



AMMTO Peer Review

Accelerating the
Democratization of Smart Manufacturing



2023 May 17

Driving the **next wave** of manufacturing productivity, energy productivity and competitiveness through smart manufacturing innovation.



2017

Founded by the
D.O.E



\$140M+

Private/public
partnership



Improve energy productivity
through sensing, control,
modeling, analytics &
platform technologies

How.

Fund the Innovation and R&D necessary to **dramatically** reduce the **cost & complexity** of using **real time operations data** to drive **revenue & cost improvements** and **generate cash**.

CESMII represents the **voice of manufacturing**; engaging the smart manufacturing ecosystem through a membership model



Manufacturers

Small, Medium & Large



**System Integrators
& Consultants**



**Machine
Builders**



**Technology
Providers**



**Academia
& Labs**

CESMII's Integrated Roadmap Pillars



SM ECOSYSTEM INTEGRATION

- Unite ecosystem in innovative collaboration
- Develop ambassadors for SM value and principles
- Leverage a national network of innovation centers



SM EDUCATION

- SM principles and practices
- Build and sustain SM skills
- SM platform and tech training
- Educator resources



SM ENABLING TECHNOLOGIES

- Collaborative R&D
- Develop key technologies
- Robust and configurable
- Integration into SM system

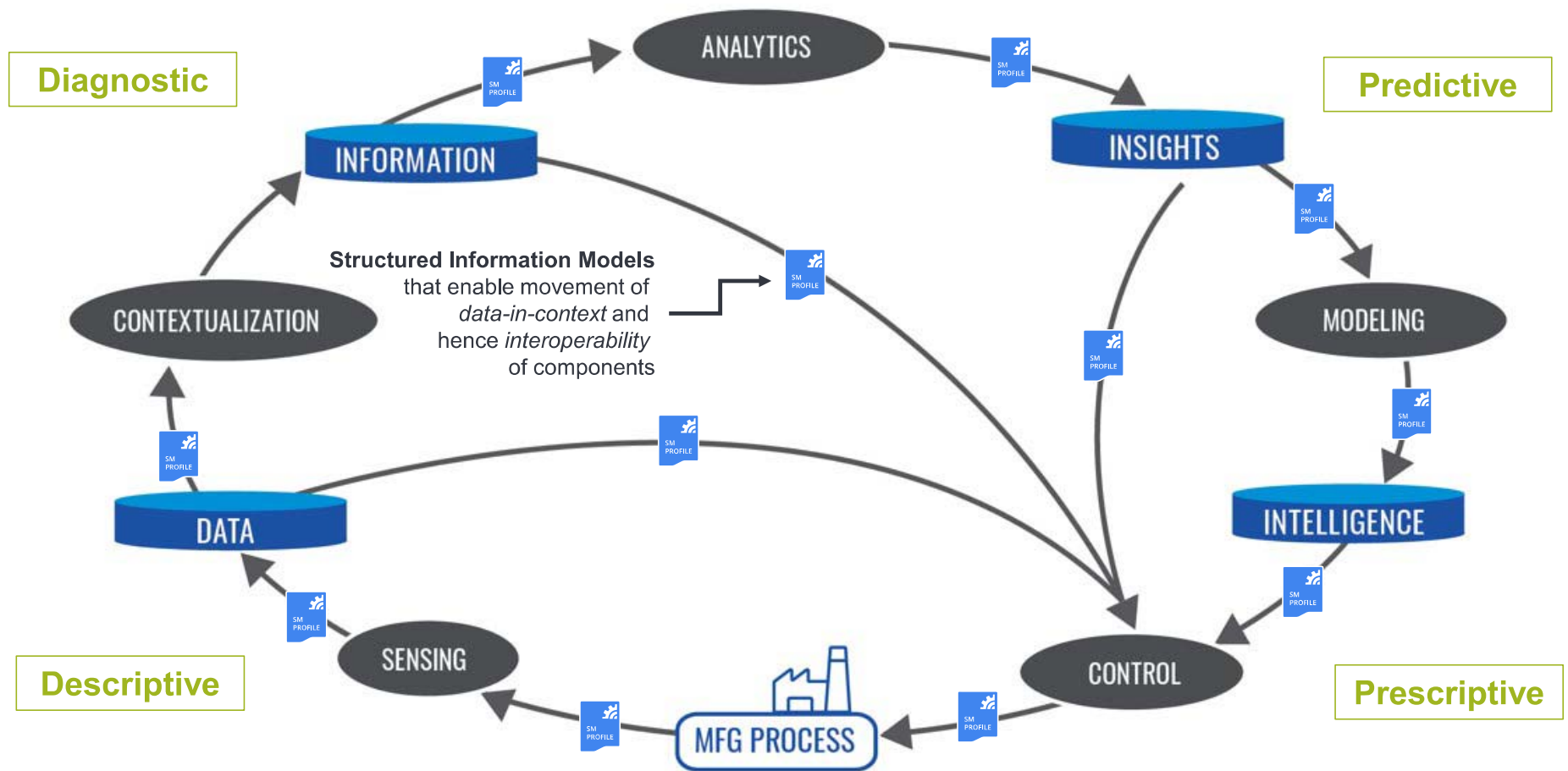


SM INNOVATION PLATFORM

- Platform and Marketplace
- Enable reuse of technologies
- Secure, flexible, scalable
- Cost effective deployment

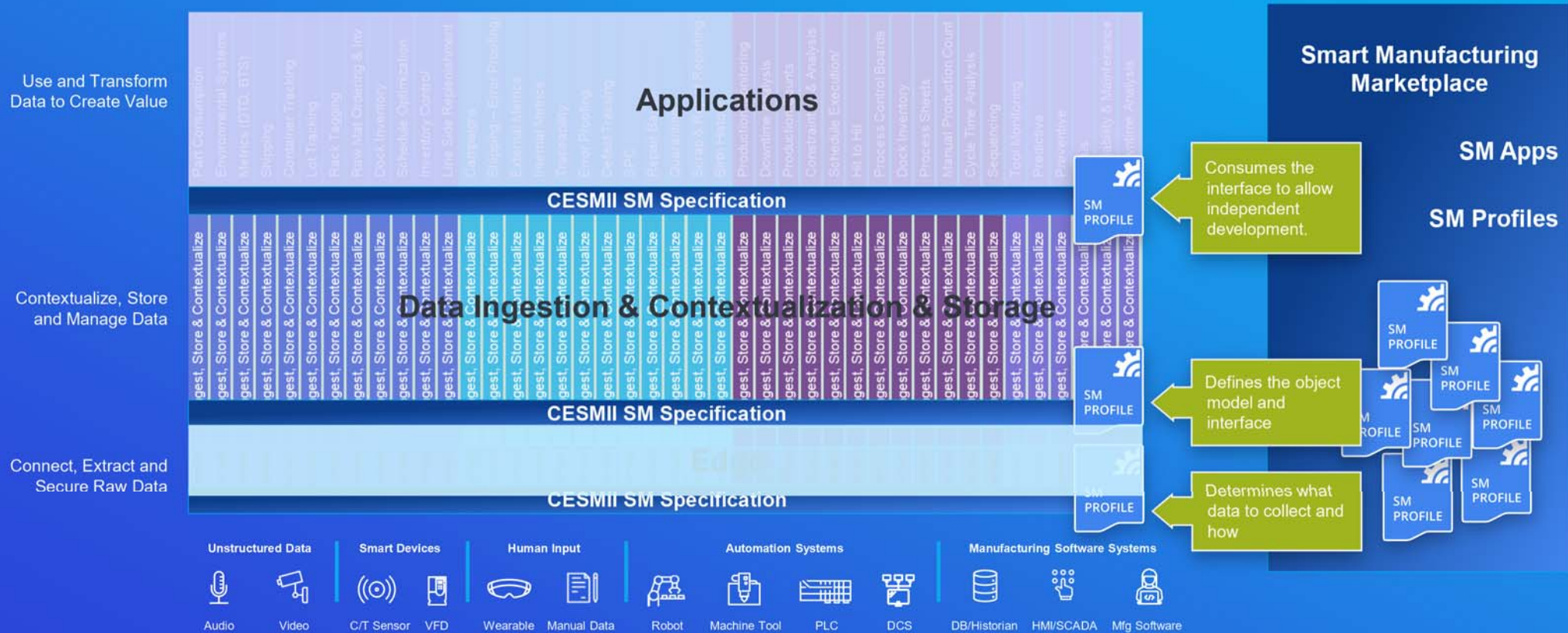


SM Technology Building Blocks and Information Flow



A Sustainable and Future-Proof Strategy for SM

Interoperability Demands an Information Model-Driven Architecture



Smart Manufacturing Roadmap Tools

The CESMII Acceleration Framework helps you establish a strategic and tactical roadmap specific to your business.

SM Acceleration Framework



This is your no-cost starting point.

Complete this assessment to gain better insight into your operations identify areas for improvement.

START HERE

Source: CESMII – The Smart Manufacturing Institute, www.cesmii.org



SM Learning System - Hardware Kit

SM Edge

- Windows
- Linux
- Comms Drivers

PLC

- Allen Bradley
- Phoenix Contact
- Siemens

Applications

- Heater Element
- Motor with Vibration
- Weighing System (Weight, Part Count, etc.)
- Current Measurement (Infer Asset Util, Quality, etc.)
- Historian (Plant Operations Data Store)
- HMI/SCADA Apps (Plant Ops Use Cases)

Sensor to SM Edge to Cloud

- Load Cell, Current Transformers, Temperature, Vibration, Humidity, Proximity, Potentiometer, Push Buttons, Selector Switches, Etc.

PLC to SM Edge to Cloud

- Load Cell, Current Transformers, Temperature, Vibration, Humidity, Proximity, Potentiometer, Push Buttons, Selector Switches, Etc.





An ecosystem of ~180 Collaborating Members



Excellence in Execution Strategy & Aligning with Our Metrics

- 1 15% improvement in energy efficiency in first-of-a-kind demonstrations at manufacturing plants or of major processes within 5 years
- 2 50% reduction in cost and time to deploy SM in existing processes within 5 years
- 3 Significant industry adoption of SM technology within 5 years
- 4 Sustainable portfolio of business, technology, research and development, and workforce development activities that directly replaces initial Federal funding within 6 years
- 5 50% improvement in energy productivity within 10 years
- 6 SM Workforce Capacity in the US will be Increased – 2X by 2020 & 5X by 2030

Focus on Industry Relevance and the Translatability/Re-Use of Project Outcomes for Many Other Manufacturers ● Primary Impact ● Secondary Impact

Create & Scale SM Capabilities

SM Enabling Technologies (ASCPM*)

ENABLING R&D PROJECTS

1 2 3 4 5 6



SM technology gaps: sensors, AI/ML, controls, modeling, 5G...

Advancing SM Technologies

PLATFORM & CAPABILITY PROJECTS

1 2 3 4 5 6



Develop core technologies: Innovation Platform, Profile Designer, Marketplace and tools

Advance SM Practices & Knowledge

EDUCATION & WORKFORCE DEVELOPMENT

1 2 3 4 5 6



Develop SM education content: train, equip & certify SM practitioners, citizen technologists...

Implement SM Capabilities

Implement & Validate SM Capabilities

SM INNOVATION PROJECTS

1 2 3 4 5 6



Implementation of SM innovations leveraging the SMIP, Profiles and Apps...

Pilot SM Technologies, Tools and Practices

APPLICATION PROJECTS

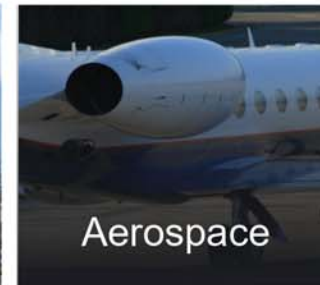
1 2 3 4 5 6



Free, pre-production use of CESMII capabilities for Proof-of-Concept development

*ASCPM = Advanced Sensors, Controls, Platform & Modelling for Manufacturing

Industries We Impact



Images Courtesy of Creative Commons

The CESMII Story

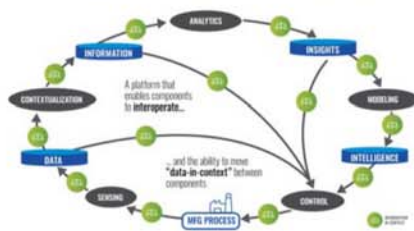
1

Develop SM technologies to solve manufacturing problems



SM Building Block Technologies

Energy Intensive Industries



10-25% reduction in energy for steel and cement industries

- ✓ Energy Productivity
- ✓ Quality, Yield, Waste
- ✓ Decarbonization



Smart Manufacturing Innovation Centers (Dissemination of Technology and Training)

2

Accelerate SM Adoption In SMMs and Supply Chain



SM Innovation Platform, Profiles, Marketplace

Small & Discrete Manufacturing



25-50% reduction in SM implementation costs

- ✓ Performance & Productivity
- ✓ Implementation Cost/Complexity
- ✓ SMM & Supply Chain Adoption

3

Upskill the Workforce Through Education, Training



SM Education and Training

Talent Pipeline & Incumbent Workforce



6 new curriculums, >6000 students and professionals trained

- ✓ Education & Training
- ✓ Upskilling
- ✓ SM adoption



Impacting Energy and Operational Performance Through Smart Manufacturing (SM) Technology, Innovation and Knowledge

SMMs

Food

Steel

Paper

Drying

Steel

Chemicals

Thermal

Grinding

Cement

Aerospace

Standards based *plug and play* infrastructure for interoperability and cost effective SM solution implementation



Energy Monitoring and Machine Learning Model for Energy Consumption in Food Industry leads to 5% reduction in energy costs, 25% relative improvement in yield



Structured Information Models (SIM Profiles) that enable movement of data in context and hence interoperability of components



Low cost hardware and reusable SIM Apps to help SMEs target 10% improvement in energy intensity and equipment efficiency on CNC, paint booth and welding machines

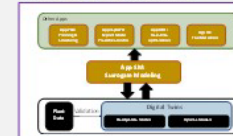


Digital Twin of a Steel Continuous Casting process predicts maintenance worth \$2M saving



Data analytics and anomaly detection leads to 5% improvement in yield and 2% decrease in energy consumption in powder based Additive Manufacturing

Reaction & Optimization Models for Air Separation Units (Chemical, Oil & Gas) leads to 10% reduction in energy consumption



Monitoring, modeling and control solutions optimizes thermal processes for aerospace composite parts, reducing energy use by 35%

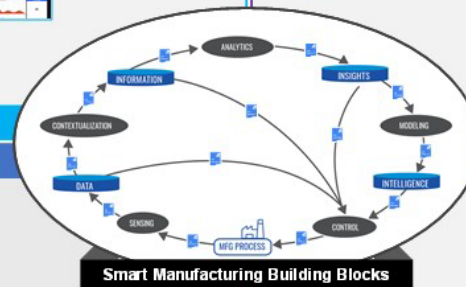


Model based process optimization results in ~30% energy reduction in wet granulation in Pharma



DIAGNOSTIC
DESCRIPTIVE

PREDICTIVE
PRESCRIPTIVE



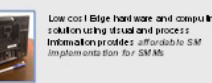
3D Displacement and Optical Strain Sensor for Steel Continuous Casting enables better performance and higher quality and quality potentially worth \$50M/yr



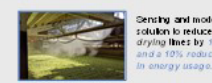
Off the shelf sensors, low cost gate way, visualization and analysis tool to optimize costing, improve performance for a small food manufacturer, reduces downtime and improves quality for nutrition bars



ML Based Soft Sensor for Enhanced Air Content in Brownstock Slushing (Pulp and Paper) reduces downtime by 25% and water usage by 10%



Low cost edge hardware and computing solution using cloud and process information profiles - affordable SM implementation for SMEs

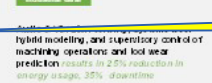


Sensing and modeling solution to reduce hop drying times by 14% and a 10% reduction in energy usage

Multi-physics predictive models and Advanced Controls lead to optimized operating conditions resulting in 10-15% reduction in energy usage in Cement Kilns



Hybrid predictive models reduce energy consumption per part by 37% for large industrial gear grinding operations



Hybrid modeling and supervisory control of machining operations and tool wear prediction results in 25% reduction in energy usage, 35% downtime



Water usage optimization and water usage in precipitation and dewatering stages for monodonal and bi-pharma process

SM Learning Kit with Co-located hardware and software, complemented by training modules to upskill the SMM workforce and leadership



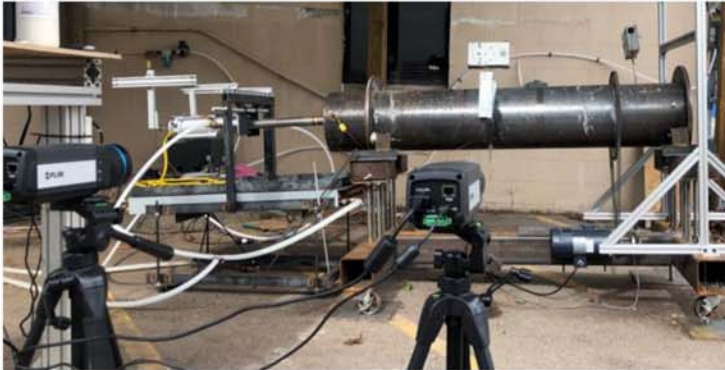
Public and industrial partners created an ABB awarded 4yr BB Digma program focused on SM technologies integrated with state-of-the-art facilities and industry grade equipment



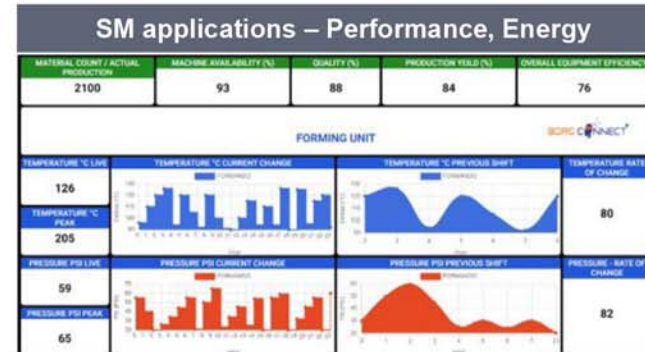
National Presence - Smart Manufacturing Innovation Centers: Grange Manufacturing & Supply Chains where they are - local presence, test beds, training...



Project Examples



Multi-physics predictive models and Advanced Controls lead to optimized operating conditions resulting in **10-15% reduction in energy usage** in **Cement Kilns**



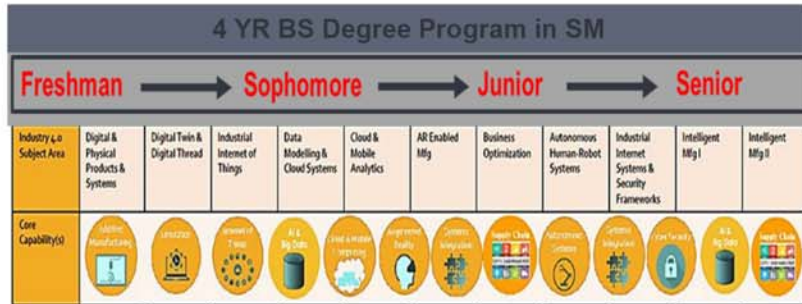
Low-cost, low-complexity Connectivity hub



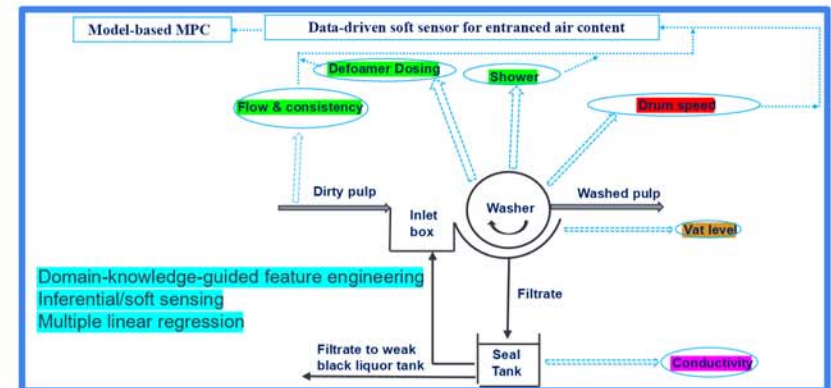
Low cost hardware and reusable SM Apps to help SMMs target **10% improvement in energy intensity** and equipment efficiency on **CNC, paint booth and welding machines**



Project Examples



Purdue and industrial partners created an **ABET accredited 4-yr BS Degree program** focused on SM technologies integrated with state-of-the-art facilities with industry grade equipment



ML Based Soft Sensor for Entrained Air Content in Browstock Washing (**Pulp and Paper**) reduced defoamer usage by **35%** and water usage by **10%**

National Reach through SM Innovation Centers

Enable SM access for small, medium, and large businesses, connecting manufacturing assets to our SM Innovation platform, national policy development, industry awareness, and workforce development.



UCLA

 **Rensselaer**

**NC STATE
UNIVERSITY**

 **feyen zylstra**
Industrial Tech Solutions

 **CASE
WESTERN
RESERVE
UNIVERSITY**

 **digital foundry**
AT NEW KENSINGTON

**PURDUE
UNIVERSITY**

Our Charter: The Smart Manufacturing Executive Council has been formed to engage business and technology executives, thought leaders and visionaries advocating for the transformation of the U.S. manufacturing ecosystem.

Our Objective: To develop practical guidance and policy recommendations that will help this ecosystem across this digital divide.

- Leverage admired Manufacturing Businesses, **demonstrating their leadership on this journey**, and showing others the way
- Inspire this ecosystem to evolve their strategies and business models to truly **support the democratization of manufacturing technologies** and ensure that SMMs can engage in Smart Manufacturing as well
- Provide guidance for each of the **8** stakeholder groups in our manufacturing ecosystem, helping them understand their role in this evolution, and **invest in the knowledge and skills** required for this transformation
- **Inform US policy makers** on the transformative actions and policies that will **accelerate US adoption** of Smart Manufacturing



LEARN MORE



Backup Slides

