How Digitalization Is Transforming Modern Manufacturing and Implications for Iowa

Iowa Innovation Council

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About ITIF

- 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
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.

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.

“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"
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
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

Business value
- Resource productivity and efficiency
- Speed to market
- Customization to individual customer needs
- Agility to changing customer needs
- Value opportunity through new services

Levers
- Product Conception & Evaluation (From 10 to 5 weeks)
- Product Design & Prototyping (From 29 to 19 wk)
- Product Sourcing & Manufacturing (From 12 to 6 wk)
- Overall speed improvement (30 wk)

Time to market impact potential
- 40% improvement
- 51 wk

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 Institute, “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

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 Becoming a Priority Worldwide

Netherlands: Smart Industry
Belgium: Made Different
Portugal: Industria 4.0
Denmark: M.A.D.E.
Mexico: Industry 4.0 Roadmap
Slovakia: Smart Industry
Wallonia: Marshall 4.0

Manufacturing USA
Made Smarter
Industria Conectada 4.0
Industrie du Futur
ABII - Associação Brasileira de Internet Industrial
Prime Minister’s Industry 4.0 Taskforce

Manufacturing Innovation 3.0
Industrial Value Chain Initiative (IVI) in China 2025
Made in China 2025
Made in India

Courtesy: Dave Vasko, Rockwell Automation
Countries Aggressively Implementing Policies to Achieve Digital Manufacturing Leadership

<table>
<thead>
<tr>
<th>Year Launched</th>
<th>Program</th>
<th>Declared Funding US Millions</th>
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<tr>
<td>2010</td>
<td>Industry 4.0</td>
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<tr>
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<td>2017</td>
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</table>

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% addionality.
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

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

Employment in Advanced Manufacturing by Digital Skill Level

- 2002
  - Low: 47%
  - Medium: 38%
  - High: 15%

- 2016
  - Low: 18%
  - Medium: 48%
  - High: 34%

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.

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 DMCSP.

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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