursing employers up to $4,000 or 50% of eligible training costs.

- Wisconsin's Industrial Manufacturing Technician (IMT) is a skilled manufacturing technician apprenticeship program delivering a combination of on-the-job learning and classroom training being expanded across 8 states.

Additional Policy Considerations

- The Investing in Manufacturing Communities Partnership (IMCP) program helped 24 communities comprehensively map regional mfg. stakeholders and SWOTs.
- FY 2019 NDAA provided $20 million for a Defense Manufacturing Communities Support Program (DMCSP) initiative.
- Iowa should consider applying to DMSCP.

U.S. IMCP Communities Map



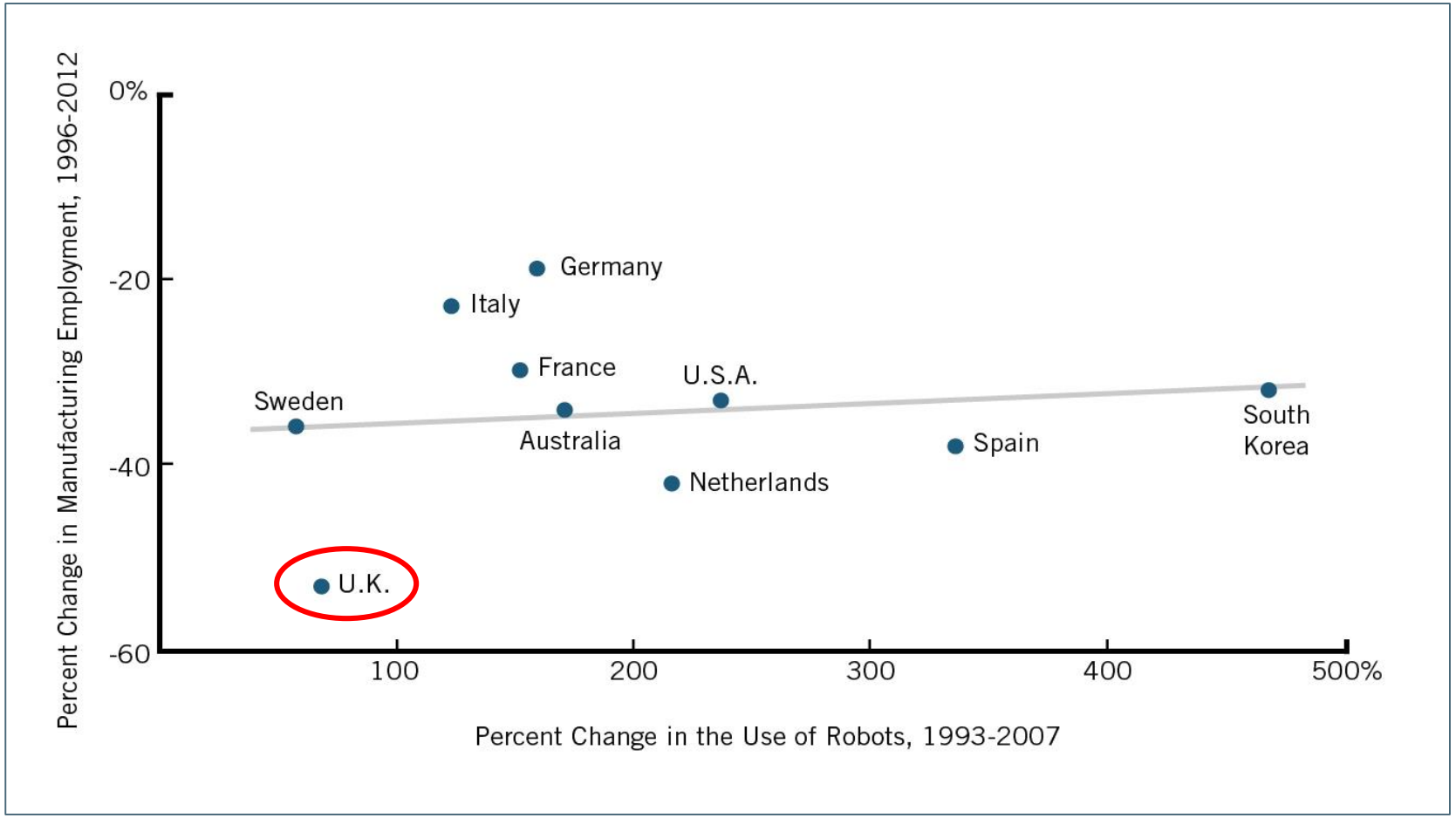
Sources: Stephen Ezell, "New 'Manufacturing Communities Act' Would Spur Broad Manufacturing Renewal"; Andy Stettner, "What Is the Defense Manufacturing Communities Support Program?"

Additional Policy Considerations

- Encourage Iowa universities to apply for a Manufacturing Engineering Education Grant (MEEG) program grant.
  - Provides funds for universities that reimagine approaches to engineering education with more alignment to industrial needs.
- Expand industrial retention efforts: For instance, Pennsylvania uses 13 indicators (esp. wage and tax data) to identify struggling manufacturers and proactively reach out with assistance programs, such as MEP.

Source: "ASME Congressional Briefing Highlights the DOD's Manufacturing Engineering Education Grant Program"

Don’t Fear Job Loss from Digital Manufacturing



Source: George Graetz and Guy Michaels, “Robots at Work”; Muro and Andes, “Robots Seem to Be Improving Productivity, Not Costing Jobs”

Thank You!

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