Digital Manufacturing Testbed: Rationale and Launch Overview

January 21, 2019

M. Ursem

N-MaC

PURDUE UNIVERSITY College of Engineering

PURDUE UNIVERSITY Polytechnic Institute

Digital Manufacturing Testbed: Rationale

"Manufacturers Need to Adopt Innovative Ways to do More with Less"

Barriers

- ***Complexity*** to Integrate Across Digital Platforms
  - Product Requirements
  - Product Design
  - Process Design
  - Supply Chain (tracking + fulfillment)
  - Service and Sustainment
- ***Sunk Cost*** Trap (technical capacity of installed assets)
- ***Skill Gap*** (technical & human)

Causes

- Technical Knowledge
  - In-House Know How
- ***Adoption Risk*** / Aversion
  - Technologies + Methods
- ***Time*** (staff and production)
- ***Business Case*** to Invest
  - Captive Asset Base
  - Reference (benefits/cost)
- Trusted, ***Non-Biased Advice***

Effects

- ***Long Lead Time***
- Production Inefficiencies
- ***Sub-Optimal Supply Chain***
- ***Added Steps***, Lost Time
- ***Erosion of Competitiveness***
  - Individual Companies
  - Supply Chains
  - Communities
- ***Intellectual Property Risks***

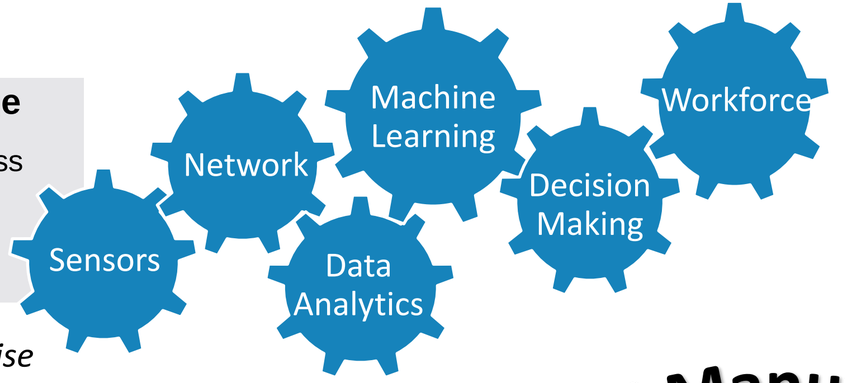
Remedies

- **Comprehensive** Engineering, Manufacturing and Supply Chain **Proving Ground**
- Leadership in ***Discovery***
  - Collaborative Environment
  - Accessible Space
- Validate and ***Demonstrate***
  - Proof-of-Concept / Pilot
  - High TRL, Adoption Ready
- ***Disseminate*** Knowledge
  - In-House and On-Site

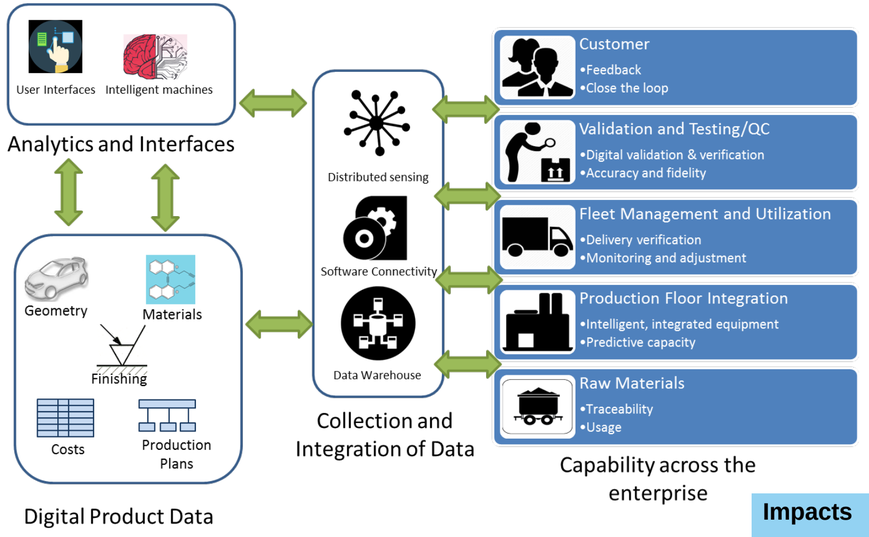
Smart Manufacturing Proving Ground

Address Challenges for Sustaining Competitive Advantage

- Quality, Due Date Precision, Production Cost and Yield, Responsiveness
- Unscheduled Downtime, Cost / Resource Control
- Supply Chain Efficiency, Risk Mitigation, Workforce Readiness



"Optimize digital information flow between and across the enterprise to accelerate the transition to Industry 4.0"



Impacts

- More Modern, More Capable Manufacturers and Supply Chain
- Stronger Workforce, More Attractive Industry and Communities

Discover

- Controlled, Integrative Enterprise Platform
- Overcome Barriers to Digital Information Connectivity
- Generate Preliminary Data for Federal Grants
- Develop Content for Demonstration Showcase and Education Programs

Disseminate

- Product and Process R&D
- Robust Digital Enterprise Connectivity
- Next-Generation Workforce Development
- Active Translation Service, with MEP
- Support Innovation and Industry Growth

Demonstrate

- Showcase New Methods, the "Art of the Possible"
- Validate Smart Technologies and Applications
- Modernize Manufacturers and their Supply Chain

M. Ursem
purdue.edu/in-mac

N-MaC

Facets of Success and Launch Overview

- Cross-Cutting Physical and Cyber-Physical Assets
- Adaptable, Flexible Configurations

Infrastructure

- Discover & Demonstrate (Technologies and Methods)
- Workshops + Technical Services
- Innovation and Prototyping Services

Activities

Prepare Manufacturers and their Workforce to:

- **Address Digital Information and Connectivity Barriers**
  - Evaluate Architectures, Tools, Methods and Costs to Optimize Approach
- **Receive + Automatically Translate** Digital Product Specifications and Design Systems into Machine Instructions
- Provide Customers **Real-Time Production Status** and **Quality Trends** During Fulfillment
- Automatically Monitor **Input Costs** and Workflow
- Anticipate and **Mitigate Unplanned Downtime**
- Leverage Digital Technologies to **Human-Proof Processes**
- Automatically Monitor **Supply Chain**

Digital Manufacturing Enterprise Testbed

Additional Benefits:

- **Improve New Product Introduction Time**
  - Improve Accuracy and Decision-Making, Minimize Human Intervention
- **Tighten Relationships** with Customers and Suppliers
- **Reduce Lead Times** from Product Conception to Production
- **Reduce** Cost of Documentation and Compliance
- **Optimize Product Execution** (on-time and on-cost)
- **Reduce Operating Costs** (nimbleness to optimize asset utilization and delivery times)
- Improve **Product Quality** and **Process Uniformity**

Outreach

- Succeed in Partnership with Local, State, Regional and Industry Participation

Sustainment

- Accessible, Collaborative Space (public/private)
- Links to Indiana Colleges and Universities
- Bridge into Leading Institutes

Scope of Industry and Regional Engagement

Technical Leadership Centers:

- Manufacturing Design Lab (MD Lab)
- Digital Enterprise Center (formerly PLM Center)
- Dauch Center for the Management of Manufacturing Enterprises (DCMME)
- Composites Manufacturing and Simulations Center (CMSC)
- Purdue Discovery Park (>25 Centers and Institutes, dozens of members)

Innovation Accelerators:

- Purdue Research Park (Innovation and Entrepreneurship Hubs)
- Purdue Aerospace District and WestGate at Crane NSWC
- Purdue Foundry and Elevate Ventures

Regional Initiatives and Workforce Development:

- Wabash Heartland Innovation Network (WHIN)
  - 200 Manufacturers in 10-county region, backed by $40M grant
- Leader in Advancing Smart Manufacturing Competencies and Pathways
  - Thousands of K-12 participants in programs and activities
  - Dozens of School Districts and Educators

Infrastructure Overview

2018

- Benchmark other Testbed models
- Interview Dozens of Manufacturers
- Design and Plan Core Building Site
  - University Design Review, with PPI "Smart and Connected Factory"
  - Alternate, Low-Cost, Rapid Option
  - IMI Final Design, Registration, Bid

2019

- **MD Lab**, 30-January 2019 Opening
- Expansion Project Q1-Q2
  - Launch June (est)
- Further Expand Capabilities, Q3-Q4+
- First Workshop, Q4 2019 (~October)

Physical Capabilities

- Composite Materials and Forming
- Subtractive Machining
- Automation, Sub Assembly and Final Assembly
- Metrology
- Adaptable Configurations and Work Environments
- Material Flows: Work in Process and Warehousing
- Rapid Product + Process Development, Prototyping
- Supply Chain Integration

Award Construction Contract (expansion)

Procure Major Equipment + Systems

Occupancy (expansion)

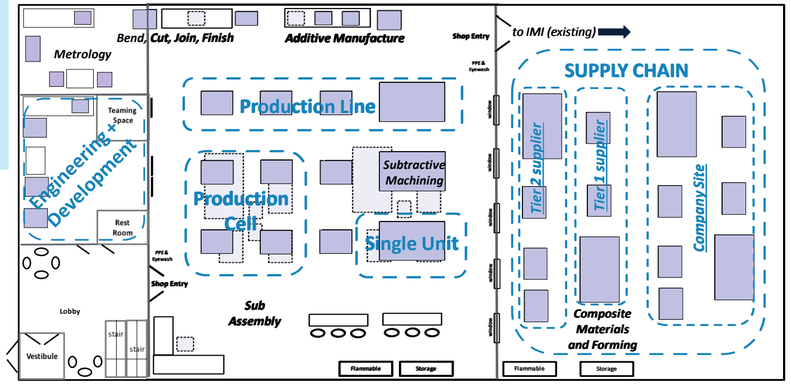
Public Workshop

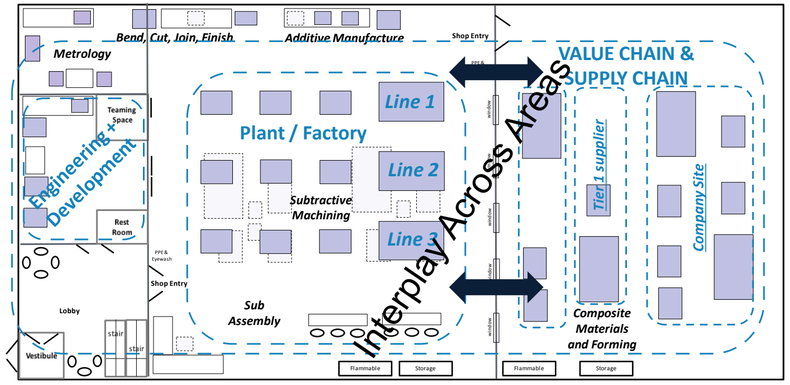
Jan '19	Feb '19	Mar '19	Apr '19	May '19	Jun '19	Jul '19	Aug '19	Sep '19	Oct '19

Infrastructure Highlights

- Jan: **COMPOSITES MATERIALS and FORMING** (MD Lab), **to launch 30-January 2019**
  - Construction Bids (receive); Fully Launch Expansion Project
  - SITE NECESSITIES INCLUDE: Integrative MES, Subtractive Tooling (basic), Assembly Area, Metrology (basic), Rapid Prototype (basic)
- Feb – Mar: Finalize Scope and Specifications for Equipment
- Apr – May: Finish Install
- Jun – Jul: Occupy + Commission

Adaptable Configurations





Recap

Digital Manufacturing Testbed: Will Address

Trends

- Industry 4.0
  - Automation and Data Exchange
  - Integration of Physical and Cyberphysical
  - Ubiquitous Interconnectivity
- Internet of Things
  - Sensors, Platforms, Architecture
  - Prevalence of Low-Cost Information
  - Analytics → Insights
- Big Data and Deep Analytics
  - Manage and Leverage Information

Value Drivers

- Core Capabilities
  - Production Agility
  - Workforce Competence
  - Equipment Maintenance
- Competitiveness
  - Production Cost & Yield
  - Quality Assurance
  - Due Date Precision

Industry Needs

- Operational Performance (line, plant)
  - Timely, In-Shift Information
    - Cycle time, Flow / Throughput, Delivery
  - Adaptability, Resilience
    - Fulfillment, Change Orders, Job Changes
  - Human Factors
- Quality and Acceptance
- Leverage Information (enterprise)
  - Accessible Insights “eliminate paper”
  - Fiscal Control
    - Inventory, Spare Parts, Shipping, Receiving
    - Cost Accounting (materials/methods, labor, utilities)

Testbed Use Case

"Optimize digital information flow between across the enterprise to accelerate the transition to Industry 4.0"

Objective

Develop Knowledge

Demonstration

User Goal (why? / how?)

Component Design and Manufacture	Systems Design: Scale for Efficiency & Speed	Supply Chain: End to End Enterprise	Optimize Quality and Productivity	Workforce Development
Sub-Function (what)				
Validate	**Prototype + Develop**	**Product Lifecycle Management**	**Operations Mgmt., Distribution, Logistics**	**Short Courses (seminars, badges, certificates, CEUs)**
Testbed Capabilities (examples)				
• PHYSICAL | metrology (contact + non-contact), characterization, disassembly • DIGITAL | compare model to actual • COST MODELING | materials selection, manufacturing methods	• MATERIALS SELECTION • COMPONENT SIMULATION • DESIGN for MANUFACTURE • MANUFACTURING METHOD • BETA TESTING, PILOT RUNS • TECHNICAL REFINEMENT • OPERATIONS + MAINTENANCE	• APPLICATION of DIGITAL TWIN | optimal interoperability throughout enterprise • PRODUCT DEFINITION | 3D model, manufacturing variability • DATA INTEGRITY | ubiquity, secure / appropriate access, computational efficiency	• DATA ACQUISITION + SENSORS • INFORMATION MANAGEMENT | AI, IoT, deep learning • PREDICTIVE MAINTENANCE • ENTERPRISE STATILITY & CYBERSECURITY | line, plant (boundary layer / edge), supply chain, value chain, global net	• PRODUCT LIFECYCLE MANAGEMENT METHODOLOGY • INDUSTRY 4.0 | methods, architecture, systems integration • INDUSTRIAL ENGINEERING • IoT APPLICATIONS / CODING • LEVERAGING IoT and BIG DATA (mechatronics, maintenance, operations management)

M. Ursem
purdue.edu/in-mac

IN-MaC

BACKUP

PURDUE FORT WAYNE

PURDUE UNIVERSITY

Krannert School of Management

PURDUE POLYTECHNIC SOUTH BEND

PURDUE UNIVERSITY NORTHWEST

MADE IN INDIANA – PURDUE UNIVERSITY MEP

ENGAGE PURDUE

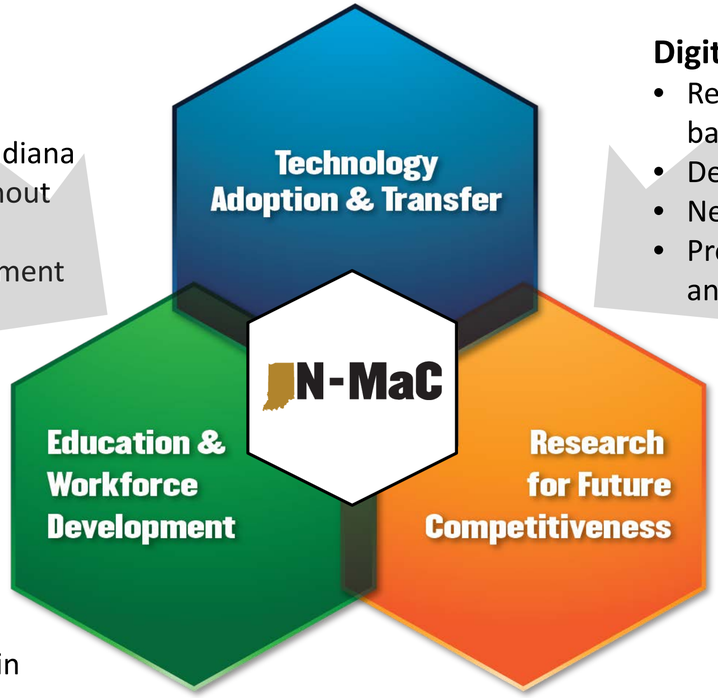
PURDUE UNIVERSITY Discovery Park

PLM PURDUE CENTER

CMTC Composites Manufacturing & Simulation Center

DAUCH CENTER FOR THE MANAGEMENT OF MANUFACTURING ENTERPRISES – CMME

- Expertise to address chronic manufacturing challenges
- Outreach to stakeholders across Indiana
- Deliver technical solutions throughout Indiana, in partnership with MEP
- Lead portal for workforce development and research



Digital Manufacturing Enterprise Testbed

- Research to address digital information connectivity barriers to overcome chronic Industry challenges
- Demonstration of new technologies
- Next generation workforce development
- Product scaling expertise and capacity for Indiana start-ups and growing enterprises

WHIN – Wabash Heartland Innovation Network

PURDUE RESEARCH FOUNDATION

PURDUE UNIVERSITY College of Engineering

PURDUE UNIVERSITY Polytechnic Institute

PURDUE UNIVERSITY Polytechnic Institute

CAREERMAKERS™

- Incumbent workforce education
- Manufacturing talent pipeline , K-16
- Accessible, interconnected college to university pathways
- Courses and instructional development in areas of present and emerging demand
- Partnership with professional societies

- Research consortia with Indiana manufacturers
- Develop methods and tools to solve imperative manufacturing challenges
- Dissemination channels for technology solutions and education programs
- Lead portal from Industry for technical support, workforce development and research

Leverage Institutional Strengths to Build a Stronger, More Capable Manufacturing Ecosystem

M. Ursem
purdue.edu/in-mac

N-MaC