September 2025

Strengthening the U.S.' Competitiveness Through **Smart Manufacturing**

CESMII
THE SMART MANUFACTURING INSTITUTE

mission. strategy. role.

Strengthening the U.S.' Competitiveness Through **Smart Manufacturing**

U.S. Department of ENERGY

2017

Founded by the D.O.E, a Program in **UCLA**

$200M+

Private/public partnership

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

How.

Drive and fund the Innovation and R&D necessary to **dramatically** reduce the **cost** & **complexity** of using **real time operations data,** enabling **revenue growth, cost improvements** and ultimately, **competitiveness.**

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

Manufacturers
Small, Medium & Large

System Integrators & Consultants

Machine Builders

Technology Providers

Academia & Labs

National Mandate to Strengthen the U.S.' Competitiveness Through Smart Manufacturing

CESMII
THE SMART MANUFACTURING INSTITUTE

Investing to reduce cost, complexity and time to deploy by 50%

Join This Community to…

- ✅ Facilitate Genuine Cultural Transformation and OT/IT Convergence
- ✅ Member-Directed Innovation and Research
- ✅ Position Your Organization for Significant, Long-term Productivity Growth
- ✅ Access the Smart Manufacturing Interoperability Platforms, Applications and Tools
- ✅ Participate in the Transformation of the Smart Manufacturing Ecosystem
- ✅ Understand Global and Regional Data Initiatives and Standardization Initiatives

210+ Members

LEARN MORE

An ecosystem of ~210 Collaborating Members

CESMII 1.0 Collaborative Accomplishments

A Smart Manufacturing Development Framework for Underserved Small Medium Manufacturers

Energy Efficient Cement Manufacturing

Smart Manufacturing Skills Ladder for Undergraduates and Incumbent Workers

Augmented Reality Platform for Smart Manufacturing of Wind Turbines

Strip Break Classification in Tandem Cold Rolling of Steel using Time Series AI

Utilizing the CESMII SMIP to Optimize Product Quality for Mixer-Filler Systems in the Food Industry

Smart Thermal Processing

Self-Powered Sensing and Data Science for Smart Manufacturing

Hybrid Modeling for Energy Efficient CNC Grinding

Scalable Smart Manufacturing Workforce Development Community Model with VR/Digital Twin Technology

Smart Manufacturing for Chemical Processing: Energy Efficient Operation of Separation Unit

Smart Manufacturing of Cement

Smart Manufacturing Workforce Development Model

Energy Management Systems for Subtractive and Additive Precision Manufacturing

Bayesian Dropout Approximation of Process Outcomes

Smart Warehouse with Augmented Reality

Supply Chain Optimization

Reduction of Energy Consumption in Brewing Hop Drying Using Smart Manufacturing

Smart Manufacturing Platform – Smart App Infrastructure

Packaged SMIP Smart Connector for Ectron Computers

From Manual Operations to the Cloud: Using Smart Manufacturing Technologies to Enable Small Manufactur

Data Modeling for Smart Aerospace Additive Manufacturing

Energy Efficient Material Processing Through Automated Process Monitoring and Controls

Operational Efficiencies & Traceability Improvement Initiative

Efficient ELISA Kit Manufacturing with Precision Productivi

Smart Manufacturing Profiles for CNC Machining

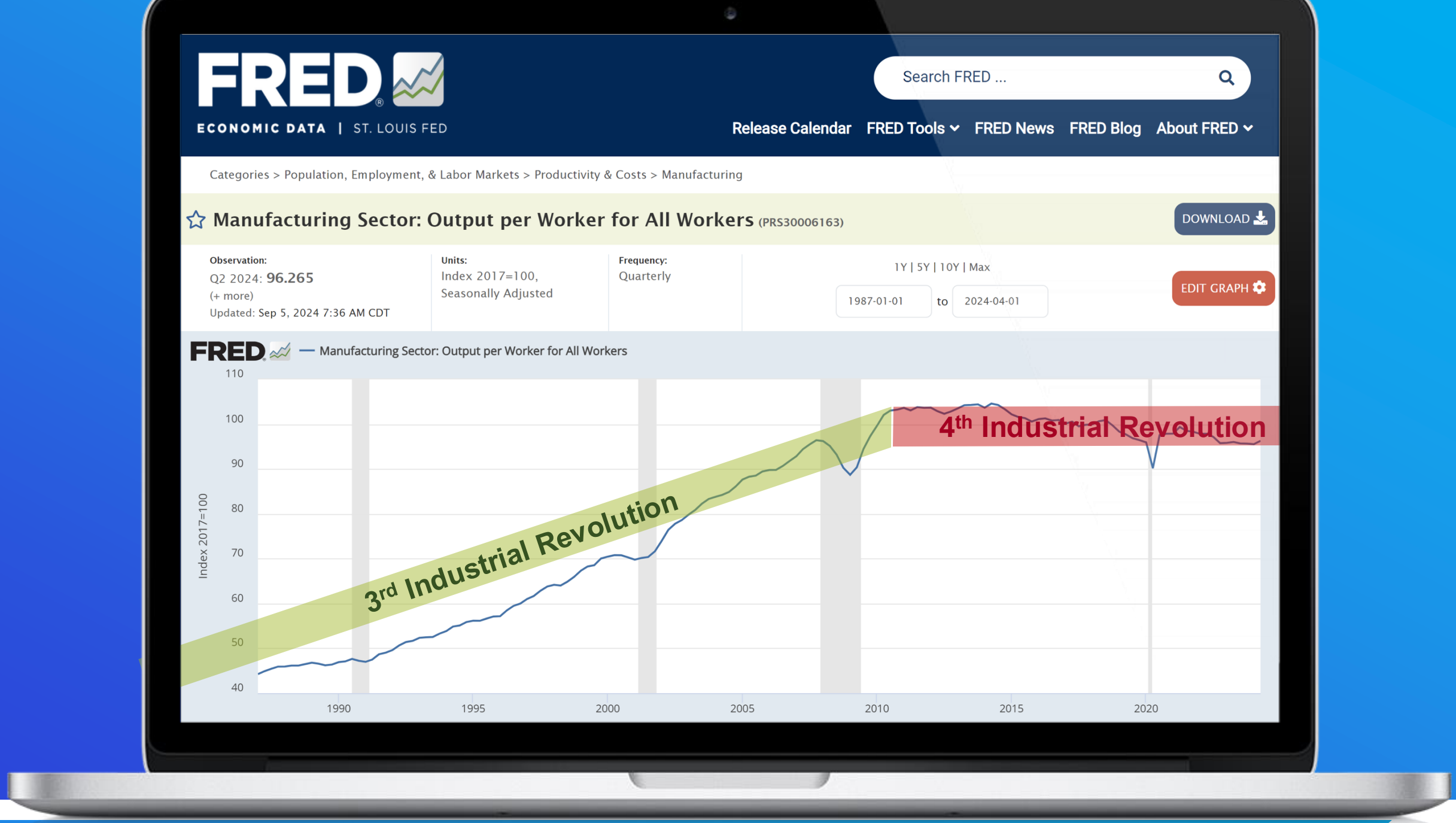
Predictive Diagnostics of Tube Mill and Roll-forming Equipment

SMIP to Optimize Continuous Cooling Tunnels for Industrial Food Processing

Smart Manufacturing Innovation Platform Azure IoT Bridge

Smart Connected Workers in Advanced Manufacturing

IoT-Enabled Manufacturing Testbeds for Democratizing SM Knowledge, Technology and Innovation



The value & ROI of manufacturing digitization has been understood for decades,

in fact, after 30 years of pursuing this value...

The outcome of 30 years of **unbridled innovation…**

(One Use Case at a time)

Industry 3.0…

- ❌ Proprietary, Closed
- ❌ No Interoperability
- ❌ Data Silos
- ❌ Stovepipe Architecture
- ❌ Vendor Lock-in
- ❌ No Application Portability
- ❌ Difficult to Scale – Up or Down

Logistics*	Quality*	Production*	Maintenance*	Management*
Environmental Systems	Campaigns	Production Monitoring	Tool Monitoring	Information Portal
Metrics (DTD, BTS)	Shipping – Error Proofing	Downtime Analysis	EAM - Predictive	Energy/Building Mgmt
Shipping	External Metrics	Production Counts	EAM - Preventive	Cost Management
Container Tracking	Internal Metrics	Constraint ID & Analysis	EAM - Crisis	Policy Deployment
Lot Tracking	Traceability	Schedule Execution/	Reliability & Maintenance	Best Practice
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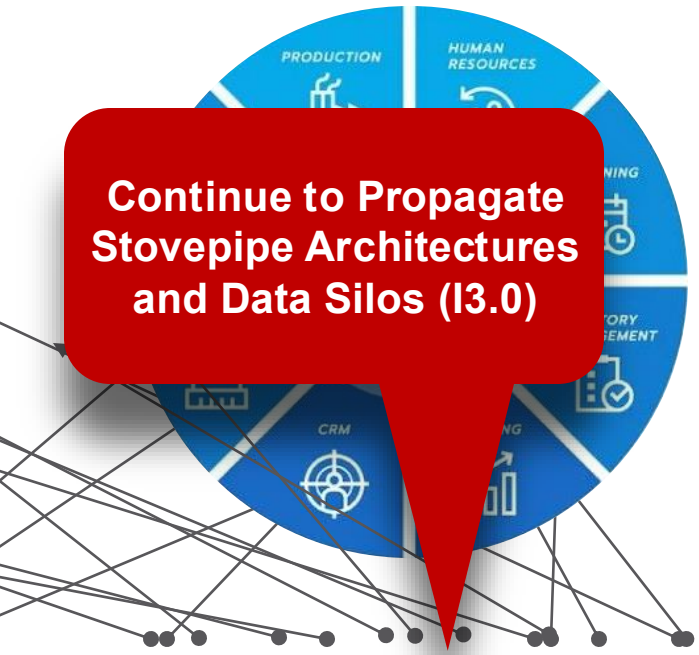
Dock Inventory	SPC	Dock Inventory	Programmable Dev Supp	Issues Management
Schedule Optimization	Repair Bay OI	Process Sheets	Plant Design & Layout	Production Log
Inventory Control	Quarantine	Manual Production Coun	Die Re-Chroming	Knowledge Managemen
Line Side Replenishmer	Scrap & Reject Reportin	Cycle Time Analysis		Training
Part Consumption	Birth History	Sequencing		

*1600 non-sanctioned (Shadow-IT) systems



Continue to Propagate Stovepipe Architectures and Data Silos (I3.0)

I4.0 Use Cases

Logistics*	Quality*	Production*	Maintenance*	Management*
Environmental Systems	Campaigns	Production Monitoring	Tool Monitoring	Information Portal
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The Cost & Complexity of our Manufacturing Systems is Constraining US Productivity

The cost of each Use Case represents **50 - 80% infrastructure redundancy** – with no reusability or portability

Data Connection, Ingestion, Storage and Contextualization is replicated **for EACH manufacturing use case (application**)

Application integration replicated for each connected use case (application)

No centralized location for data, data management, master data, business logic, application integration, role-based security, configuration, audit trails, etc.

Each Manufacturer Bears the Full Cost of this Complexity

Manufacturing Systems Complexities

There are 9 fundamental production types…

each with significantly unique automation and data fundamentals

Manufacturing Types	Work Order Types
Discrete Manufacturing	Engineer-to-Order (ETO)
Batch/Hybrid Processing	Make-to-Order (MTO)
Continuous Processing	Make-to-Stock (MTS)

Each of the 9 Combinations…

- ✓ Has a unique set of business processes
- ✓ Contributors: Legacy, Speed, Volume, Co. Size, Compliance, SKU Count, Variability…
- ✓ Characterized by 3V's – Volume, Variability & Value

	ETO	MTO	MTS
Discrete	CNC Relational	PLC CNC Relational	PLC Relational
Batch Hybrid	PLC DCS Relational Time	PLC DCS Relational Time	PLC DCS Relational Time
Cont. Process	DCS Time	DCS Time	DCS Time

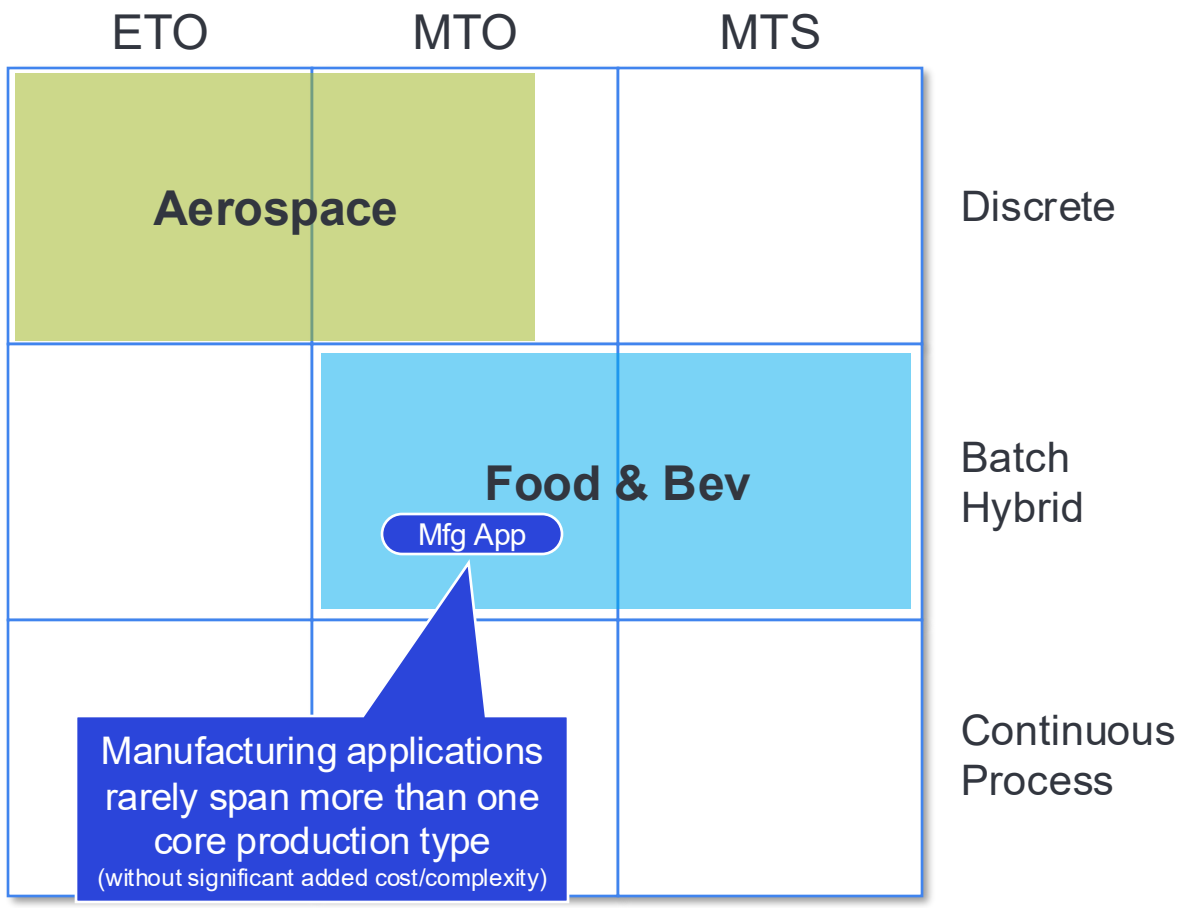
Automation & control strategies vary by production type

Manufacturing context & resulting data ingestion strategies & application infrastructure vary by production type

Manufacturing Systems Complexities

Application Standardization Strategies for Manufacturers Almost Always Fail Across Production-Type Boundaries

Industries	ETO	MTO	MTS	Disc	Hyb	Proc
Aerospace	x	x		x		
Automotive Assembly		x	x	x	x	
Automotive Suppliers	x	x	x	x	x	x
Building Products			x	x	x	x
Chemicals		x	x		x	x
Consumer Packaged Goods					x	x
Electronics	x	x	x	x		
Food, Bev & Tobacco			x		x	
Ind Machinery & Equipment	x	x	x	x		
LifeSciences		x	x		x	
Medical Device	x	x		x		
Metal Fab/Job Shop	x	x		x		
Metals			x		x	
Mining			x		x	
Oil & Gas		x	x			x
Power & Energy Utilities/Dist			x		x	x
Printing & Publishing		x	x	x		
Rubber & Plastic		x	x		x	
Semiconductor		x	x	x		
Textiles		x	x		x	
Transportation		x	x	x	x	
Water / Waste Water			x			x
Wood & Milled Products		x	x		x	



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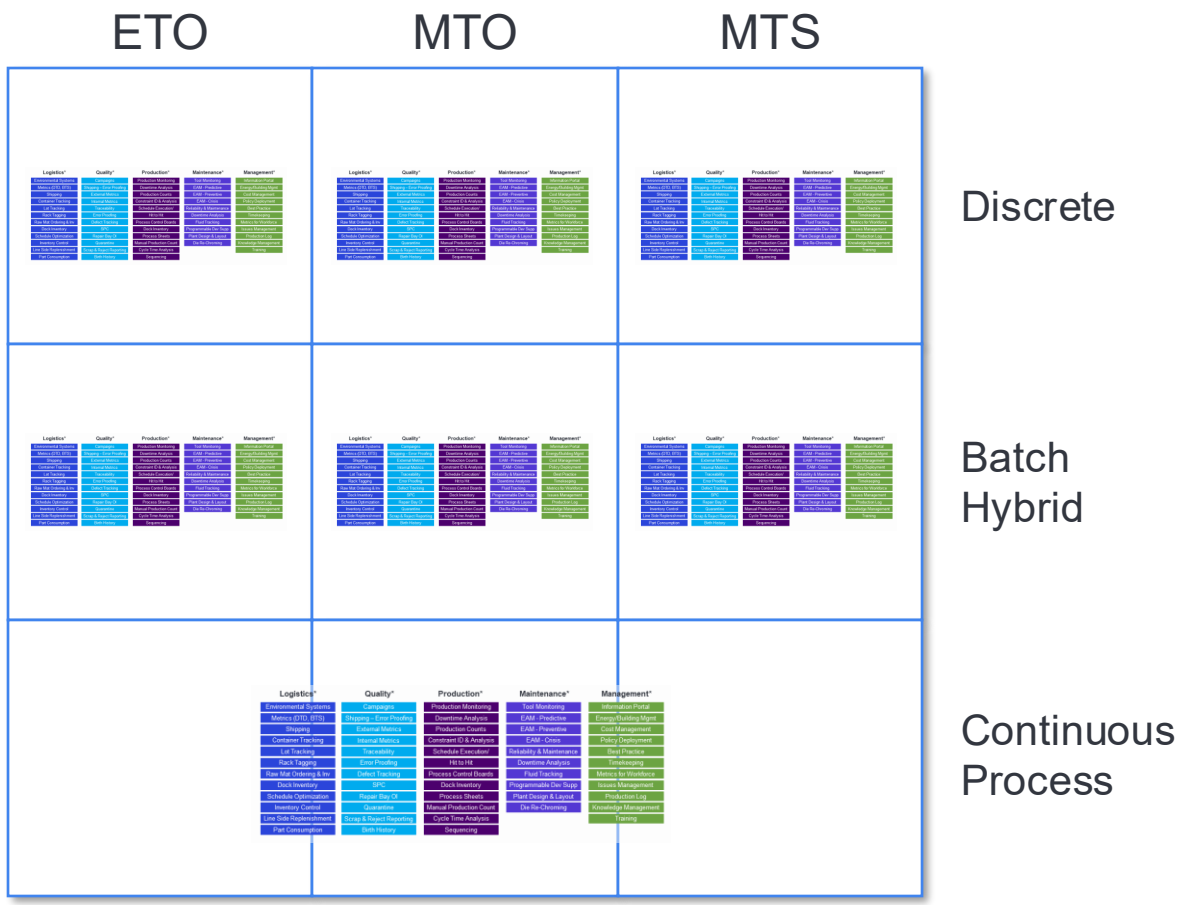
Automotive Suppliers	x	x	x	x	x	x
Building Products			x	x	x	x
Chemicals		x	x		x	x
Consumer Packaged Goods					x	x
Electronics	x	x	x	x		
Food, Bev & Tobacco			x		x	
Ind Machinery & Equipment	x	x	x	x		
LifeSciences		x	x		x	
Medical Device	x	x		x		
Metal Fab/Job Shop	x	x		x		
Metals			x		x	
Mining			x		x	
Oil & Gas		x	x			x
Power & Energy Utilities/Dist			x		x	x
Printing & Publishing		x	x	x		
Rubber & Plastic		x	x		x	
Semiconductor		x	x	x		
Textiles		x	x		x	
Transportation		x	x	x	x	
Water / Waste Water			x			x
Wood & Milled Products		x	x		x	



Accelerating the Democratization of Smart Manufacturing

CESMII is enabling smart, sustainable operations for ALL manufacturers, driving the next wave of manufacturing productivity, energy productivity and competitiveness through smart manufacturing innovation.

Technology

Enabling Technologies that Decrease Cost & Complexity of SM by 50%

- ☑ **Interoperability through Open Specifications**
- ☑ **OT Data Foundations**

Knowledge

Business and Technology Tools, Strategies & Education to help align resources & people for success

- ☑ **Align Manufacturing Strategy with Digital Capabilities & Roadmap**
- ☑ **Next Gen Connected Workforce**

Ecosystem

Convene relevant industry stakeholders to solve problems no one company can solve on its own

- ☑ **Engage, Learn & Serve**
- ☑ **Cultivate a Smart Manufacturing Mindset**

In order to “Strengthen U.S.’ Competitiveness Through Smart Manufacturing”…

What Must Be True?

Technology

The Importance of Open Specifications & Interoperability for OT

The Foundation for Modern OT Infrastructure, Tools, AI/ML Models and Apps

IT

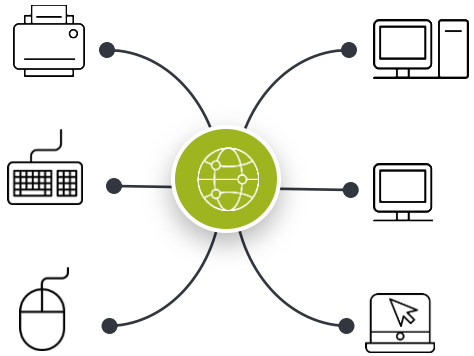
1980s: Device Drivers were purpose-built (proprietary) for each device, and installed as a ‘project’

OT

2020s: Every OT data source (sensor to machine to software) is non-standard and requires a ‘project’ to extract the right data for every use case & application (vendor lock-in)

Historic Example:
From Device Installation Projects to Plug ‘n Play

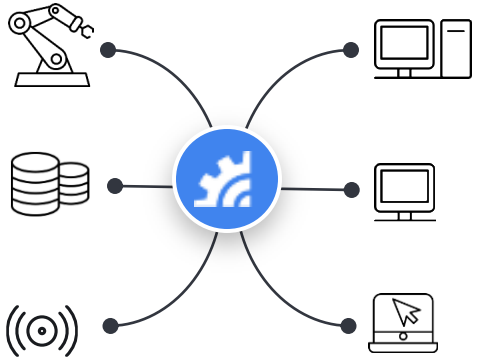
40 Years of standards USB, Wi-Fi, TCP/IP...



- ✓ Software and hardware from 1000’s of vendors can be installed by anyone
- ✓ Standard way to get data through a browser

Urgent Need:
Open Specifications & Model-Driven Architectures

Secure, Interoperable, Plug & Play Infrastructure



- ✓ **Sensors, equipment and processes** can be discovered as objects with graph relationships
- ✓ Applications can be developed against an open API
- ✓ Facilitate the more effective creation and reuse of trained AI models

Moving Beyond our Legacy of Information Constraints

Secure, Sanctioned, Scalable and Interoperable Information Accessibility at Every Level

Historic Purdue Model

- **Business Planning** — L4 — FINANCE, SUPPLY CHAIN, IT, DESIGN
- **Manufacturing Operations** — L3 — OPERATIONS, QUALITY, SCHEDULING
- **Supervisory Controls** — L2
- **Process Controls** — L1
- **Physical Plant** — L0 — PRODUCTION, MAINTENANCE, QUALITY, ENGINEERING

Purpose-Built Segmentation of Control & Information Functions

Smart Manufacturing Model

Smart Manufacturing Platform

- **Business Planning** — L4
- **Process Controls** — L1
- **Physical Plant** — L0

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Data & Application Interoperability via Standardized Information Models & Open Specifications

Moving Beyond our Legacy of Information Constraints

Secure, Sanctioned, Scalable and Interoperable Information Accessibility at Every Level

Status Quo:
Clerical/Manual-Step-Dependent Decision Support

Gain actionable insight

Human Analysis

Locate Engineering Drawings

Locate Sensor Data

Locate Asset History

Locate Technical Docs

Smart Manufacturing:
AI-Assisted Decision Support

Human Capital Mgmt

Material Management

Risk Management

Asset Management

(AI) Solutions

Data Transformations

Metadata Enrichment

Data Management

Contextualization

DATA INGESTION

Historian

PLC, IoT

MES

QMS

CMMS

ERP

Simulation

Docs

OT

IT

ET

The Choice Every Manufacturer Faces…

Single Use Case to Enterprise Strategy…Unit Ops to Supply Chain

Status Quo
Industry 3.0

- ✗ Expensive to buy & sustain
- ✗ Build from scratch every time
- ✗ Another data silo, stovepipe architecture
- ✗ Vendor Lock in
- ✗ Difficult to align OT and IT

or…

Smart Manufacturing
Industry 4.0

- ✓ Lower cost, lower complexity
- ✓ Application Interoperability
- ✓ Minimize data silos
- ✓ Natural path to standardization
- ✓ OT & IT fully aligned

CESMII's Mission: Help Manufacturing Embrace SM

The Choice Every Manufacturer Faces…

Continue to Proliferate the Cost & Complexity of the Past **or…** Choose Smart Manufacturing

Industry 3.0
Status Quo

- ❌ Expensive to Buy, Implement & Sustain, No Economies of Scale
- ❌ No Data Standards, No Reusability or Portability of Infrastructure
- ❌ Each Solution is a Stovepipe Architecture, Proliferation of Data Silos
- ❌ Standardization Costly and Complex
- ❌ Vendor and Ecosystem Lock-in
- ❌ Divergent Views on Data Principles a Major Barrier to OT/IT Convergence

Industry 4.0
Smart Manufacturing

- ✅ Economies of Scale, to Dramatically Reduce Cost & Complexity
- ✅ Develop, Adopt & Refine OT Data Standards
- ✅ Minimize Data Silos by Selecting Interoperable Platforms & Apps
- ✅ Natural, Low-Friction Path to Standardization
- ✅ Open, Standard API's Minimize Vendor Lock-in
- ✅ OT Data Foundations Will Facilitate OT & IT Alignment

Meeting Your Productivity and Profitability Expectations REQUIRES a Manufacturing Data Foundation

CESMII Requirements for SM Compliance

The Journey to Interoperability

Open, Standardized Access

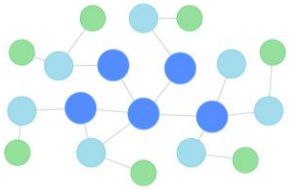
Open API

SM Imperative #3: Create an open, common API for Manufacturing Systems, Rapid App Dev, Scaling AI Deployments, EAI, Supply Chain Optimization…

- ☑ Establish a standard API, consisting of a base set of server primitives that a wide array of platforms can implement to commoditize access to manufacturing data

Graph Aware, Graph Preserving

Knowledge Graph

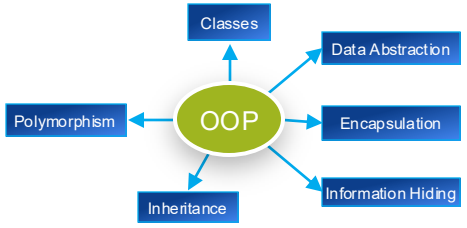


SM Imperative #2: A Clear Set of Requirements Enabling Manufacturing Platform and Application Interoperability (Compliance = SM Interoperability Platform)

- ☑ Instantiate SM Profiles as Type Safe Objects from the SM Marketplace
- ☑ Persist Instance Objects & Relationships (present and past) in a Knowledge Graph

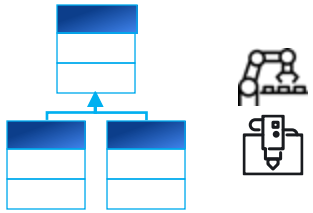
Object Oriented & Type Safe

Namespace



Standardized Information Models

SM Profiles



SM Imperative #1: Open, Standards-Based Information-Modeling Strategy for Manufacturing (& related Supply Chain) Devices, Assets & Processes

- ☑ Leverage and contribute to a global community building information models (SM Profiles)

CESMII Requirements for SM Compliance

Open, Standardized Access

Open API

Graph Aware, Graph Preserving

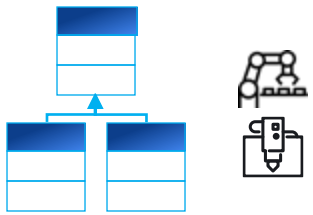
Knowledge Graph

Object Oriented & Type Safe

Namespace

Cross Domain, Harmonized Information Models

SM Profiles



SM Imperative #3: An open, common API for Manufacturing Systems

- ☑ Establish a standard API, consisting of a base set of server primitives that a wide array of platforms can implement to commoditize access to manufacturing data

SM Imperative #2: A Clear Set of Requirements for Manufacturing Platforms to Aspire to Application Interoperability (Compliance = SM Interoperability Platform)

- ☑ Instantiate SM Profiles as Type Safe Objects from the SM Marketplace
- ☑ Persist Instance Objects & Relationships (present and past) in a Knowledge Graph

SM Imperative #1: Open, Standards-Based Information-Modeling Strategy for Manufacturing (& related Supply Chain) Devices, Assets & Processes

- ☑ Leverage and contribute to a global community building information models (SM Profiles)

SM Imperative #1

Open Information-Modeling Strategy for Manufacturing

A Smart Manufacturing Profile… the Foundation of a Global Production Language

…Is an Information Interface Contract

- Describe the data type (including unit of measure), semantic and structure for manufacturing data
- Provide type safety, ensuring that data sets (objects) can be traced back to their definition

…Supports Communication Abstraction

- Consumers of the Information Model data do not need to know how to communicate with underlying systems
- Multiple disparate data sources can be mapped to a single, modern, type/graph-aware API.

…Provides a reliable Feature set and structure for AI

- Information Model ‘instances’ found in a running operation represent canonical truth about the data in the operation and can reliably be used for AI training and model execution (bottoms up)
- Information Model standards can be adopted by an operation through adaption at the Edge, without requiring re-engineering the physical system

SM Profiles are an extension to the OPC UA Information Model (part 5) that can be distributed to automate the creation of information value throughout a software architecture

- ✓ **Dramatic Reduction in Cost & Time-to-Value**
- ✓ **Application Interoperability and Standardization**
- ✓ **Support Standardization Efforts**
- ✓ **Information Model Portability and Reusability**
- ✓ **Application Portability and Reusability**

SM Profiles Form the Basis for Interoperability

A Building-Block Approach to Semantic Interoperability for Machines & Processes

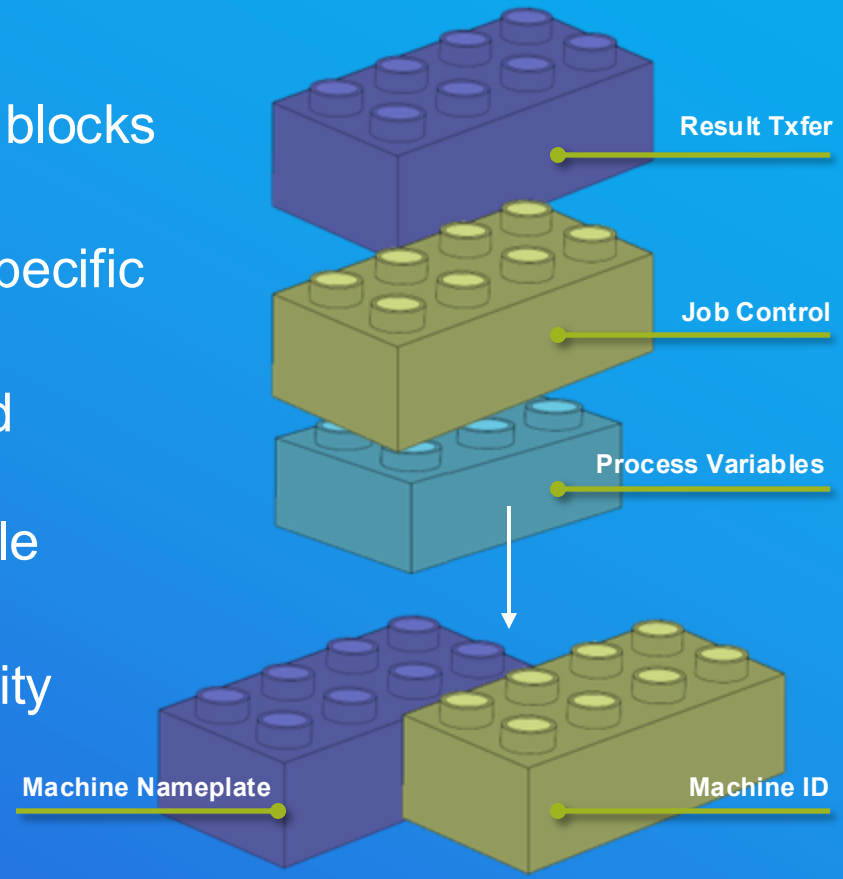
OPC UA for Machinery

Part 1: Basic Building Blocks

SM PROFILE

CESMII SM Profile™ Designer

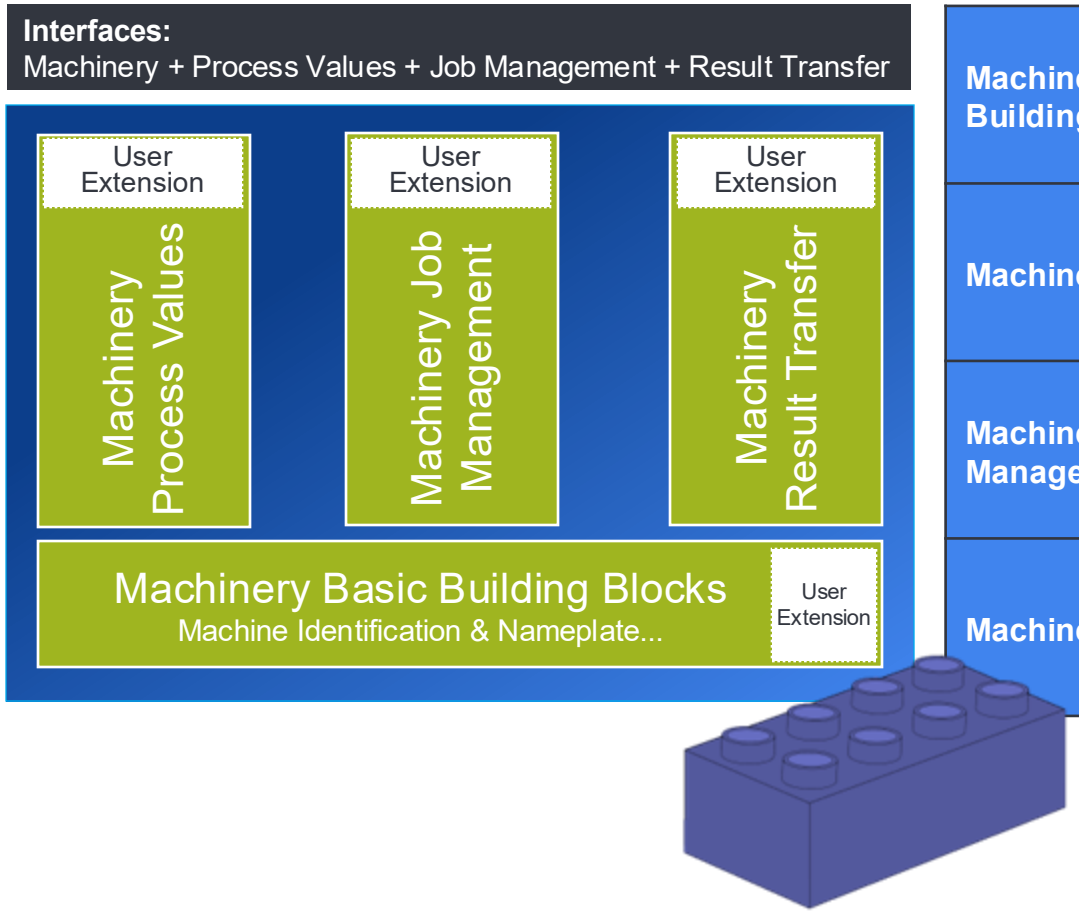
- Defines harmonized basic building blocks for broad use
- Each building block created for a specific use case
- Can be composed - referenced and inherited - from other Profiles or implemented as a standalone Profile
- Can be extended / customized to accommodate additional functionality



Imposing Structure On Manufacturing Data Sources (Device, Asset, Process…) That Are Inherently Unstructured

Building Block Profiles: “Machinery”

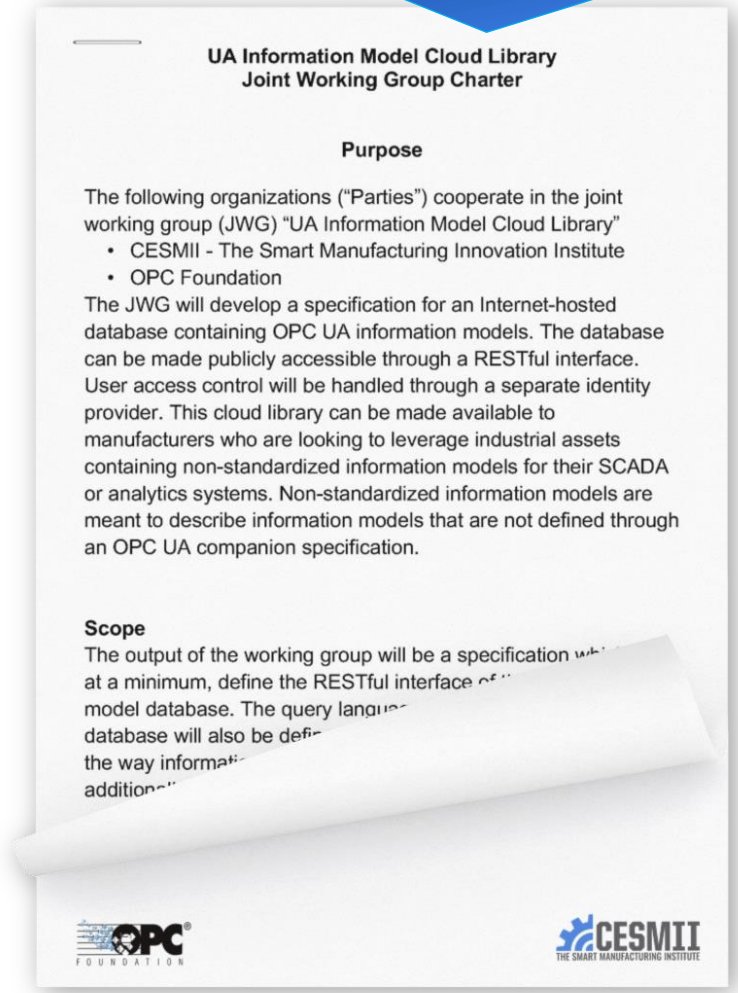
A Set of Baseline Building Blocks for Most Machines & Processes



Machinery Basic Building Blocks	Defines various building blocks for Machinery that allow to address use cases across different types of machines and components of machines defined in various companion specifications. Contains building blocks for – Machine Identification and Naming.
Machinery Process Values	Defines information about process values, for example provided by actuators or sensors. This covers a number of use cases for instance Read or write access to process values, Read or write access to setpoints of process values.
Machinery Job Management	Defines building blocks for execution and control of Job Orders (units of work to be executed). Machinery – Job Mgmt is based on and inherits the information model of UA for ISA-95 – Job Control (OPC 10031-4).
Machinery Result Transfer	The result transfer information model provides mechanisms to transfer results that are produced by a Server or its underlying system. The characteristics of such results is to contain meta data together with the individual results.

A Global Community Investing in Manufacturing Information Modelling

An Open Standard for Information Model Storage, Search & Access (Human/Machine Readable)



UA Information Model Cloud Library
Joint Working Group Charter

Purpose

The following organizations ("Parties") cooperate in the joint working group (JWG) "UA Information Model Cloud Library"

- CESMII - The Smart Manufacturing Innovation Institute
- OPC Foundation

The JWG will develop a specification for an Internet-hosted database containing OPC UA information models. The database can be made publicly accessible through a RESTful interface. User access control will be handled through a separate identity provider. This cloud library can be made available to manufacturers who are looking to leverage industrial assets containing non-standardized information models for their SCADA or analytics systems. Non-standardized information models are meant to describe information models that are not defined through an OPC UA companion specification.

Scope

The output of the working group will be a specification wh
at a minimum, define the RESTful interface of
model database. The query langu
database will also be defi
the way informati
additiona

Joint Working Group

- ABB
- Ascolab
- Atlas Copco
- amazon
- Beeond
- Bitctrl
- Bosch
- Capgemini
- CESMII
- Endress + Hauser
- Equinor
- Google
- Hilscher
- IBM
- Idata
- Inray
- Microsoft
- Prediktor
- Renault
- SAP
- Siemens
- Softing
- VDMA
- Wago
- 4CE Industry

More than 800 companies contributing
More than 40 active working groups
More than 25 sectors in active development

Standard

Standard OPC UA Companion Specs
- VDMA
- MTConnect
- Industry Associations

Not Standard

CESMII SM Profile Designer™
- Machine Builders
- System Integrators
- Any Domain Expert

Not Standard

CESMII Ecosystem Investments
- ThinkIQ
- Inductive Automation
- OSI AssetFramework
- PTC ThingWorx Templates
- Rockwell Automation
- SymphonyAI Templates
- Siemens

Smart Manufacturing Marketplace

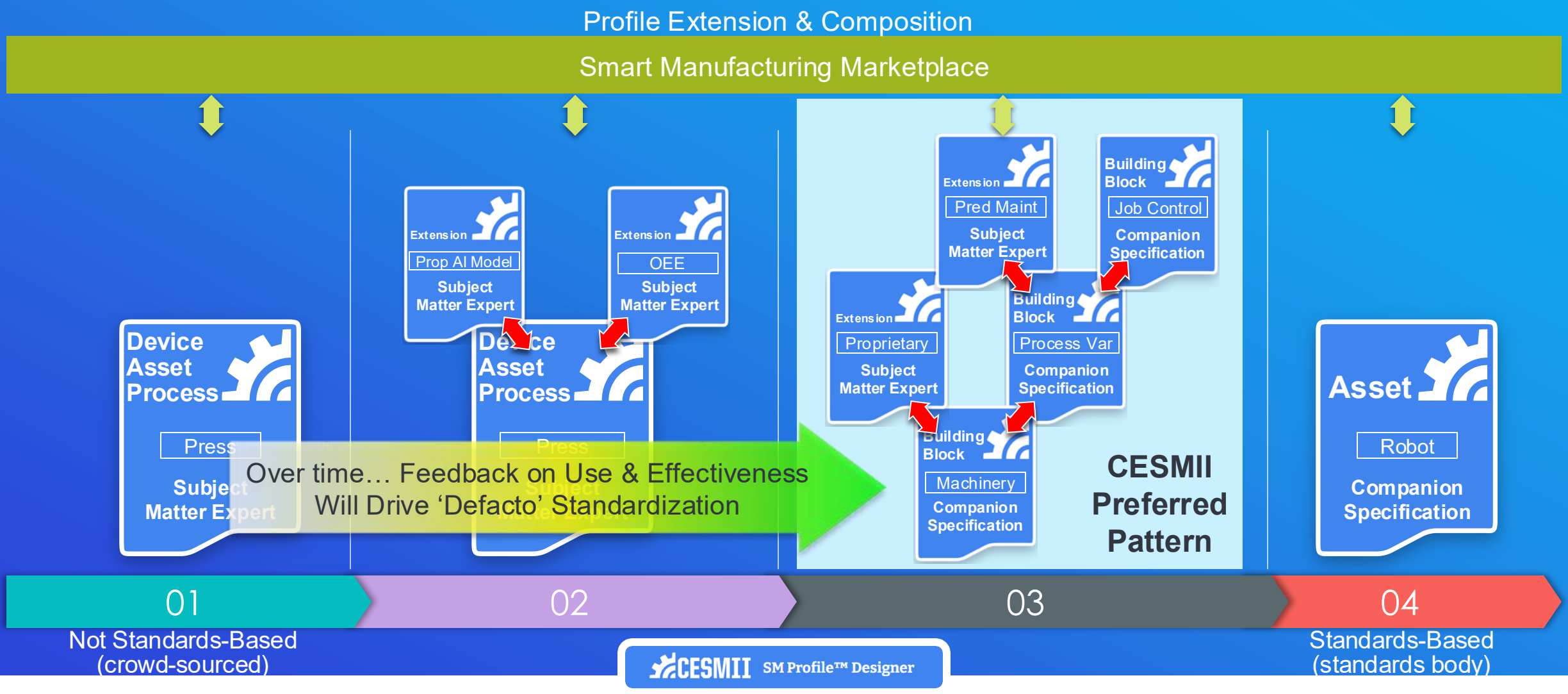
SM Apps

SM Profiles

Cloud Library (Open Specification)

Smart Manufacturing Interoperability Demo

SM Imperative #1: Open, Standards-Based Information-Modeling Strategy for Manufacturing (& related Supply Chain) Devices, Assets & Processes



Community Collaboration to Create Standard Information Models

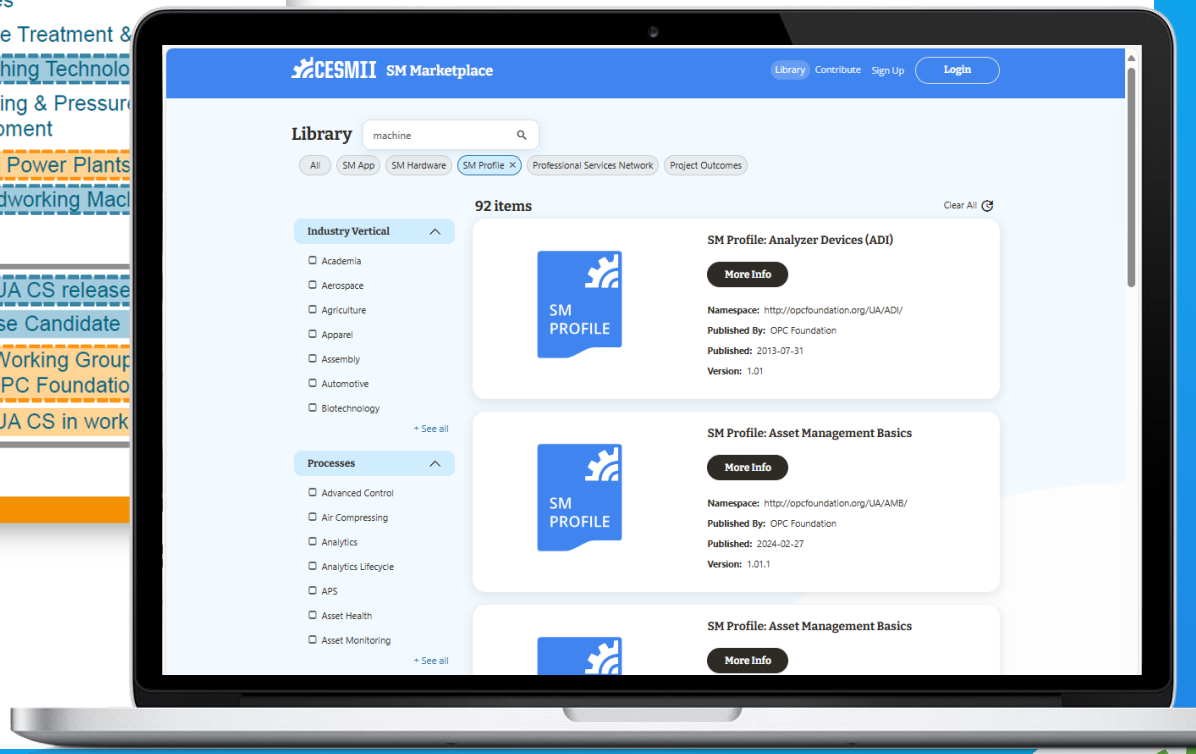
OPC UA serves as basis for the Global Production Language

VDMA

- Additive Manufacturing
- Agricultural Machinery
- Air Conditioning & Ventilation
- Air Pollution Control
- Automated Guided Vehicles
- Battery Production
- Building Control and Management
- Building Materials
- Ceramic Machinery
- Cleaning Systems
- Compressors, Compressed Air and Vacuum Technology
- Construction Equipment
- Continuous Conveyors
- Cranes
- Die & Mould
- Drying Technology
- Electrical Automation
- Engines & Systems
- Fire Fighting Equipment
- Fluid Power
- Food Processing and Packaging Machinery
- Foundry Machinery
- Glass Machinery
- Hydro Power Plants
- Industrial Trucks
- Integrated Assembly Solutions
- Intralogistic Systems
- Lasers and Laser Systems for Material Processing
- Length Measurement Technology
- Lifts & Escalators
- Machine Tools and Manufacturing Systems
- Machine Vision
- Metallurgical Plants and Rolling Mills
- Micro Technologies
- Mining
- Photovoltaic Equipment
- Plastics & Rubber Machinery
- Power Transmission Engineering
- Precision Tools
- Printing & Paper Technology
- Process Plant & Equipment
- Productronic
- Pumps & Systems
- Refrigeration & Heat Pump Technology
- Robotics
- Security Systems
- Software & Digitalization
- Surface Technology
- Testing Technology
- Textile Care, Fabric and Leather Technology
- Textile Machinery
- Thermal Power Plants
- Thermo Process Technology
- Valves
- Waste Treatment &
- Weighing Technolo
- Welding & Pressur Equipment
- Wind Power Plants
- Woodworking Mac

OPC UA CS release
Release Candidate
Joint Working Group with OPC Foundatio
OPC UA CS in work

VDMA | Andreas Faath | Managing Director VDMA MII

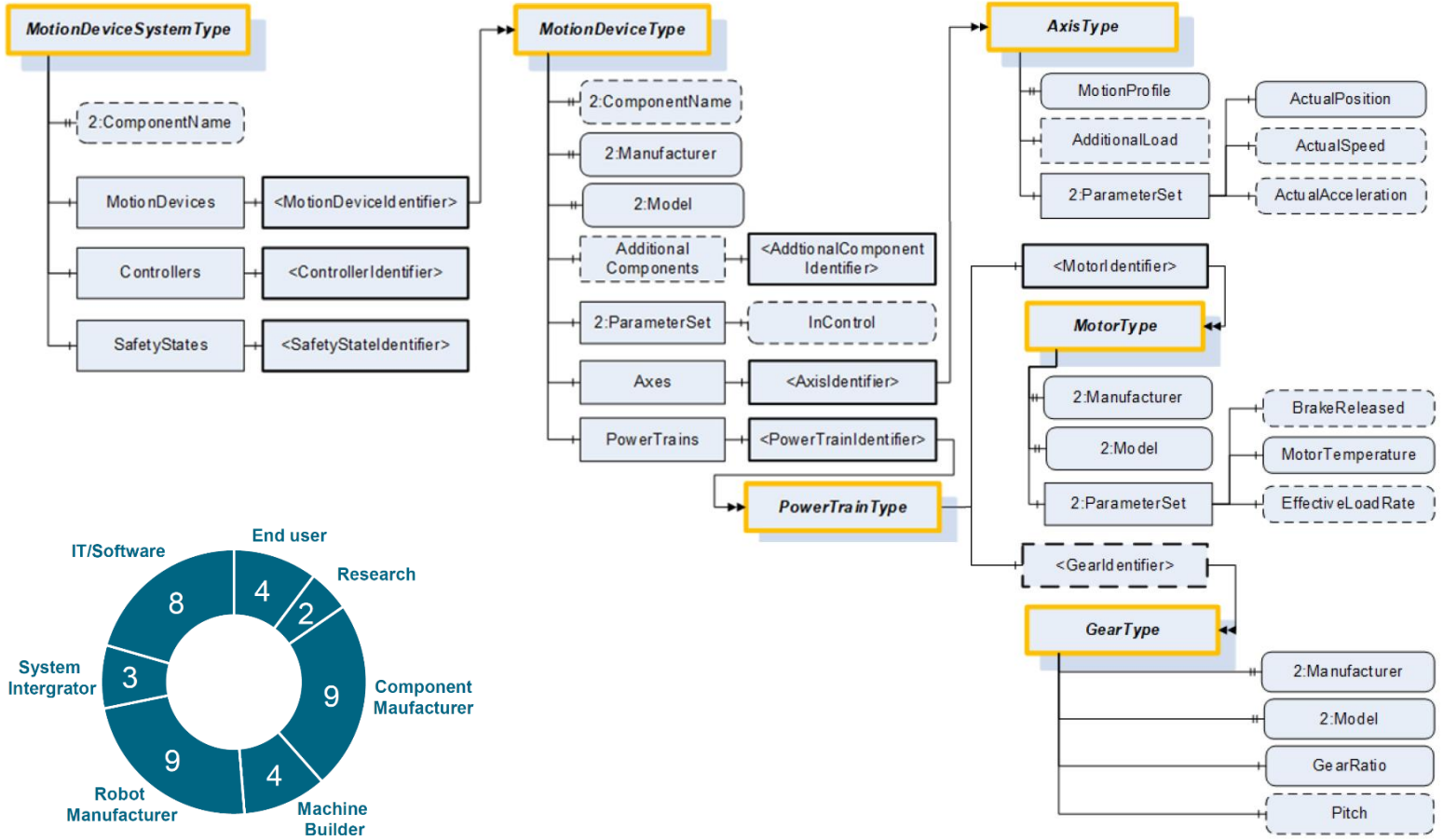


Robotics SM Profile Working Group

The Value of SM Profiles (Standard)

Core Working Group

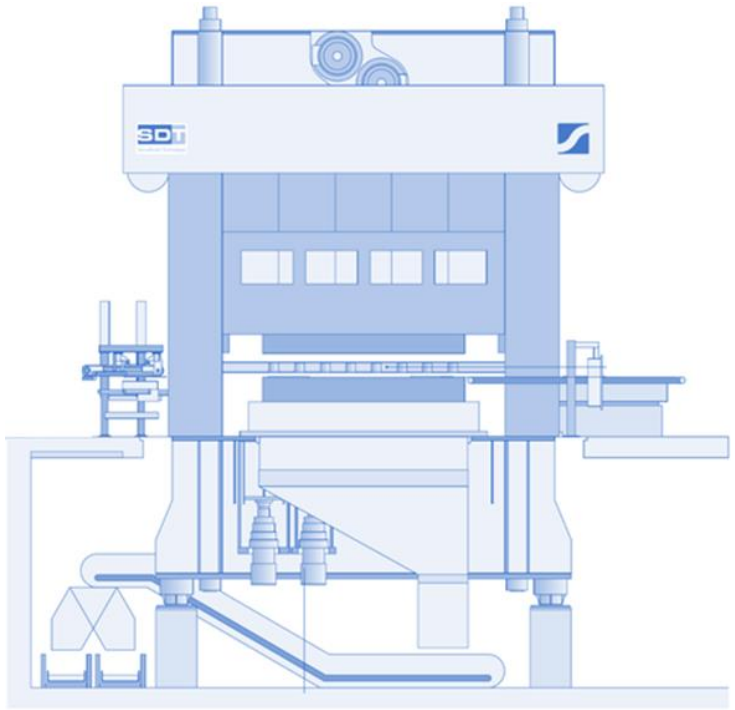
- ABB AS Robotics
- Unified Automation GmbH
- AUDI AG
- B+R Automatizace
- Beckhoff Automation
- CAX-SERVICE GmbH
- Daimler AG
- ENGEL AUSTRIA GmbH
- EPSON Deutschland GmbH
- Fortiss An-Institut
- Fraunhofer IGCV
- KEBA AG
- KraussMaffei Automation
- KUKA Deutschland GmbH
- Mitsubishi Electric
- SIEMENS AG
- Volkswagen AG
- YASKAWA Europe GmbH



The Value of SM Profiles (CESMII Project)

Mechanical Press

1 Automation Controller/PLC (Source)
Servo Motors, Pumps, etc. (Devices)
1,000,000 Data Points to Choose From



Mechanical Press Profile…

Asset Performance
Press State
Production Count (pcs)
Scrap Count (pcs)
Setup Cycles (pcs)
Running Time (min)
Faulted Time (min)
Starved Time (min)
Blocked Time (min)
Setup Time (min)
Out of Auto (min)
Transfer Cycling (min)
Transfer in Auto and Faulted (min)
Transfer Not in Auto (min)
Setup Time (min)
Total Time (min)
Production Efficiency (%)
OEE (%)
Loader Cycle time (sec)
Overall Cycle time (sec)
Unloader Cycle time (sec)
+Fault Description
MTBR
MTBF
Etc.

Quality
+Stroke Wave Capture
+Automated Quality Checks
+SPC

Predictive Maintenance
+PM Model
+Main Motors Head Pressure
+Motor Cooling System Water
+Press Force Head Pressure

Events
+Notifications
+Enterprise Integration

Energy
+Energy Targets
+Air
+Water
+Electricity
Etc.

Workflows
+Workflows

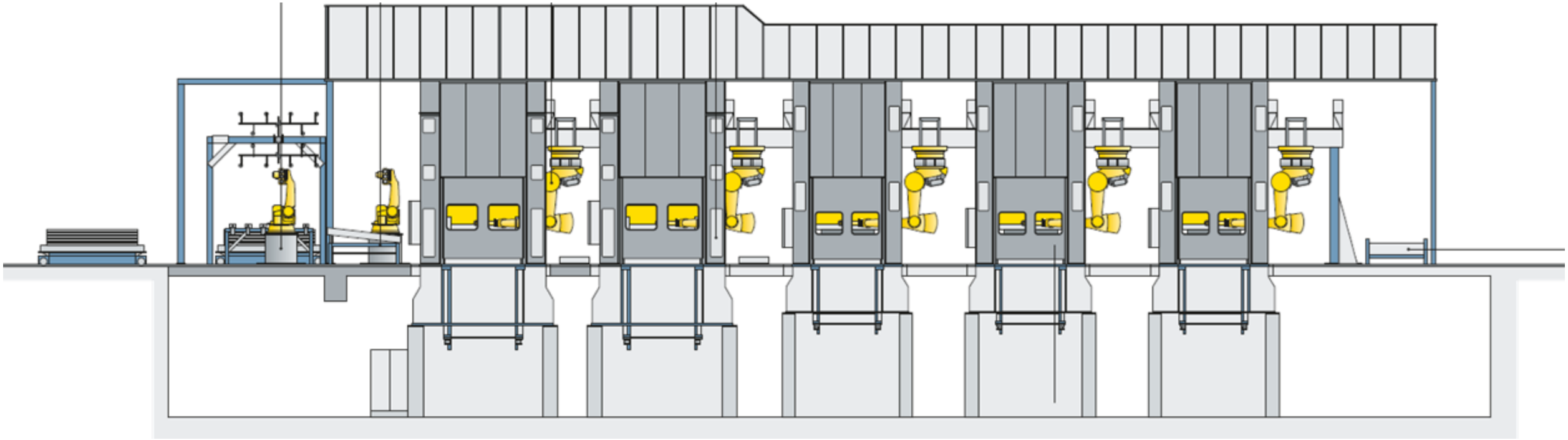
Production
Operator ID
Part Number
Description
Work Order #
Target Quantity
Target Start Time
Actual Start Time
Target Completion Time
Actual Completion Time
Max Press Stroke Rate
Priority
Promise Date
Etc.

Hydraulics
Zone 1 Temperature
Zone 1 Pressure
Zone 2 Temperature
Zone 2 Pressure
Counterbalance Air Pressure
Clutch/Brake Air Pressure
Lube Oil Pressure
Etc.

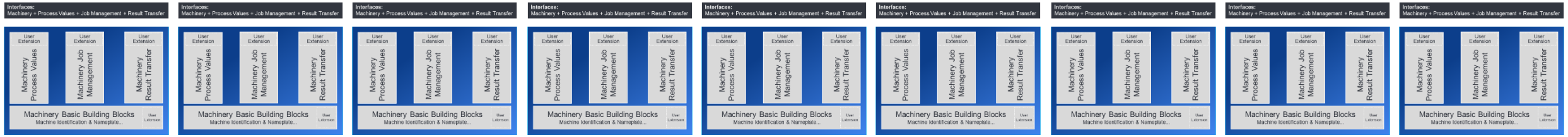
Simulation/Design
+Design

Documentation
+Documents

SM Profiles in Action

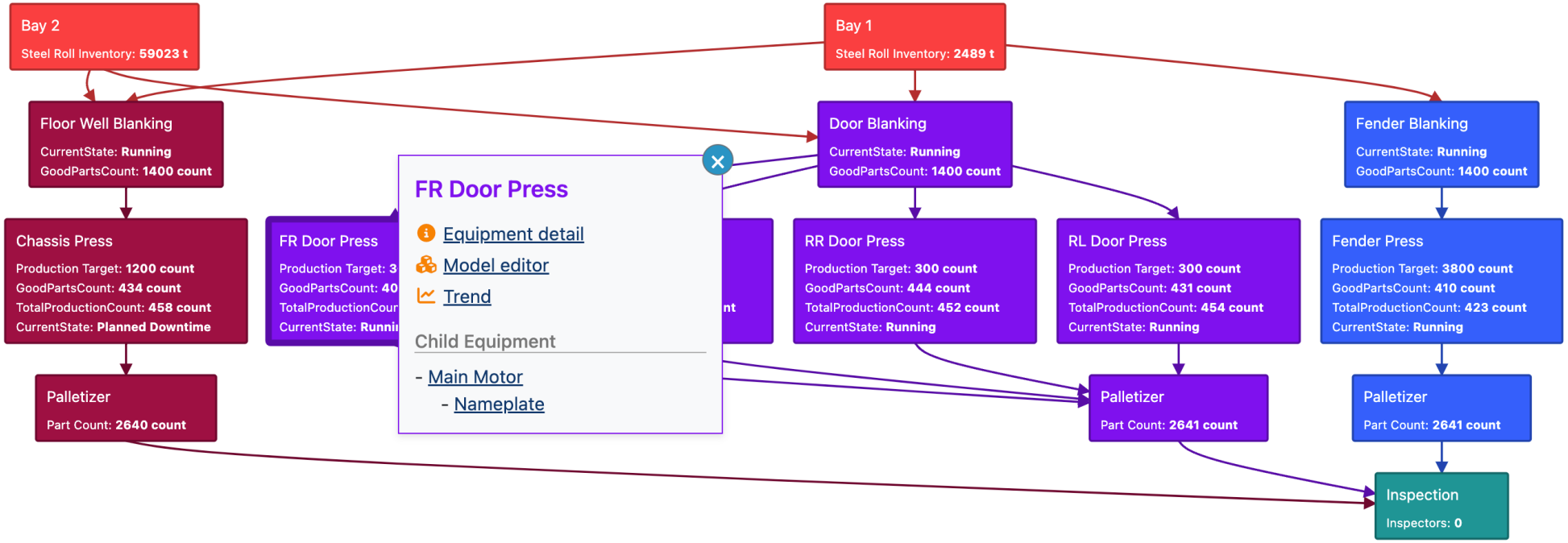


Palletizer Robot | Floor Well Blanking | Chassis Press | FR Door Press | Door Blanking | RR Door Press | RL Door Press | Fender Press | Palletizer Robot



SM Profiles in Action

SM Profiles Self-Assembled as a Knowledge Graph in the ThinkIQ SMIP



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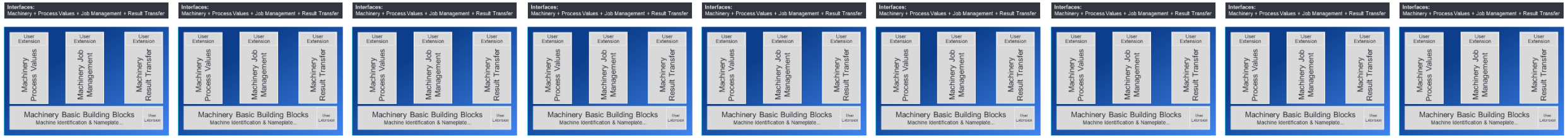
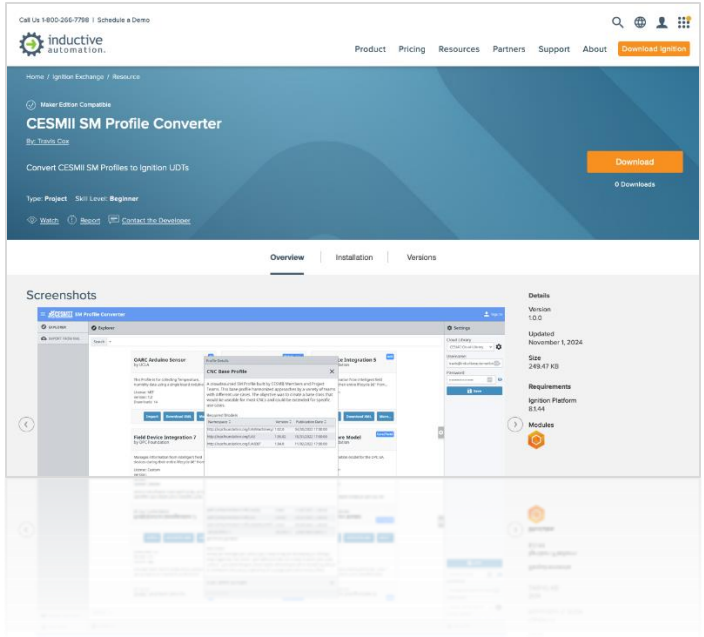


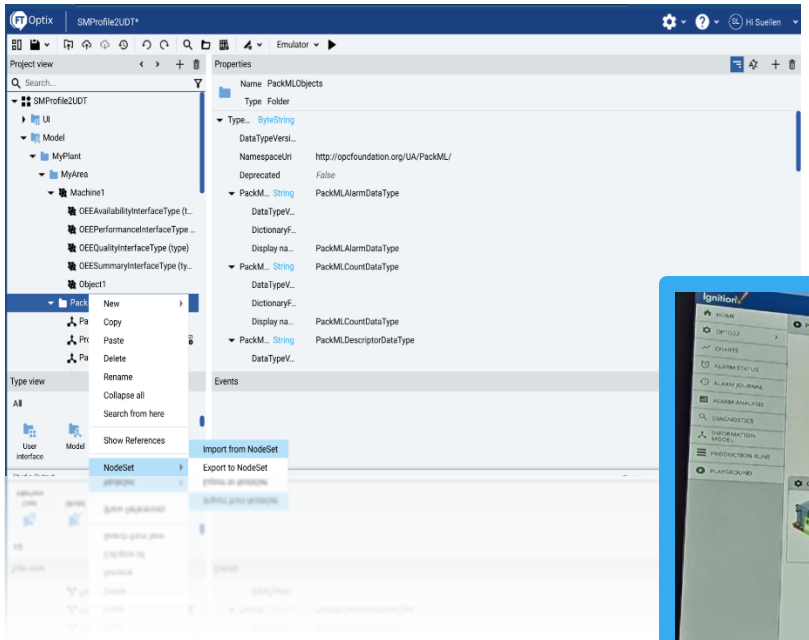
New Technology Providers Importing SM Profiles*

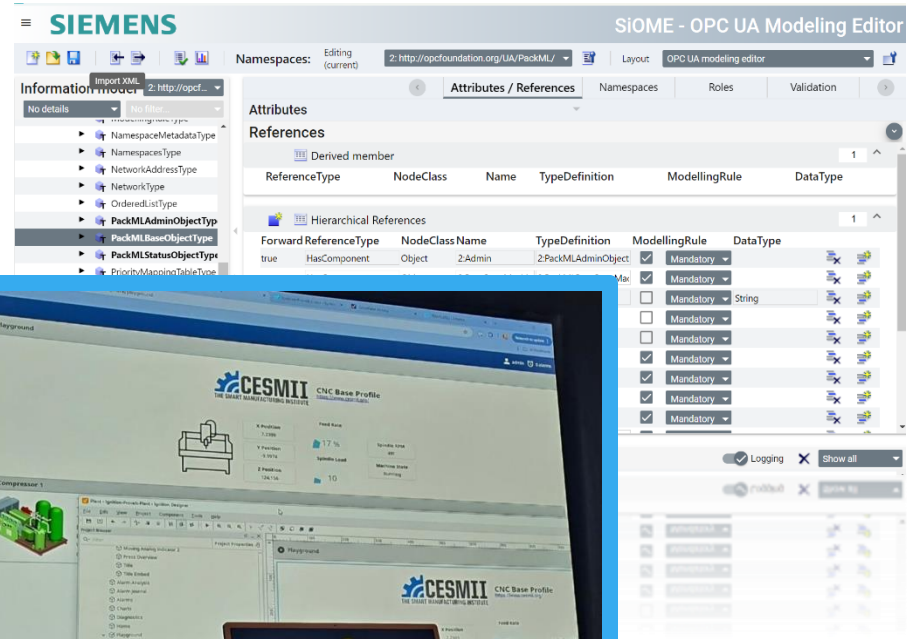
inductive automation

Rockwell Automation

SIEMENS







* …in addition to ThinkIQ SymphonyAI ptc AVEVA

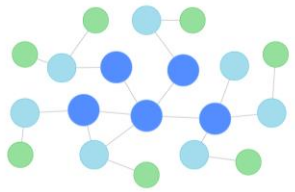
CESMII Requirements for SM Compliance

Open, Standardized Access

Open API

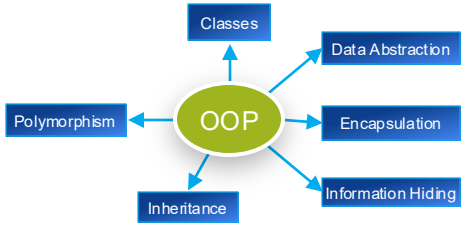
Graph Aware, Graph Preserving

Knowledge Graph



Object Oriented & Type Safe

Namespace



Cross Domain, Harmonized Information Models

SM Profiles

SM Imperative #3: An open, common API for Manufacturing Systems

- ☑ Establish a standard API, consisting of a base set of server primitives that a wide array of platforms can implement to commoditize access to manufacturing data

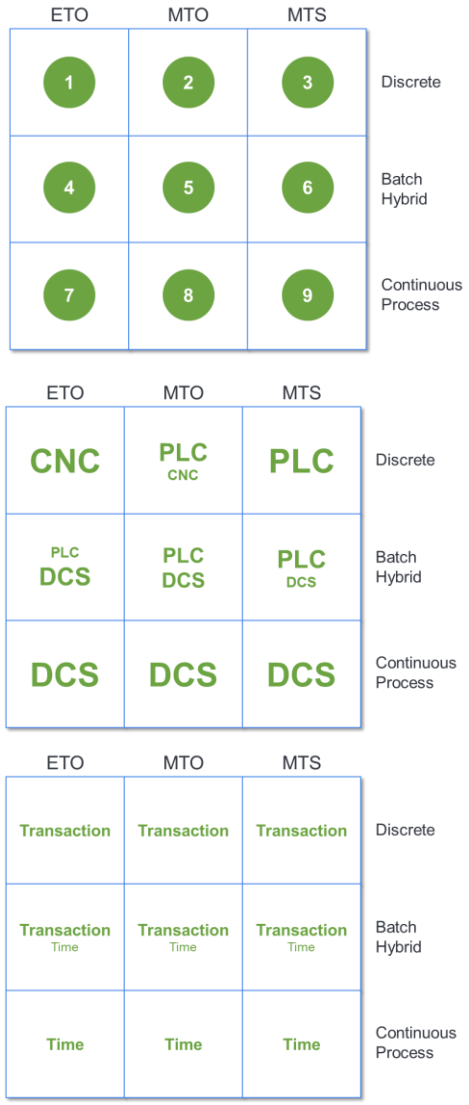
SM Imperative #2: A Clear Set of Requirements Enabling Manufacturing Platform and Application Interoperability (Compliance = SM Interoperability Platform)

- ☑ Instantiate SM Profiles as Type Safe Objects from the SM Marketplace
- ☑ Persist Instance Objects & Relationships (present and past) in a Knowledge Graph

SM Imperative #1: Open, Standards-Based Information-Modeling Strategy for Manufacturing (& related Supply Chain) Assets & Processes

- ☑ Leverage and contribute to a global community building information models (SM Profiles)

SM Imperative #2



Smart Manufacturing Interoperability Platform (SMIP) Requirements*

CESMII THE SMART MANUFACTURING INSTITUTE

- ✓ Ingest SM Profiles from the SM Marketplace
- ✓ Persist instance objects & relationships (present and past) in a graph
- ✓ Support hierarchical and non-hierarchical structures
- ✓ Supports all data types, structured and unstructured, relational and time-series…
- ✓ Support multiple open & standard data sources
- ✓ Support the Open SM API to enable discovery of plant models, equipment & process profile instances & relationships
- ✓ Scale effectively from small sites to large enterprise

The North Star: **SM Interoperability Reference Architecture**

Industry Apps
Production
Maintenance
Quality
Engineering

AI

Digital Twins

PLM Integration

Enterprise & SC Integration

New Capabilities

Smart Manufacturing Marketplace

Standard API

SM Interoperability Platform
- Instantiate SM Profiles (Objects)
- Persist Instance Objects, History & Relationships in a Graph
- Support Multiple Open & Standard Data Sources

Graph Relationships Type-Safe

Ingest SM Profiles

Cloud Library (Open Specification)

CESMII SM Profile™ Designer

SM Edge
Support Multiple Edge Services

Unstructured Data
Audio, Video

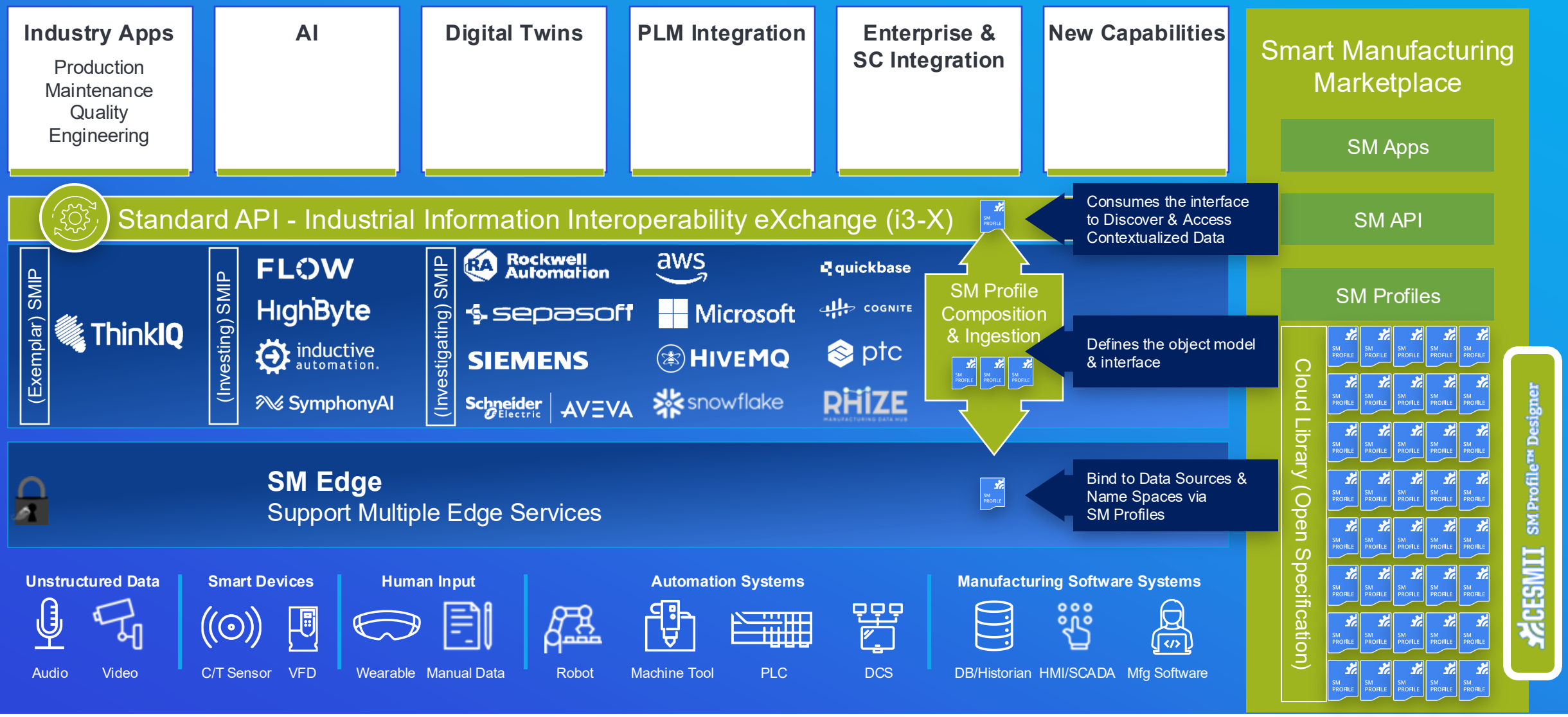
Smart Devices
C/T Sensor, VFD

Human Input
Wearable, Manual Data

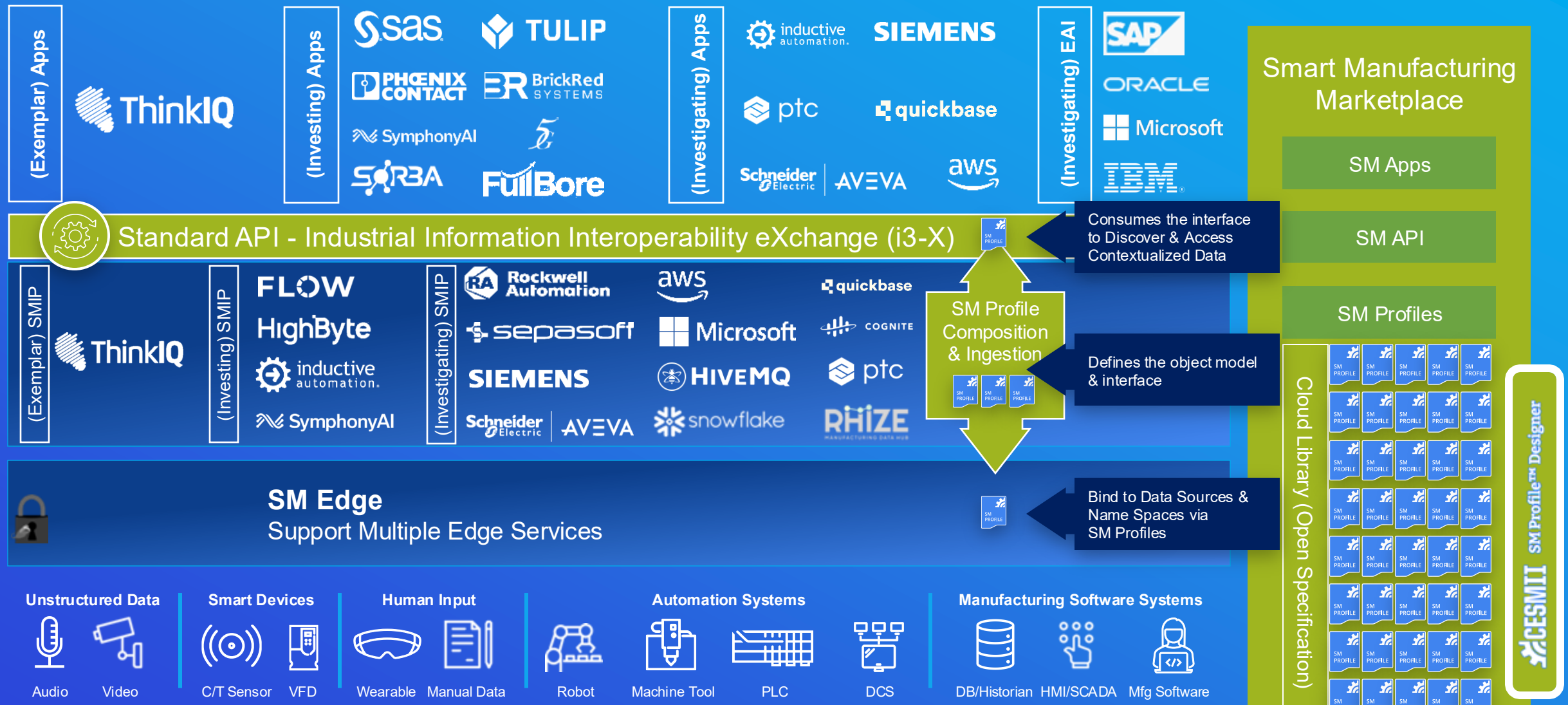
Automation Systems
Robot, Machine Tool, PLC, DCS

Manufacturing Software Systems
DB/Historian, HMI/SCADA, Mfg Software

CESMII Compliance: **SM Interoperability Platforms**



CESMII Compliance: **SM Interoperability Apps**



CESMII Requirements for SM Compliance

Open, Standardized Access

Open API

SM Imperative #3: Create an open, common API for Manufacturing Systems, Rapid App Dev, Scaling AI Deployments, EAI, Supply Chain Optimization…

- ☑ Establish a standard API, consisting of a base set of server primitives that a wide array of platforms can implement to commoditize access to manufacturing data

Graph Aware, Graph Preserving

Knowledge Graph

Object Oriented & Type Safe

Namespace

SM Imperative #2: A Clear Set of Requirements for Manufacturing Platforms to Aspire to Application Interoperability (Compliance = SM Interoperability Platform)

- ☑ Instantiate SM Profiles as Type Safe Objects from the SM Marketplace
- ☑ Persist Instance Objects & Relationships (present and past) in a Knowledge Graph

Cross Domain, Harmonized Information Models

SM Profiles

SM Imperative #1: Open, Standards-Based Information-Modeling Strategy for Manufacturing (& related Supply Chain) Devices, Assets & Processes

- ☑ Leverage and contribute to a global community building information models (SM Profiles)

SM Imperative #3

An Industry First… Standard Manufacturing Information API

A Joint Working Group Following W3C Best Practices for Standards-Development, Est. 2024

i3-X (Industrial Information Interoperability eXchange) Objectives

- Create a common API, consisting of a base set of server primitives that a wide array of platforms can implement to commoditize access to manufacturing data
- Encourage a proliferation of portable apps to help spur adoption of such platforms
- Create a vibrant marketplace of apps bringing value to end-users

Note: Apple and Android users benefit from common APIs for access to device and platform capabilities exposed to app developers that have led to App Stores full of creative, useful, and enjoyable app experiences. Those platform vendors have benefited, but more importantly, the user has benefited.

- Foster Competition and Accelerate Innovation
- Reduce Time to Build, Implement & Sustain Apps
- Eliminate Data Silos & Stovepipe Architectures
- Reduce Vendor Lock-In

GitHub

LEARN MORE

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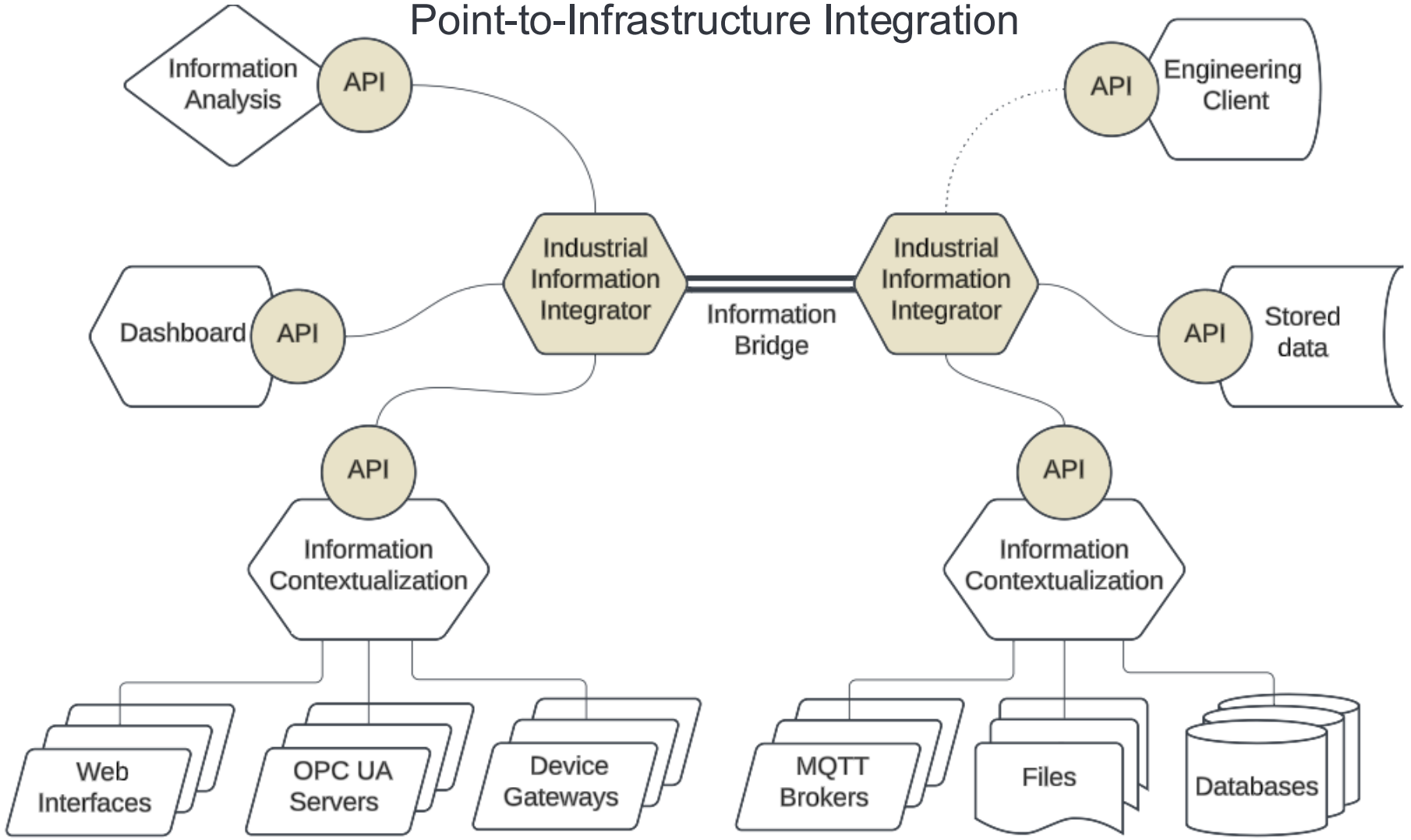
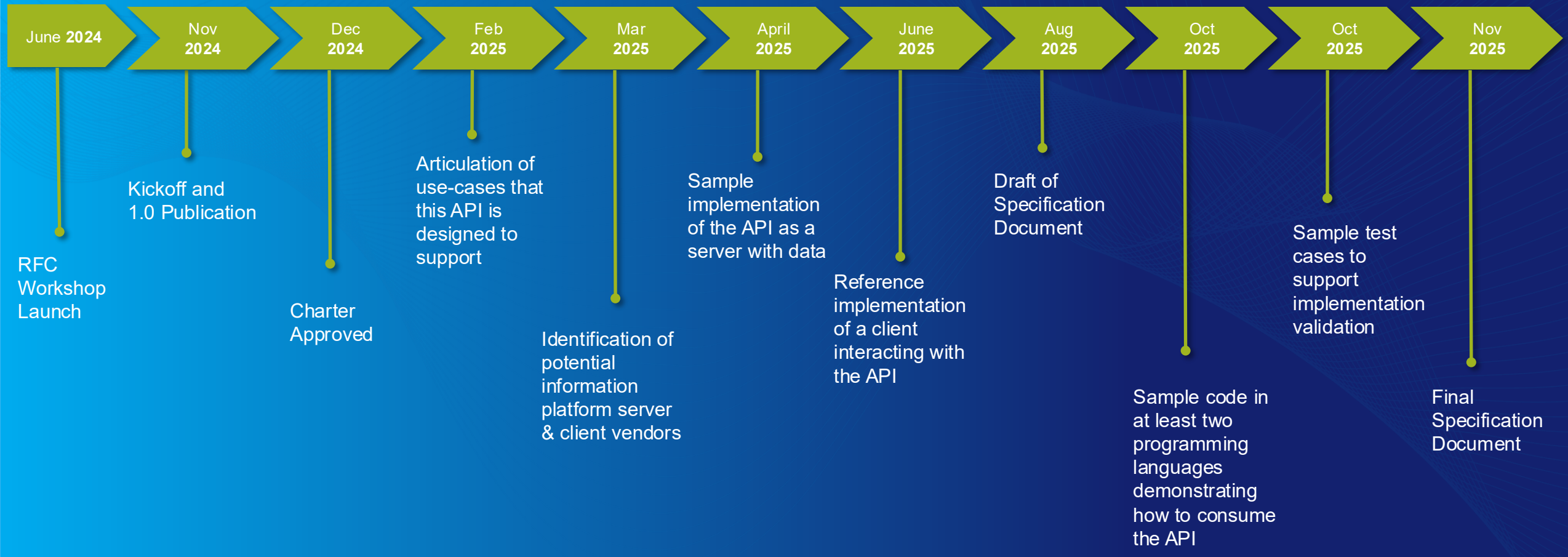
Industrial Information Interoperability eXchange



i3-X Working Group Timeline



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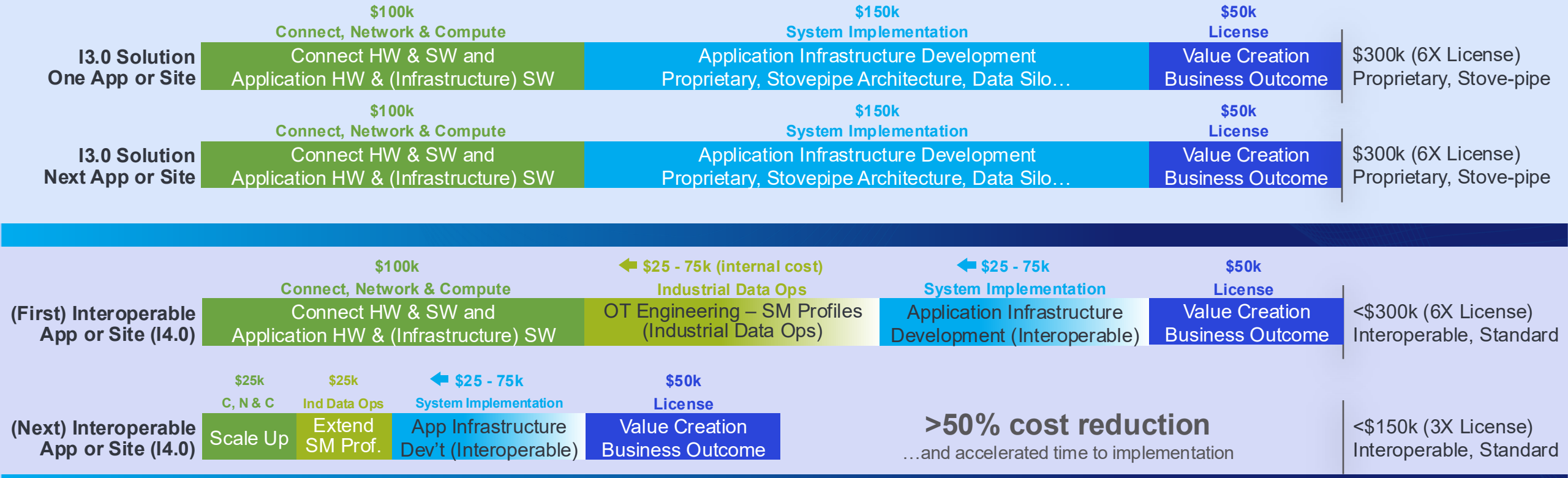
‘Hidden’ Costs of Manufacturing System Implementation

A significant barrier to the adoption of SM/digital transformation – for all manufacturers

- I3.0 solutions at scale are justifiable primarily by large manufacturers, for large sites
- I3.0 solutions don’t scale down well to small and medium sites
- Enterprise roll-outs almost always stall
- Finding economies of scale (from Site 1 to Site N) is highly elusive
- SME’s struggle to justify I3.0 Solutions

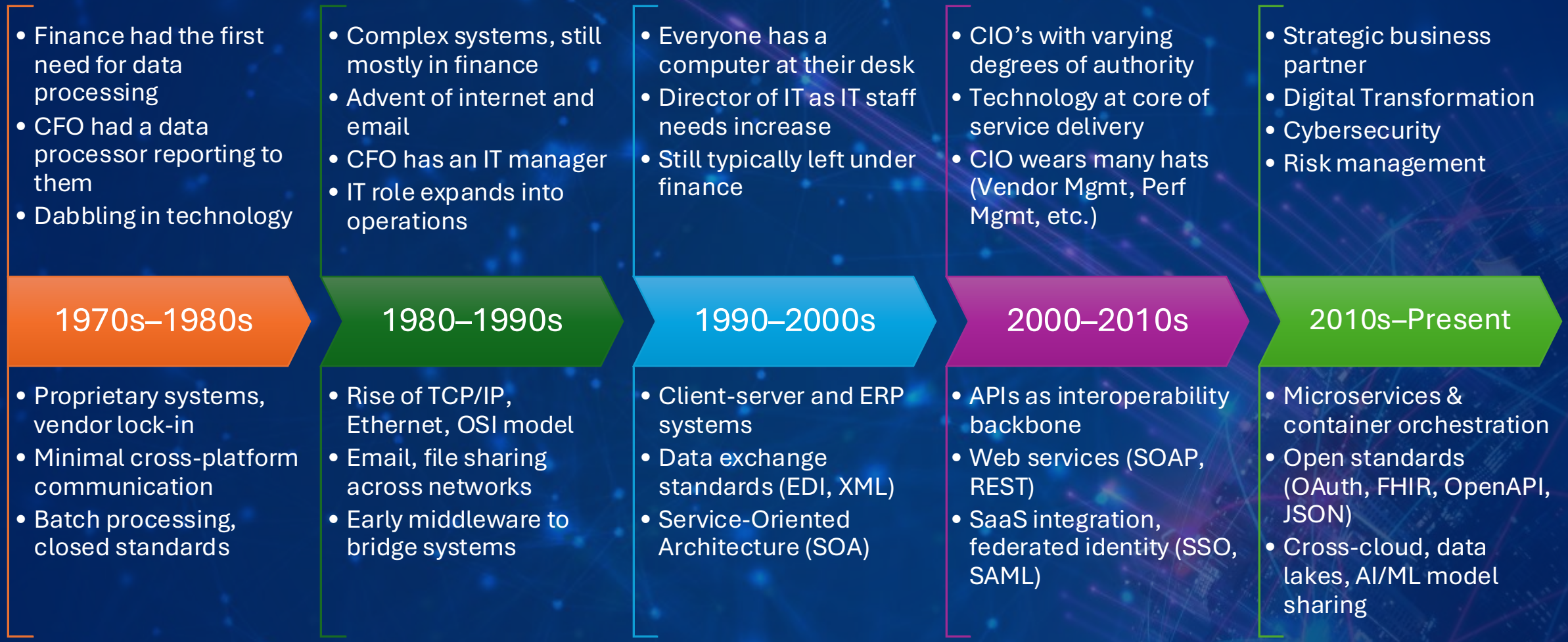


OT Engineering (Industrial Data Ops) is likely an internal function/cost, requiring the development of OT information modelling as a new competency

Global Smart Manufacturing Harmonization

Standards Advocacy, Community Engagement
Supply Chain and Manufacturing Data-Space Development

Evolution of IT: From Data Processing to CIO Office



Evolution of Interoperability: From Proprietary to Modern

Accelerating the Democratization of Smart Manufacturing

CESMII is enabling smart, sustainable operations for ALL manufacturers, driving the next wave of manufacturing productivity, energy productivity and competitiveness through smart manufacturing innovation.

Technology

Enabling Technologies that Decrease Cost & Complexity of SM by 50%

- ☑ **Interoperability through Open Specifications**
- ☑ **OT Data Foundations**

Knowledge

Business and Technology Tools, Strategies & Education to help align resources & people for success

- ☑ **Align Manufacturing Strategy with Digital Capabilities & Roadmap**
- ☑ **Next Gen Connected Workforce**

Ecosystem

Convene relevant industry stakeholders to solve problems no one company can solve on its own

- ☑ **Engage, Learn & Serve**
- ☑ **Cultivate a Smart Manufacturing Mindset**

In order to “Strengthen U.S.’ Competitiveness Through Smart Manufacturing”…

What Must Be True?

Knowledge

Knowledge

Establish education, training and organizational capabilities that align resources and people for success

SM Roadmap Tools

Resources for business executives, innovation champions, and managements consultants, who need to understand technology-enabled operating modes and justify their investment.

LEARN MORE

Curriculum Resources

Resources for professors and trainers teaching SM principles, skills and ideologies at universities, community colleges, training centers and in the workplace.

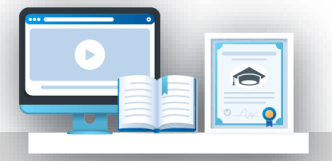
LEARN MORE

Training Resources

Resources for students and existing workforce from process engineers to technicians, and operators — that need to understand how to leverage SM-produced data, insights and capabilities in their daily work.

LEARN MORE

Building Sustainable Cultures of Digitally Enabled Operational and Organizational Excellence



Smart Manufacturing
Technologies, Tools, Curricula

Expand the Catalog
Access tools and technology solutions available through the ecosystem for different industry needs.

Develop | Verify | Market
Grow your portfolio with the ecosystem support to help develop, verify and market new solutions.

CESMII
THE SMART MANUFACTURING INSTITUTE

CONSULTING SUPPORT

EDUCATION SUPPORT

TECHNOLOGY SUPPORT

Smart Manufacturing
Support Ecosystem

Expand the Network
Find professionals with specialized skills that complement your team.

Train | Equip | Certify
Enhance the skills in your team to improve regional support for manufacturers in their adoption journey.

…and meeting **manufacturers** ‘where they’re at’

Demo Day/Roadshow Opportunities

SM Introductory Presentations and Demonstrations

½ Day Workshops

Leadership Workshops

1-2 Day Workshops/ Bootcamps

Hands-On Technical Training

Education Catalog

Workforce Training Programs

AWARENESS → **EDUCATION** → **IMPLEMENTATION**

SM Strategic Roadmap

SM Roadmap Professionals

SM Implementation Projects

Smart Manufacturing Integrators

The Evolution of a Smart Manufacturing Mindset

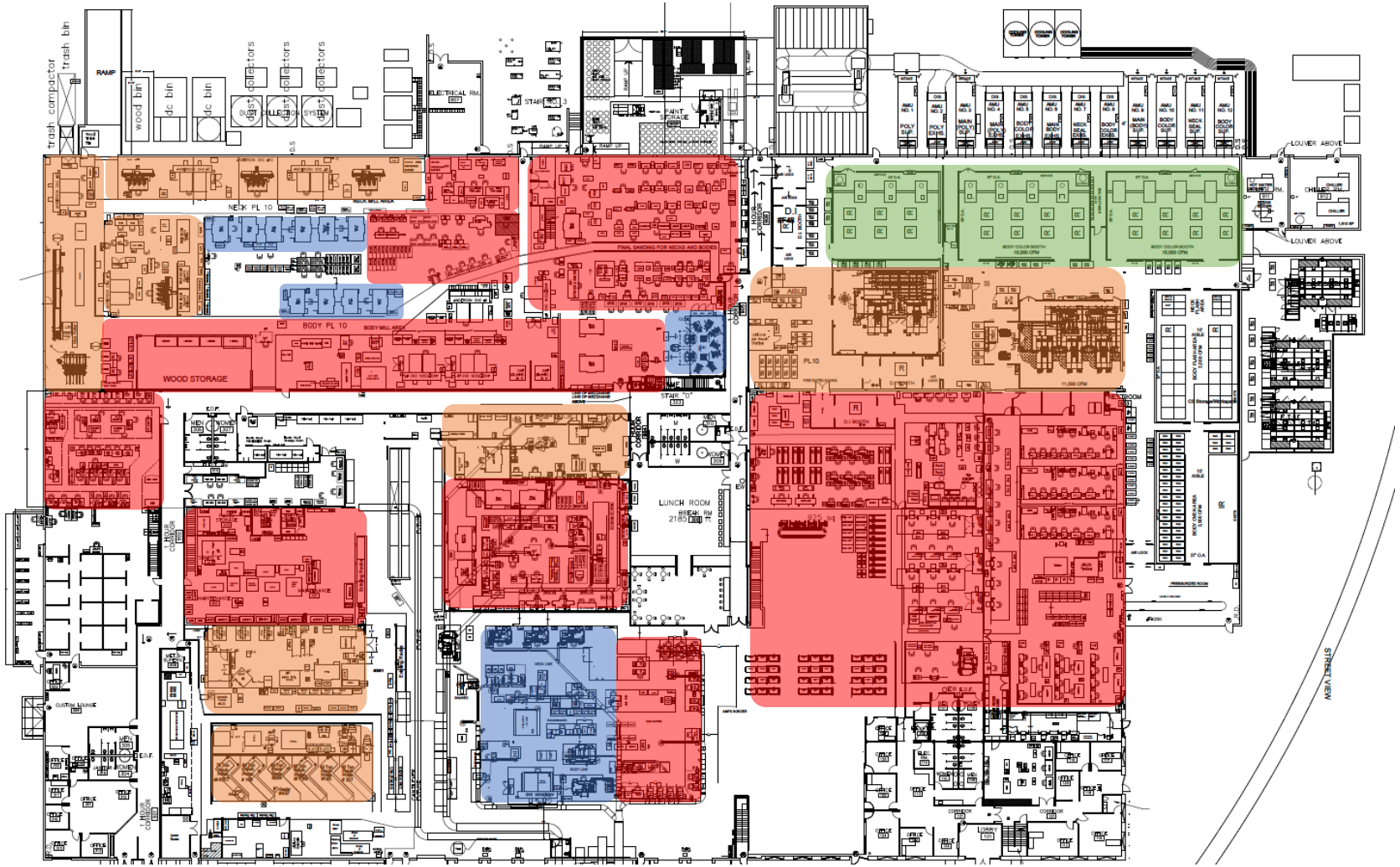
Establish a Strategic Roadmap

Align the team on goals, a culture of innovative collaboration, and a roadmap that defines the path to advancing digital maturity.

	RUN	IMPROVE	TRANSFORM
Establish a Resilient and Agile Ecosystem	Develop fundamental data exchange elements with strategic partners	Key data is exchanged in real time, enabling collaboration and decision-making across partners.	Disruptions are mitigated with predictive and prescriptive decisions across the eco-system
Optimize the People Work	Define the processes and standardize work. Eliminate, simplify or automate	Provide workers access to the data they need to perform their jobs when they need it in a user-friendly format for each specific job.	Improve safety and quality through AI-based guidance, assistance techniques and workflow.
Integrate Interoperable Systems Platform	Systems are silos and built for function or purpose. Independent data models	Common Platform, connectivity and unified data model for contextualization and applications resource	Fully integrated systems on platform. Applications enabling predictive and prescriptive decisions
Build Data Driven Processes	Begin the shift from decisions by opinion to decisions based on facts (data)	Data is collected and contextualized and used in standardized reports and decision processes	Data is complete, trusted, transformed and transparent. Available to all at the right time, place and context.
Develop Digital Culture and Mindset	Establish Manufacturing Excellence program (CI, TPM, Lean, Six Sigma)	Digitally enable Mfg Excellence program with a Data-Digital First approach. Digital Lean.	Digital Culture and Mindset is part of Manufacturing DNA.
Develop Future State Vision & Strategy	Digital opportunities are emerging but not developed into future state strategic plan.	Digital Vision has been created for future state and started to build into execution strategy	Digital Vision, Future State and Strategy are in place & operationalized in appropriate functions

"Smart Manufacturing is a team sport. We can no longer work in silos" Lisa Zasada, General Mills

Enterprise, Site, Area Readiness/Maturity



Manufacturing Data Source Type

- Automated / Connected Equipment
- Connectable Equipment
- Legacy / Analog Equipment
- Manual Activities

Accelerate Your Smart Manufacturing Strategy

MANUFACTURER INNOVATION ADOPTION PROCESS

Explore | Assess | Focus | Roadmap | Execute & Sustain | Validate

What is Possible
- ❑ Attend Events
- ❑ Check Competitors
- ❑ Understand Options
- ❑ Challenges Addressed
- ❑ Success Stories

Why SM for us?

Democratized Technology
- ❑ Seek Demonstrations
- ❑ Pilot Technology

Current State
- ❑ Competitiveness
- ❑ Market Readiness
- ❑ People/Process/Tech

Current Opportunities
- ❑ Educate Leaders

Challenges, Opportunities
- ❑ Business Drivers
- ❑ Value Proposition

Future State
- ❑ Tech-enabled Strategy
- ❑ Select Solutions, Path
- ❑ People/Process/Tech

Business Drivers
- ❑ Key Milestones
- ❑ 1-3 Year Plan

Project Definition
- ❑ Scope, Business case

SM Foundation
- ❑ Establish Infrastructure
- ❑ Dev SM Solutions

Implement Solutions
- ❑ Quick Wins – Agile
- ❑ People, Process, Tech

Change Management
Knowledge Transfer
- ❑ Training and Adoption

Support

Validate Success
- ❑ Business value
- ❑ Impact
- ❑ Timeliness

Accelerate your journey with a Strategic Smart Manufacturing Roadmap
One of our certified professionals can help jump start your SM journey, align your business strategy, and increase operational performance.

Smart Manufacturing Acceleration **Roadmap** Framework

Explore | Assess | Focus | Roadmap | Execute & Sustain | Validate

Resources, Templates, and Tools

Prepare & Execute Assessment Process
- Kick Off Meeting
- Suggested Stakeholders
- Assessment Invite
- Business Practices Assessment
- Roadmap Progression

Develop Themes/Insights from Assessment
- SM State Transition Matrix
- Assessment Reports
- Assessment Analysis Helper

Review Insights with Clients & Determine Opportunities/Gaps
- Assessment Summary Deck

Develop Deep-Dive Questions & Determine Audience
- Deep Dive Interview Questions

Coordinate & Conduct Deep-Dive Interviews

Analyze Insights from Interviews & Review with Client
- Deep Dive Analysis Helper
- Deep Dive Summary

Develop Opportunities & Business Impact/Value
- Use Case Valuation

Define Future State
- Future State Assessment Invite
- Roadmap Glossary
- Business Practices Assessment & Reports

Develop Roadmap Business Objectives & Programs
- Roadmap Builder - Roadmap (Objectives, Programs)

Develop Roadmap Initiatives Purpose, and Scope
- Roadmap Builder – Roadmap (Initiatives, Business Value)

Prioritize Programs, Initiatives & Projects
- Roadmap Builder – Timeline, Now Expanded, Timeline Chart

Finalize Roadmap, Develop Communication Decks
- Roadmap Summary

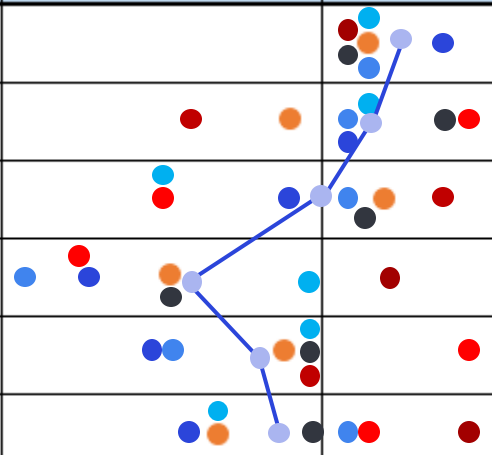
Learn More

Gaining Alignment and Understanding Gaps/Opportunities

Number of Respondents: **120**

ABC Company **Current State Assessment Results**

Descriptive words/Definition:	*Disconnected, Highly Manual, Highly Reactive, Isolated, low and unsophisticated technology adoption*	*Learning about Digitalization of the Business and the opportunities that can be acheived.*	*Vision for tactical execution. Best practices shared across teams and organizations. Primarily manual sharing of data and information across People, Processes, and Technology. Evaluative decision making after reviewing data and information.*	*Proactively use data and insights to plan for and drive continuous process improvement. Proactive and Predictive management of People, Processes, and Technology.*	*Strategic vision and in-progress execution to fully optimize and leverage People, Process, and Technology. Information is acted upon in near real-time by People, Process, and Technology*
Critical Smart Manufacturing Areas	**Reactive**	**Aware**	**Collaborative**	**Proactive**	**Adaptive**
Manufacturing Strategy and Leadership					
Manufacturing Excellence & Culture					
Data-Driven Processes					
Systems Infrastructure and Integration					
Workforce Optimization					
SC Resilience & Agility					



- Supply Chain management, Purchasing, Sourcing
- Engineering, R&D, Design, Technical Management
- Information Technology or Systems IT/IS
- C-Level/Executive Management
- Operations, Production, Plant Management
- Quality
- Other
- All Company Average

Smart Manufacturing State Transition Matrix

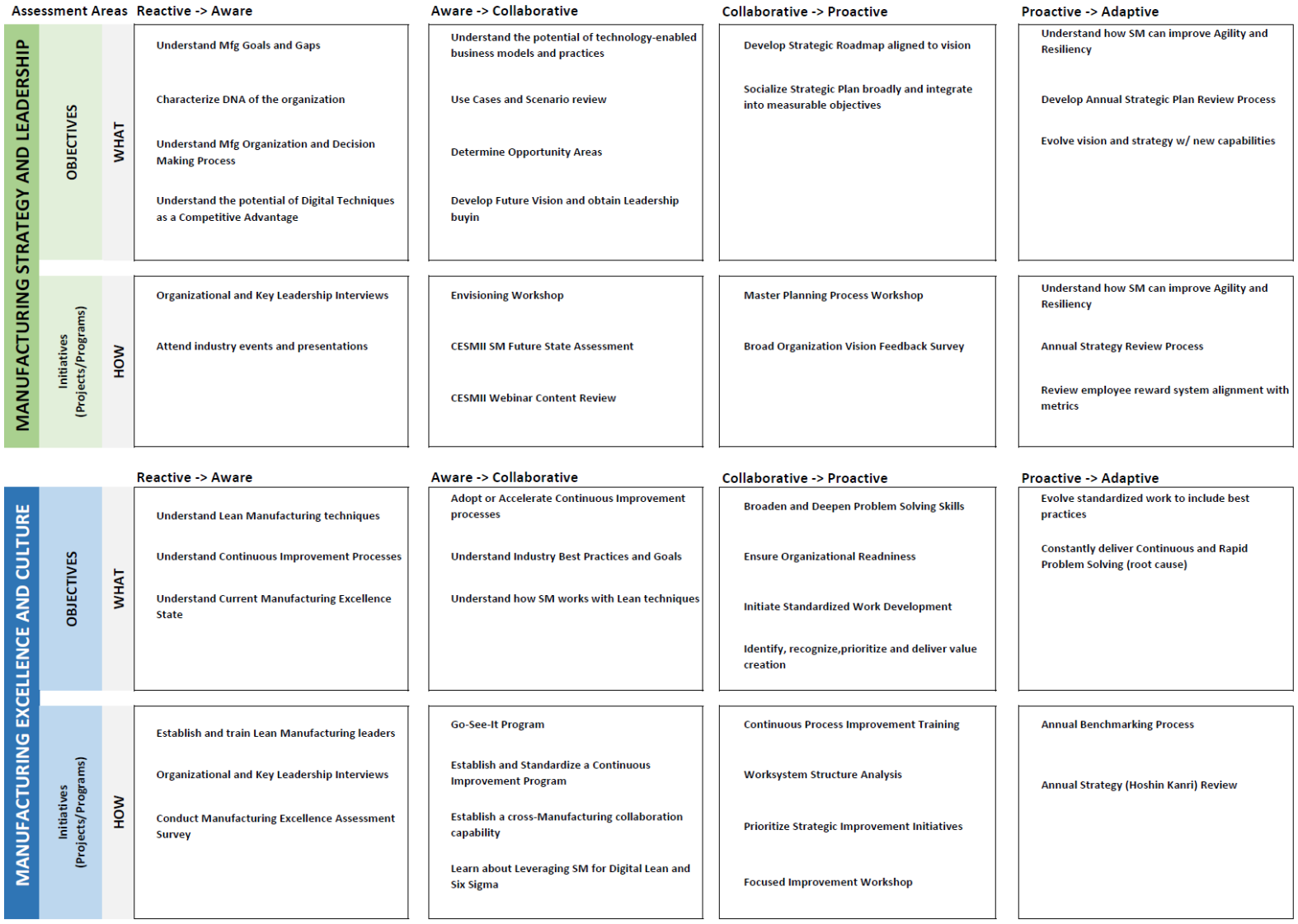
	Disconnected, Highly Manual, Highly Reactive, Isolated, low and unsophisticated technology adoption	*Learning about Digitalization of the Business and the opportunities that can be acheived.*	*Vision for tactical execution. Best practices shared across teams and organizations. Primarily manual sharing of data and information across People, Processes, and Technology. Evaluative decision making after reviewing data and information.*	*Proactively use data and insights to plan for and drive continuous process improvement. Proactive and Predictive management of People, Processes, and Technology.*	*Strategic vision and in-progress execution to fully optimize and leverage People, Process, and Technology. Information is acted upon in near real-time by People, Process, and Technology*
Critical Smart Manufacturing Areas	**Reactive**	**Aware**	**Collaborative**	**Proactive**	
Manufacturing Strategy and Leadership		⊗	⊗ → ⊗		
Manufacturing Excellence & Culture			⊗ → ⊗		
Data-driven Processes		⊗ → ⊗			
Connected Systems	⊗	→ ⊗			
Optimized Workforce		⊗	→ ⊗		
Supply Chain Resilience & Agility		⊗	→ ⊗		

Resources and Tools for Manufacturer to establish Technology-Enabled Roadmap

⊗ Current State ⊗ Future State

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

SM Business Case: Strategy Development



Assessment Areas			Reactive -> Aware	Aware -> Collaborative	Collaborative -> Proactive	Proactive -> Adaptive
MANUFACTURING STRATEGY AND LEADERSHIP	OBJECTIVES	WHAT	Understand Mfg Goals and Gaps Characterize DNA of the organization Understand Mfg Organization and Decision Making Process Understand the potential of Digital Techniques as a Competitive Advantage	Understand the potential of technology-enabled business models and practices Use Cases and Scenario review Determine Opportunity Areas Develop Future Vision and obtain Leadership buyin	Develop Strategic Roadmap aligned to vision Socialize Strategic Plan broadly and integrate into measurable objectives	Understand how SM can improve Agility and Resiliency Develop Annual Strategic Plan Review Process Evolve vision and strategy w/ new capabilities
	Initiatives (Projects/Programs)	HOW	Organizational and Key Leadership Interviews Attend industry events and presentations	Envisioning Workshop CESMII SM Future State Assessment CESMII Webinar Content Review	Master Planning Process Workshop Broad Organization Vision Feedback Survey	Understand how SM can improve Agility and Resiliency Annual Strategy Review Process Review employee reward system alignment with metrics

			Reactive -> Aware	Aware -> Collaborative	Collaborative -> Proactive	Proactive -> Adaptive
MANUFACTURING EXCELLENCE AND CULTURE	OBJECTIVES	WHAT	Understand Lean Manufacturing techniques Understand Continuous Improvement Processes Understand Current Manufacturing Excellence State	Adopt or Accelerate Continuous Improvement processes Understand Industry Best Practices and Goals Understand how SM works with Lean techniques	Broaden and Deepen Problem Solving Skills Ensure Organizational Readiness Initiate Standardized Work Development Identify, recognize,prioritize and deliver value creation	Evolve standardized work to include best practices Constantly deliver Continuous and Rapid Problem Solving (root cause)
	Initiatives (Projects/Programs)	HOW	Establish and train Lean Manufacturing leaders Organizational and Key Leadership Interviews Conduct Manufacturing Excellence Assessment Survey	Go-See-It Program Establish and Standardize a Continuous Improvement Program Establish a cross-Manufacturing collaboration capability Learn about Leveraging SM for Digital Lean and Six Sigma	Continuous Process Improvement Training Worksystem Structure Analysis Prioritize Strategic Improvement Initiatives Focused Improvement Workshop	Annual Benchmarking Process Annual Strategy (Hoshin Kanri) Review

SM Business Case: Justification

SM Business Case: ROI

Loss Areas	Current	Future	
Rate Loss	10%	5%	Comparison of running rate to target rate
Unplanned Downtime	7%	3%	Equipment and/or work process failure
Quality	2%	2%	% of output that is shippable without rework (no defects)
Conversion Loss (Waste)	8%	7%	Scrap and waste
Cycle Time (hours)	62	60	Average time from beginning to end of conversion process
Energy Waste	25%	15%	Overuse of Energy

Rate Loss

Units/Day 215,939 ▲ 10,283

If no increase in demand - run less days		Sell more- plants days constant	
Annual Revenue	$ 175,000,000	Annual Revenue	$ 183,750,000.00
Annual Production	51,414,000	Annual Production	53,984,700
Days of Production	238	Days of Production	250
Fixed Cost *	$ 49,761,905	Fixed Cost	$ 50,000,000
Variable Cost	$ 110,000,000	Variable Cost	$ 115,500,000
Profit per unit	$ 0.30	Profit per unit	0.34
Gross Margin Improvement	**$ 238,095**		**$ 3,250,000**

* assuming labor relieved during idle periods

UnPlanned Downtime

units/day 213,882 ▲ 8,226

If no increase in demand - run less days		Sell more- plants days constant	
Annual Revenue	$ 175,000,000	Annual Revenue	$ 182,000,000
Annual Production	51,414,000	Annual Production	53,470,560
Days of Production	240	Days of Production	250
Fixed Cost *	$ 49,807,692	Fixed Cost	$ 50,000,000
Variable Cost	$ 110,000,000	Variable Cost	$ 114,400,000
Profit per unit	$ 0.30	Profit per unit	0.33
Gross Margin Improvement	**$ 192,308**		**$ 2,600,000**

* assuming labor relieved during idle periods

Quality

Units/Day 205,656 ▲ -

If no increase in demand - run less days		Sell more- plants days constant	
Annual Revenue	$ 175,000,000	Annual Revenue	$ 175,000,000
Annual Production	51,414,000	Annual Production	51,414,000
Days of Production	250	Days of Production	250
Fixed Cost *	$ 50,000,000	Fixed Cost	$ 50,000,000
Variable Cost	$ 110,000,000	Variable Cost	$ 110,000,000
Profit per unit	$ 0.29	Profit per unit	0.29
Gross Margin Improvement	**$ (0)**		**$ (0)**

* assuming labor relieved during idle periods

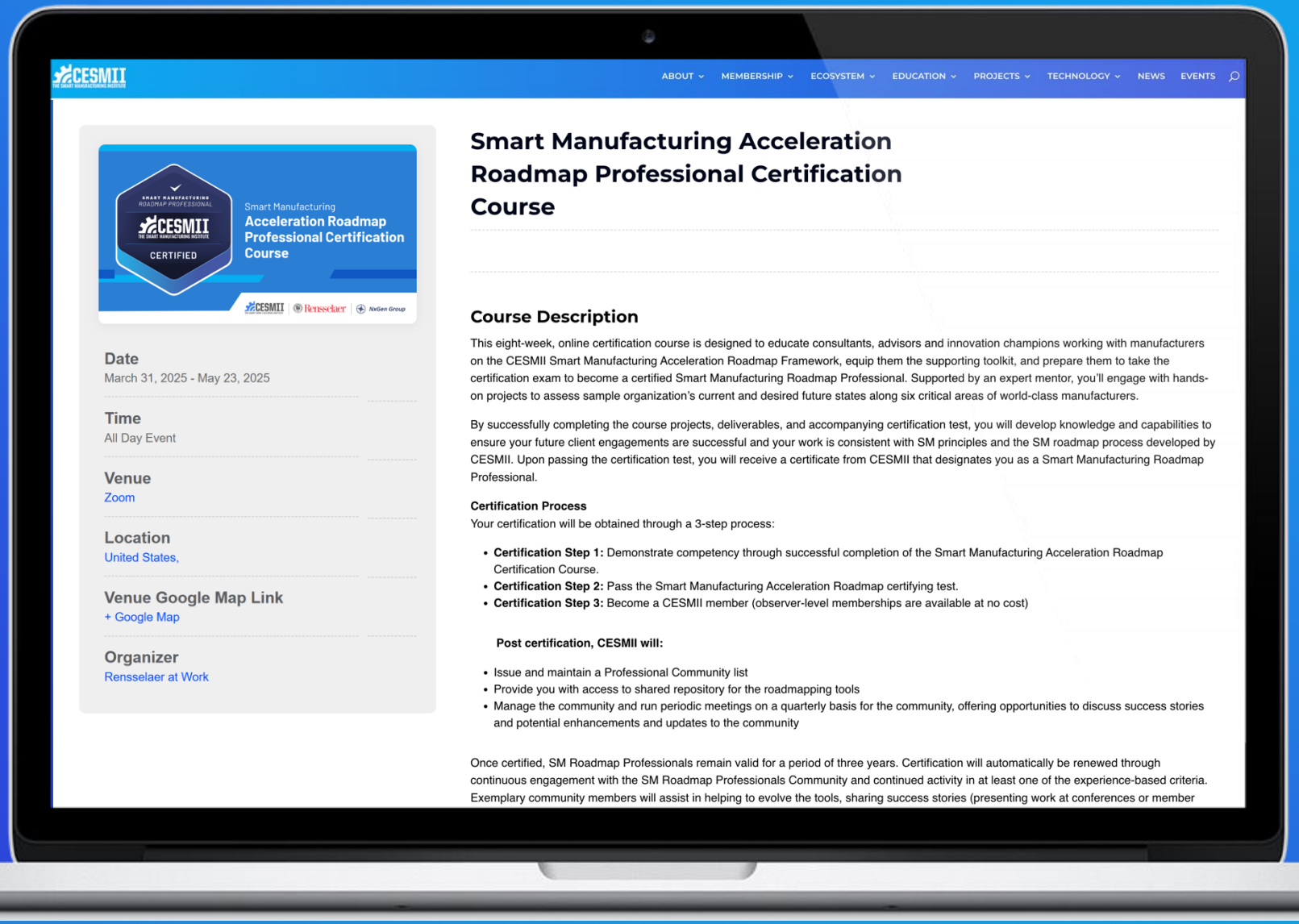
Conversion Loss

units/day 207,301 ▲ 1,645

If no increase in demand - run less days		Sell more- plants days constant	
Annual Revenue	$ 175,000,000	Annual Revenue	$ 176,400,000
Annual Production	51,414,000	Annual Production	51,825,312
Days of Production	248	Days of Production	250
Fixed Cost *	$ 49,960,317	Fixed Cost	$ 50,000,000
Variable Cost	$ 109,736,000	Variable Cost	$ 110,616,000
Profit per unit	$ 0.30	Profit per unit	0.30
Gross Margin Improvement	**$ 303,683**		**$ 784,000**

* assuming labor relieved during idle periods

SM Roadmap Professional Training



Price: $2,500

Duration: 8 weeks

Next Course: June

Delivered fully online; Project-based hands-on work

Weekly live evening sessions with industry experienced coach

Designed for experienced consultants with manufacturing expertise

Receive CESMII certification

Learn More

CESMII Certified
Smart Manufacturing Roadmap Professionals

A growing community of experienced professionals using these processes and tools to help manufacturers in every region!

THIS COULD BE **YOUR TEAMMATE!**

Learn More

Accelerating the Democratization of Smart Manufacturing

CESMII is enabling smart, sustainable operations for ALL manufacturers, driving the next wave of manufacturing productivity, energy productivity and competitiveness through smart manufacturing innovation.

Technology

Enabling Technologies that Decrease Cost & Complexity of SM by 50%

- ☑ **Interoperability through Open Specifications**
- ☑ **OT Data Foundations**

Knowledge

Business and Technology Tools, Strategies & Education to help align resources & people for success

- ☑ **Align Manufacturing Strategy with Digital Capabilities & Roadmap**
- ☑ **Next Gen Connected Workforce**

Ecosystem

Convene relevant industry stakeholders to solve problems no one company can solve on its own

- ☑ **Engage, Learn & Serve**
- ☑ **Cultivate a Smart Manufacturing Mindset**

Ecosystem

Convene all relevant industry stakeholders to accelerate the adoption of Smart Manufacturing

Smart Manufacturing Executive Council

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 to develop practical guidance and policy recommendations that will help this ecosystem.

Manufacturing Extension Partnerships

A Manufacturing Extension Partnership (MEP) is a national network that helps small and medium-sized manufacturers (SMMs) improve efficiency, productivity, and competitiveness. CESMII partners with MEPs to accelerate Smart Manufacturing (SM) adoption.

Smart Manufacturing Innovation Centers

Smart Manufacturing Innovation Centers (SMICs) are centers of excellence throughout the U.S. that enable access to small, medium, and large businesses, connecting manufacturing assets to our SM Interoperability Platform, national policy development, industry awareness, and workforce development.

International Manufacturing-X

International Manufacturing-X (IM-X) is a global initiative fostering a decentralized, collaborative data ecosystem to enhance resilience, sustainability, and competitiveness in smart manufacturing. It integrates the entire value chain—from design to the circular economy—through digitalization and global cooperation across academia, industry, and policy.

SMART MANUFACTURING EXECUTIVE Council

Strengthening the U.S.' Competitiveness Through Smart Manufacturing

Our Charter: The Smart Manufacturing Executive Council has been formed to advocate for the strengthening of U.S. manufacturing and offer strategic guidance to revitalize our competitiveness and transform the future of U.S. manufacturing.

Our Objective: To develop the strategies, the value justification and policy recommendations that will help US manufacturers become more competitive.

- 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 relevant stakeholder group 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

SMART MANUFACTURING EXECUTIVE Council

Strengthening the U.S.' Competitiveness Through Smart Manufacturing

Chris Campbell
Andersen Windows

Antoine Dhennin
ArcelorMittal

Larry Megan
Baldwin Richardson Foods

Alpen Patel
Caterpillar

Jim LaPenna
Corning

Dave Krivan
Dana

Craig Sutton
Eaton

Michael Hotaling
ExxonMobil

Michael Bastian
Ford

Scott King
Ford

Mike Tomasco
FUJIFILM

Jon Hobgood
GE Healthcare

Lisa Zasada
General Mills

Jeff Abell
General Motors

Anthony Huffman
Georgia-Pacific

Steve Glor
IDEXX

Ken Creasy
Invio Automation

Maria Araujo
McCain Foods

Josh Dotson
Koch Industries

Audrey St. Onge
Lallemand Baking

Matthew Laing
Lilly

Jesus Flores
Linde

Roger Brecht
Nestlé Purina

Brian Perlstein
Owens Corning

Jeff Kent
Procter & Gamble

Rich Van Dyke
PepsiCo

Kelly Dodds
Raytheon

Brendan Mullins
ResMed

John McKenzie
Stellantis

Venu Pillai
Thermo-Fisher Scientific

Trever White
Toyota

Rachelle Howard
Vertex Pharmaceuticals

LEARN MORE

SMART MANUFACTURING EXECUTIVE Council

Meet the Advisory Board

SMART MANUFACTURING EXECUTIVE COUNCIL
CO-CHAIRS

John **Dyck**

CESMII

Jeannine **Kunz**

sme

Sudhi **Banglore**

FullBore Driving for Impact

Dean **Bartles**

MTDG Manufacturing Technology Deployment Group, Inc.

Rick **Bullotta**

Formerly thingworx

Simon **Jacobson**

Gartner

Matthew **Littlefield**

LNS Research

Colin **Masson**

ARC Advisory Group

Peggy **Smedley**

specialty publishing media

Bart **Talloen**

WORLD ECONOMIC FORUM

Jim **Wetzel**

NxGen Group

Jeff **Winter**

Critical manufacturing

FRED ECONOMIC DATA | ST. LOUIS FED

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Manufacturing Sector: Output per Worker for All Workers (PRS30006163)

Observations
Q1 2025: **97.008**
Updated: May 8, 2025 7:36 AM CDT
Next Release Date: Jun 5, 2025

Units:
Index 2017=100,
Seasonally Adjusted

Frequency:
Quarterly

1Y | 5Y | 10Y | Max

1987-01-01 to 2025-01-01

Edit Graph

Download

The Administration's Policy, Trade Agreements and Tariffs Shine the Spotlight on Manufacturing and Reshoring, but at a Time When US Productivity Has Stalled and Manufacturers Struggle to Hire/Retain their Workforce

Source: U.S. Bureau of Labor Statistics via FRED®
Shaded areas indicate U.S. recessions.

fred.stlouisfed.org

Fullscreen

Manufacturing is at a Generational Inflection Point

This Administration Needs **Trusted Advisors**

U.S. Manufacturers Need the **Economic Framework** & **Strategic Guidance** to Fuel Sustained Innovation & Productivity Growth

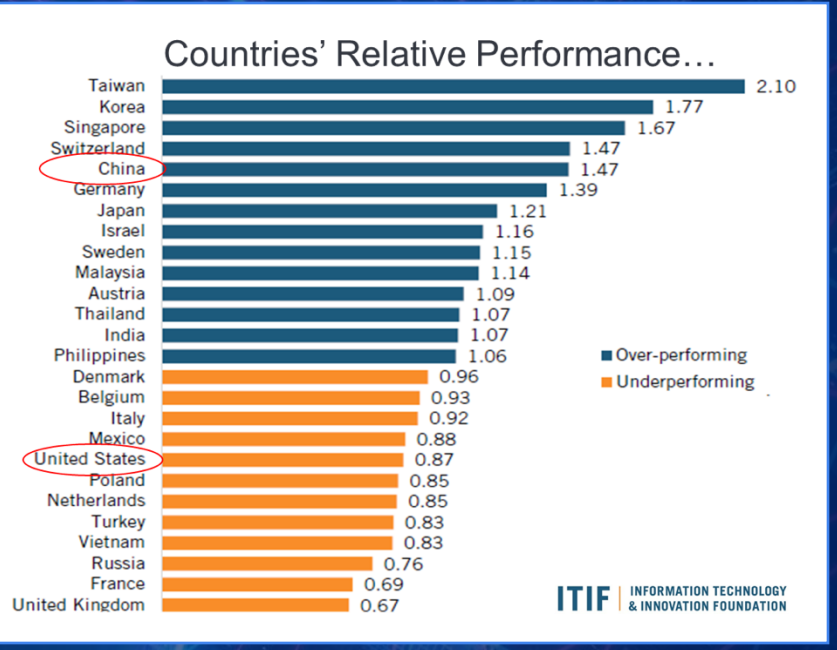
- Economic incentives to invest in automation, worker education, AI and digital transformation
- Address our labor challenges via automation, education & immigration policy

- Invest in innovation for the entire manufacturing value chain
  - Energy, materials, machines, machine builders, manufacturing data infrastructure…
- Ensure that ALL sizes of manufacturers are able to participate and benefit in this reshoring

ITIF | INFORMATION TECHNOLOGY & INNOVATION FOUNDATION
HAMILTON CENTER ON INDUSTRIAL STRATEGY

The Hamilton Index, 2023: China Is Running Away With Strategic Industries

ROBERT D. ATKINSON AND IAN TUFTS | DECEMBER 2023



In order to “Strengthen U.S.’ Competitiveness Through Smart Manufacturing”…

What Must Be True?

Who Are The Key Stakeholder Groups

Federal Policy Makers
Provide Industrial Policy guidance that favors investment in manufacturing productivity and competitiveness

Influence & Educate…

F1000 Manufacturing Leadership
Inspire confident investment in automation, workforce education and smart manufacturing

Engage & Educate…

Small & Medium Manufacturers
Is there a value proposition to entice or incentivize SMMs to engage in SM

Educate & Incentivize…

SMART MANUFACTURING
EXECUTIVE Council

Fly-In

Aligning Smart Manufacturing Essentials to Federal Policy

1. Smart Manufacturing Tax Credits
2. Worker Upskilling
3. Data Interoperability & Resilient Supply Chains

The 5 Promises of Smart Manufacturing

1. Attract, Empower and Retain the Workforce of Today and Tomorrow
2. Uncompromising Customer Focus
3. Risk Mitigation and Optimization (Safety, Quality, Productivity)
4. Structured Innovation and Transformation, Driving Speed to Market
5. Profitably Achieve Sustainability and Circular Economy Goals

Smart Manufacturing Innovation Centers

CESMII enables businesses of all sizes to connect assets to our SM Interoperability Platform while advancing policy, industry awareness, and workforce development through SMIC satellite locations.

50 Energy Efficiency Recommendations

89 Mfg Assets Connected to SMIP

144 Industry Engagement Events

~1000 SM Assessments & Surveys

7000/yr SM-Educated Students

6000/yr SM-Upskilled Workers

Manufacturing Extension Partnership

There are 51 MEP Centers across all 50 states and Puerto Rico.
20 of which are CESMII Members and collaborating with us on Smart Manufacturing best practices.

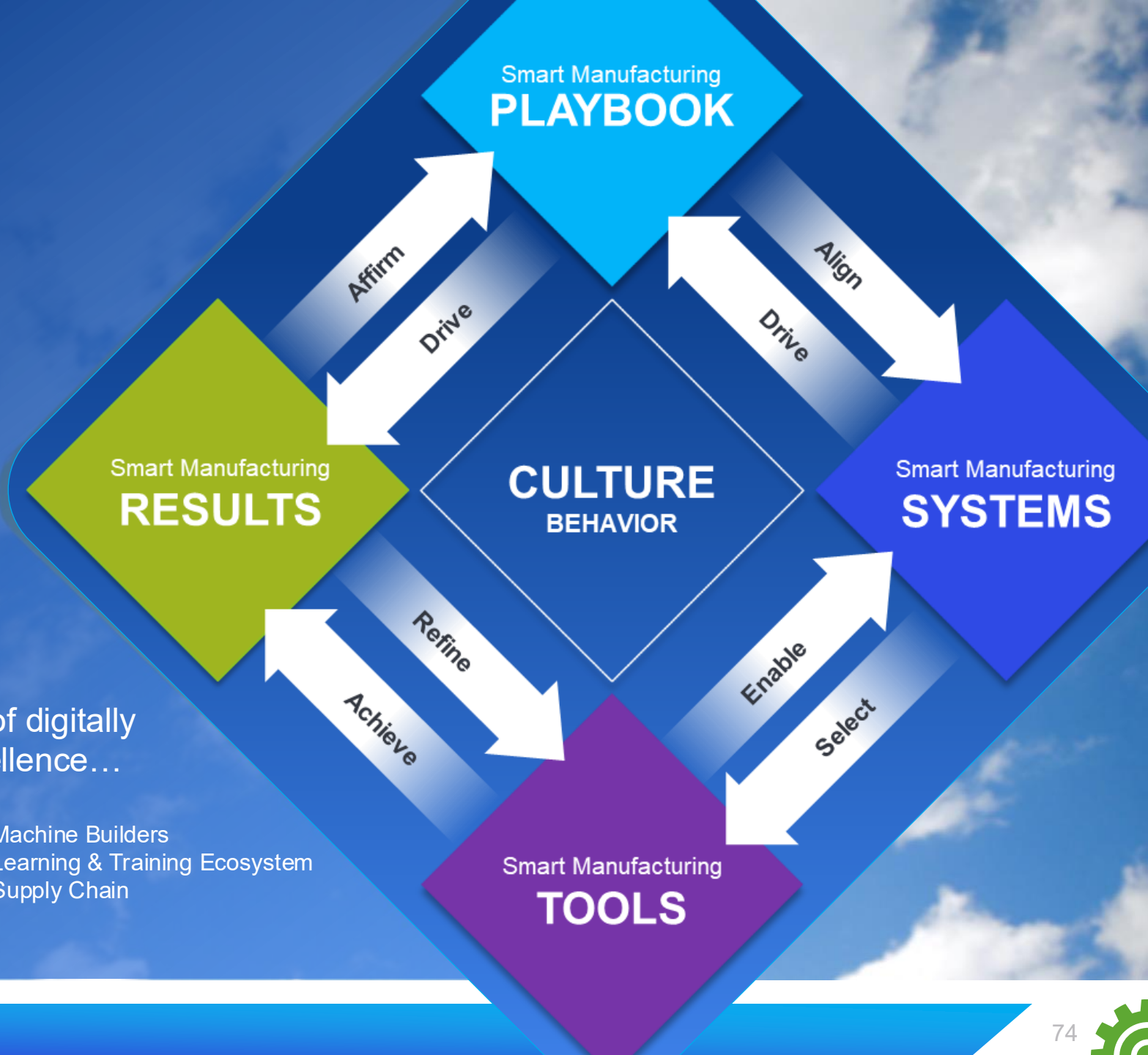
NIST MANUFACTURING EXTENSION PARTNERSHIP

Developing a
Smart Manufacturing Mindset…

The Smart Manufacturing *Playbook*

The basis for building a sustainable culture of digitally enabled operational and organizational excellence…

- Corporate Manufacturing & Supply Chain Leadership
- Technology Providers
- Strategy Consultants & System Integrators
- Federal Policy Makers
- Machine Builders
- Learning & Training Ecosystem
- Supply Chain



SMART MANUFACTURING
EXECUTIVE Council
VOICE OF INDUSTRY

Trends & Drivers

- Workforce Scarcity and Skill Gaps
- Changing Customer Behavior and Expectations
- Next Generation Productivity
- Climate Disruptions
- Technology Advances
- Geopolitical Pressures & Tariffs
- Supply Chain Challenges
- Cyber Security Complexities

SMART MANUFACTURING EXECUTIVE Council

The Reinvention of US Manufacturing

Cost Center

Manufacturing is a capability and resource that is often **taken for granted.** It is a **cost center.**

SHIFT

Enabled by: Organizational **Leadership** & **Smart Manufacturing** Capabilities

Business Enabler

Manufacturing is a **competitive advantage.** It drives differentiating **business** and **customer outcomes.**

*The Future of the American Economy Depends on our Ability to **Reinvent US Manufacturing***

SMART MANUFACTURING EXECUTIVE Council

SM Mindset and Operating Model Principles

	TODAY	FUTURE…
Mindset	Victim	**Driver & Enabler**
	Operational Focus	**Customer Obsession**
	Reacting & Responding	**Proactive & Anticipatory**
	Safety, Cost and Quality	**+ Resiliency & Agility**
Operating Model	Functional Excellence	**End-to-End Orchestration**
	Linear Supply Chain	**Interconnected Networks & Org. Design Changes**
	Product & Process Centric	**Employee & Data Centric**
People	Task Orientation	**Outcome Orientation**
	Skill Gaps & Long Time to Competency	**Upskilling & ZERO Time to Competency**
	"It's Just a Job" Mindset	**Purpose/Value Driven, Empowered, Work life Balance, Sustainability**
Tech	Functional Solutions & Disconnected Systems	**Open & Interoperable Systems**
	Data Models per Solution	**Common & Standard Data Platforms**
	Risk for System Breaches	**Cybersecurity Measures**

SMART MANUFACTURING
EXECUTIVE Council
VOICE OF INDUSTRY

What Must Be True?

Ecosystem

Imperatives to Accelerate the Adoption of Smart Manufacturing

MANUFACTURING LEADERSHIP

Jeff Abell
Director, Global R&D

EDUCATORS & TALENT LEADERS

Larry Megan
Head of Digital

SUPPLY CHAIN ECOSYSTEM

Brendan Mullins
Vice President – Global Manufacturing & Engineering

MACHINE BUILDERS

Rick Van Dyke
Sr. Director of Supply Chain

CONSULTANTS / SERVICE PROVIDERS

Christopher Micena
Former Sr. Director of Innovation

TECHNOLOGY PROVIDERS

Tony Huffman
Enterprise Architecture Strategist

Jeff Abell
Director, Global R&D

What **Must** Be True for:

Manufacturing Leadership

1 Define & Align The "Moon Shot" Vision & Strategy

- Internally Owned & Inspired
- Compelling & Outcome Oriented
- Translated Into Execution Strategy with Tangible Milestones

2 Organize For Success

- End-to-end Orchestration
- Define & Prioritize Organizational KPI's
- Assign an Empowered Leader
- Supportive To Business & Customer Needs

3 Walk The Talk & Drive Culture/Mindset

- Become A Driver & Enabler; Be Proactive & Anticipatory
- Learn The Technology & Language
- Make Yourself & Your Team Accessible & Accountable
- Allocate Appropriate Funding & Resources
- Incentive System

EDUCATORS & TALENT LEADERS

BALDWIN RICHARDSON FOODS CO.

Larry Megan
Head of Digital

What **Must** Be True for:

Educators & Talent Leaders

1

Manufacturers Seen as Employers of Choice

- Broader Marketing at the National & Local Level
- Emphasize Digitalization of Manufacturing
- Company Cultures that Treat Human Capital as a Differentiator

2

Increase Speed to Competency

- A More Efficient Education Ecosystems
- Knowledge Access to Enable Day 1 Productivity
- Ongoing Adaptation to New Learning Modes

3

Enable Continuous Learning at All Levels

- Readily Accessible And Certified Training Frameworks
- On-the-job Opportunities
- A Learning Culture That Creates the Needed Space
- Executive Leaders Become The CDO Of Their Function

SUPPLY CHAIN ECOSYSTEM

ResMed

Brendan Mullins
Vice President – Global
Manufacturing & Engineering

What **Must** Be True for:

Supply Chain Ecosystem

1

Partner for Success

- Build Trust
- Seek Value for Stakeholders
- Co-invest in Business & Technology Innovation

2

Clear Measures for Success

- …Appropriate for Use Case…
- Delivery Performance…
- Product Quality…
- ESE SC Visibility & Traceability
- Sustainability

3

Digital Exchange

- Timely & Accurate Data Supporting Measures of Success
- Connected Systems & Processes

MACHINE BUILDERS

PEPSICO

Rick Van Dyke
Sr. Director of Supply Chain

What **Must** Be True for:

Machine Builders

1

Data Model to Run, Maintain & Optimize

- Must Be Able to Participate in Standard SM Platform
- Digital Documentation Included with Machine

2

Common Connectors to External Systems

- Connectivity Must Be Open & Secure
- Interoperable with SM Platform
- Line/System View, Control & Optimization

3

Intelligence of Operations Built Into The Machine

- Access to Digital Documentation
- Supports Digital Twin & Ongoing Machine Learning Capabilities
- Equipment/ Performance As A Service

4

Zero Training For Basic Use

- Simple Intuitive UI/UX
- UX Compatible with Line/Plant

CONSULTANTS / SERVICE PROVIDERS

Nestlé PURINA

Christopher Micena
Former Sr. Director of Innovation

What **Must** Be True for:

Consultants & Service Providers

1

Manufacturing Owns The Strategy

- Focus on your Area of Expertise
- Upfront Diagnostic & Opportunity Assessment
- Consultants "Skin In The Game"

2

Inform & Validate Strategy & Vision

- Benchmarking & Best Practices
- Provide Strategic Insights
- Partnership / Shared Vision
- Transparency on Incentives & ROI

3

Provide Expertise Where Internal Gaps Are

- Functional Expertise & Delivery
- Leadership Expertise
- Project & Program Management Expertise
- Knowledge Transfer

TECHNOLOGY PROVIDERS

KOCH

Tony Huffman
Enterprise Architecture Strategist

What **Must** Be True for:

Technology Providers

1

Scalable & Simple

- Commoditized Data Connectors & Recipes
- Self Service & Education
- Flexible Options (Ex. Cloud, On Prem, Hybrid)
- Wrap & Extend vs. Rip & Replace
- Capabilities vs. Tools

2

Interoperable

- SM-Compliant Architectures
- “Plug & Play” Applications: You Plug In vs. We Plug In
- Product, & Ideally Pricing Transparency
- Tie to the Vision & Align to Decision Owners

3

Cyber Security & Governance

- Controlled but Accessible
- Optimizes Risk
- We Own the Data

CESMII Working with a Strategic Group of Manufacturing Nations to Form the International Manufacturing-X Council

MANUFACTURING-X

IM-X will implement a federated, decentralized and collaborative data ecosystem for smart manufacturing. Open, global and cross-industry, following FAIR Data Principles.

Connect value chains and manufacturing data networks across industries and countries.

Implement global foundations for data-driven resilient, sovereign and climate-neutral production covering the full life cycle of production and products.

Enable innovative value creation in an interoperable and sovereign data ecosystem.

LEARN MORE

INDUSTRIE 4.0 ÖSTERREICH · Alliance Industrie du Futur · ロボット革命イニシアティブ協議会 Robot Revolution & Industrial IoT Initiative · smart industry · CESMII THE SMART MANUFACTURING INSTITUTE · KOSMO 스마트제조혁신추진단 · CONFINDUSTRIA · PLATTFORM INDUSTRIE 4.0 · AUSTRALIA

CESMII Member Value…

CALL TO *ACTION*

Become a **CESMII** Member, Contribute & **Profit!**

Join the nation's largest community of industry leaders focused on Strengthening the U.S.' Competitiveness through Smart Manufacturing.

Develop a **Smart Manufacturing Strategy & Roadmap!**

Align the team on goals, a culture of innovative collaboration, and a roadmap that defines the path to advancing digital maturity.

Workshop to Align **OT & IT** Teams Around a **Modern Architecture**

Ensure that your OT/IT infrastructure and applications are architected for interoperability and based on standard manufacturing system API's.

Insist on **Interoperability** from your Partners: **Vendors, OEMs, etc.**

Work with CESMII to ensure that your external OT/IT partners and stakeholders are aligned with you on your Smart Manufacturing journey.

Coordinate **Member-Directed** Research & Innovation**!**

Convene strategic stakeholders & special interest groups around a common industry challenge and work to address that challenge.

Information Modeling Training

Objectives

- Develop a broad-based, new competency (certification) in OT Data Engineering (Industrial Data Ops)
- Create an 8-hour eLearning/instructor-led ‘OT Engineering/Information Modeling’ course
- Partner with all willing learning institutions, L2 & L3 software vendors, machine builders, etc. to align with and drive this competency into the marketplace
- Facilitate the convergence of OT & IT

Desired Outcomes

- Understanding of the underlying principles that make information modelling impactful
  - Classes, Types, Object Oriented Principles, etc.
- The value proposition of information model standardization; why information modeling is important, and
- Information modeling patterns & best practices
- Ability to define an information model and SM Profiles, and tie them to expected outcomes
  - AI, MES, Analytics, Application Integration, PLM/Digital Twin integration, etc.
- Comfortable with the SM Profile Designer
- Key Unified Name Space (UNS) principles
- Practical understanding and troubleshooting of types and specifications
- Feel equipped to create, extend and use Profiles for L2 & L3 platforms

Targeting...

- System Integrators
- OT/IT Professionals
- Consultants
- Machine Builders
- Subject Matter Experts
- Technology Providers

Partnering to Drive **US Competitiveness**

CESMII THE SMART MANUFACTURING INSTITUTE

Focused on a More Productive and Competitive Manufacturing Capability Here in the U.S.

- ✅ **Engaged, Digital-Ready Workforce**
- ✅ **Organizations Aligned for Success**
- ✅ **Information-Driven Decisions**
- ✅ **Operations & Supply Chain Agility**

The 5 Promises of Smart Manufacturing

SMEC-POV_May2025_final.pdf (cesmii.org)

National Mandate to Strengthen the U.S.' Competitiveness Through Smart Manufacturing

CESMII
THE SMART MANUFACTURING INSTITUTE

Investing to reduce cost, complexity and time to deploy by 50%

Join This Community to…

- ✅ Facilitate Genuine Cultural Transformation and OT/IT Convergence
- ✅ Member-Directed Innovation and Research
- ✅ Position Your Organization for Significant, Long-term Productivity Growth
- ✅ Access the Smart Manufacturing Interoperability Platforms, Applications and Tools
- ✅ Participate in the Transformation of the Smart Manufacturing Ecosystem
- ✅ Understand Global and Regional Data Initiatives and Standardization Initiatives

210+ Members

LEARN MORE

CESMII Workshop: Smart Manufacturing Architecture Imperatives

Designing Better Namespaces for OT & IT Convergence

Objective: Sharing our guidance, learnings, recommendations and best practices with Manufacturers and the broader OT & IT ecosystem as we collaborate to enable interoperability and significantly reduce the cost/complexity of implementing manufacturing systems

SM Imperative #1: Open, Standards-Based Information-Modeling Strategy for Manufacturing Ops
Panel Participants - Facilitated by Olivia Morales & Jonathan Wise, CESMII

- Pal Roach, **Rockwell Automation**, Sr. Principal Industry Consultant
- Travis Cox, **Inductive Automation**, Chief Technology Evangelist
- Adreas Faath, **VDMA**, Managing Director, Machine Information Interoperability
- Arlen Nipper, **Cirrus Link**, President & CEO

SM Imperative #2: A Clear Set of Requirements for SM Interoperability Platform Compliance
Panel Participants - Facilitated by Jonathan Wise, CESMII

- Doug Lawson, **ThinkIQ**, Chief Executive Officer
- John Harrington, **HighByte**, Co-Founder and Chief Product Officer
- Mark Besser, **SymphonyAI**, Sr. Vice President

SM Imperative #3: An open, common API for Manufacturing Systems
Panel Participants - Facilitated by Matthew Parris, **GE Appliances**, Director Industry 4.0

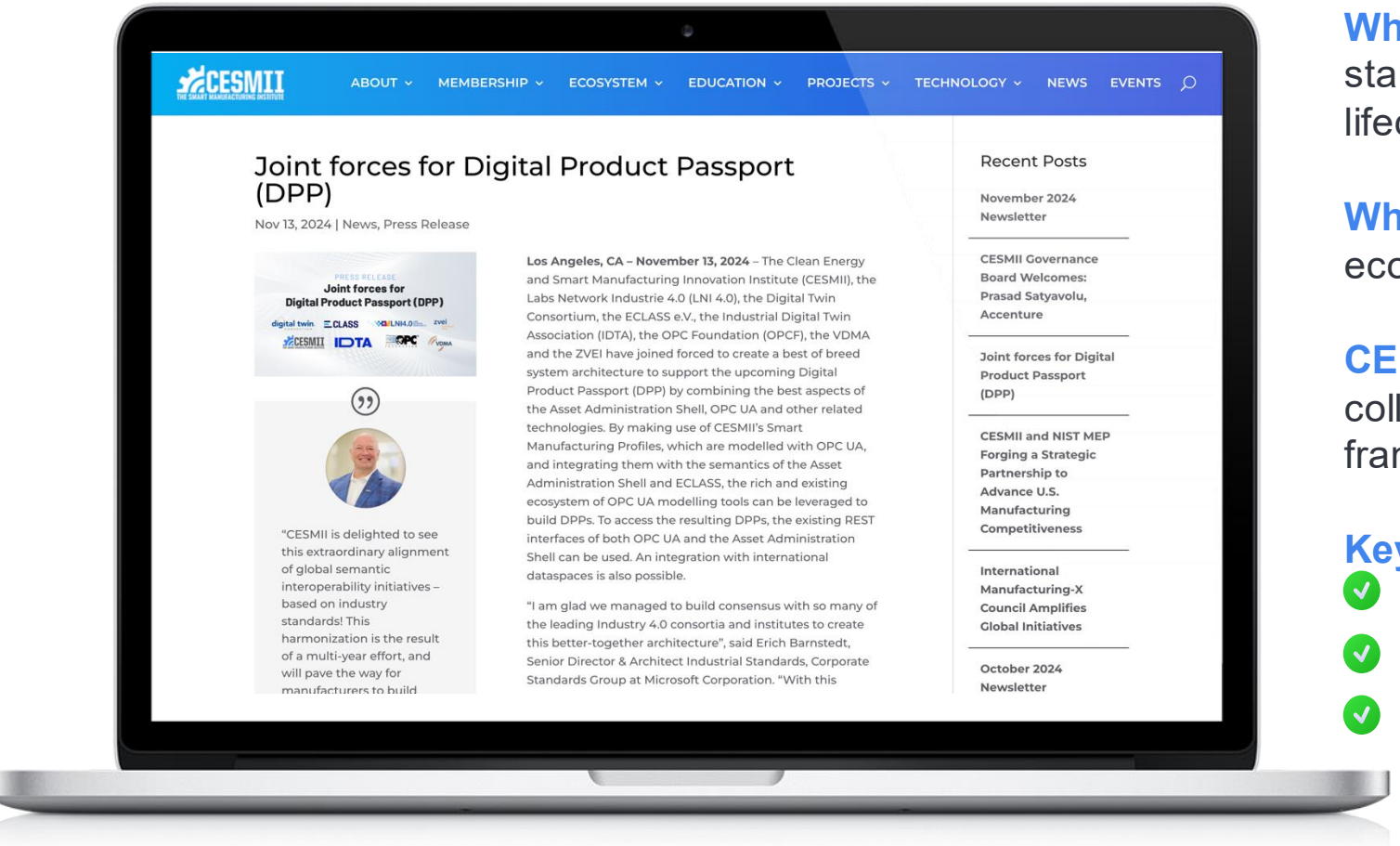
- Aron Semle, **HighByte**, Chief Technology Officer
- Caleb Eastman, **Siemens**, Principal Key Expert
- Erich Barnstedt, **Microsoft**, Senior Director & Architect, Industrial Standards
- Jonathan Wise, **CESMII** Chief Technology Architect

When: June 5, 11:00 to 2:00pm EST (Teams Meeting) Registration Link Coming Soon

Target Audience: OT and IT leaders and practitioners (analysts, developers, architects, engineers, SI's, consultants, machine builders, etc.) that have experience with software solutions in manufacturing.

Joint Forces for Digital Product Passport (DPP)

Advancing Smart Manufacturing



What is DPP? A digital record that provides standardized, real-time product data throughout its lifecycle.

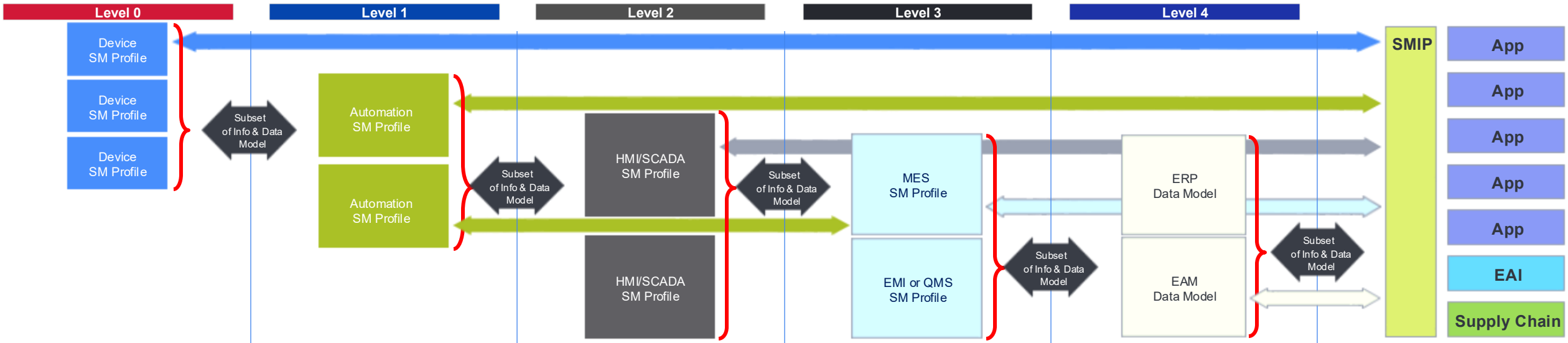
Why It Matters: Enables traceability, circular economy initiatives, and regulatory compliance.

CESMII's Role: Leading an industry-wide collaboration to create an open, interoperable framework for manufacturers.

Key Benefits:

- Reduces inefficiencies and waste
- Enhances product lifecycle insights
- Supports sustainable manufacturing

Information Model & Information Flow - How They Are Transformed At Each Level



Pump-related Devices (7000 tags)

Controller (1000 tags)
T/C Card (80 tags)
- Temperature…

Pressure Trans (40 tags x 5)
- Pressure…

VF Drive (1200 tags x 4)
- Speed…

Level Trans (40 tags x 5)
- Level…

Flowmeter (40 tags x 5)
- Flow…

Vibration Monitoring Device (50 tags x 5)
- Vibration…

Pump Master Automation Object (400 tags)

Specific Pump: Machine1.Pump4
Pump Temperature
- Motor.Windings.Temperature
- Stage1.Discharge.Temperature
- Main.Bearing#6.Temperature

Pump Alarms
- Motor.Alarms
- Stage1.Alarms

Pump Vibration
- Motor.Vibration
- Motor.Bearing.Vibration

Calibration
- E+H Calibration Specification

Etc.

Pump Master HMI Object (50 tags + Faceplates)

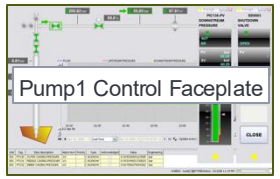
Line1.Machine1.Pump4
Pump1 Temperature
- Motor.Windings.Temperature
- Stage1.Discharge.Temperature
- Main.Bearing#6.Temperature

Pump1 Alarms
- Motor.Alarms
- Stage1.Alarms

Pump1 Vibration
- Motor.Vibration
- Motor.Bearing.Vibration

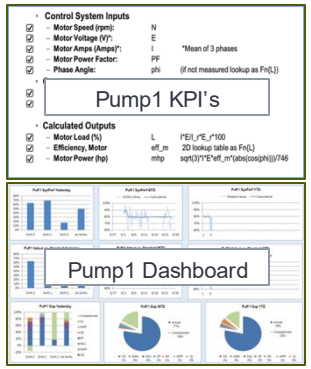
Calibration
- E+H Calibration Specification
- Last Calibration Date

Etc.



Pump Master KPI Object (25 Tags logged/stored)

Plant1.Area2.Line1.Pump4
- MTBF
- OEE
- Motor Efficiency
- Energy/Unit
- Initiate CIP



Pump Enterprise Integration (5 events/touchpoints)

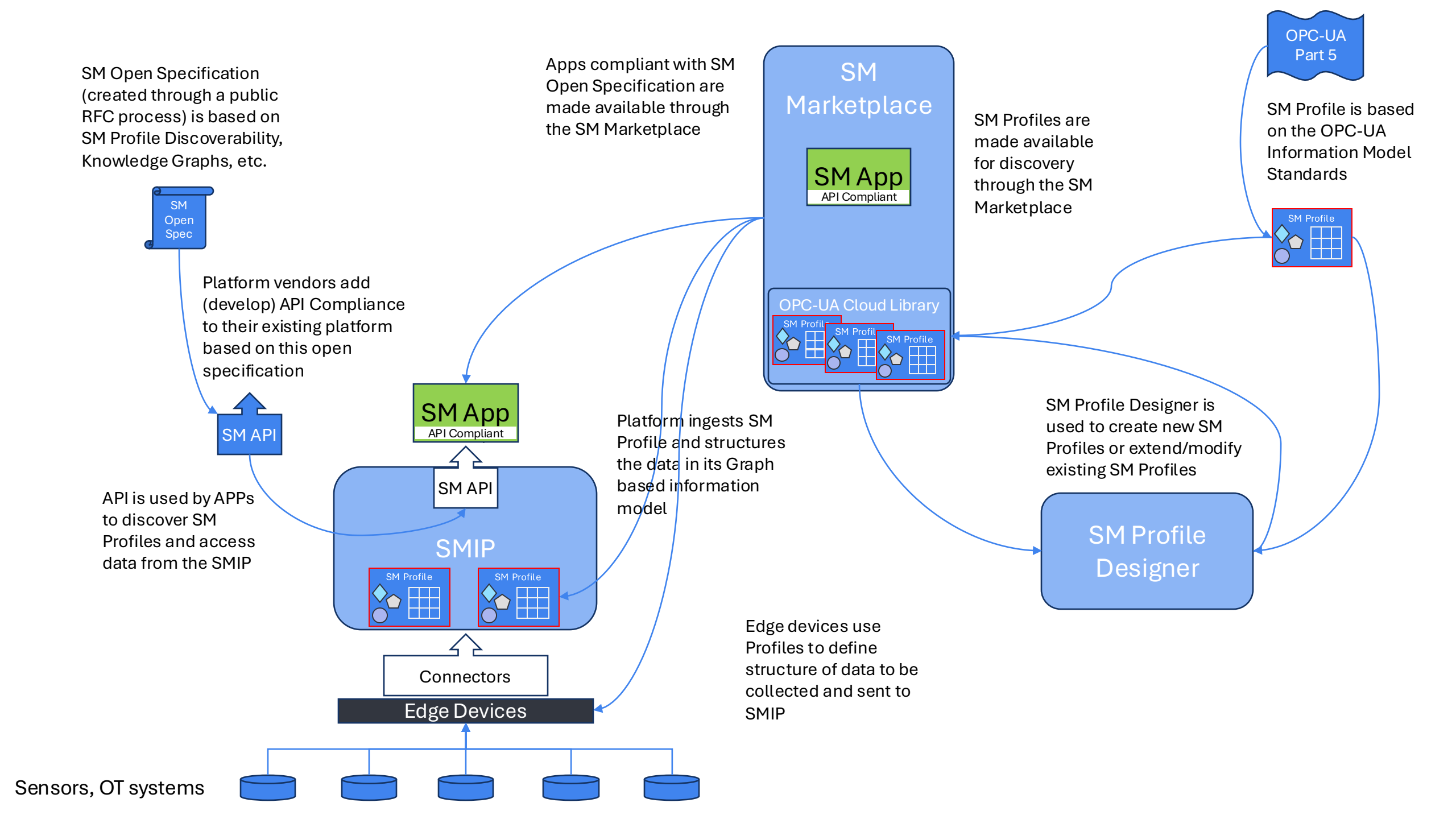
Enterprise1.Plant1.Area2. Line1.Pump4.Pressure
- Pressure Rate-of-change Exceeds Threshold: Open Critical Support Ticket

Enterprise1.Plant1.Area2. Line1.Pump4.Flow.
- Flowmeter Calibration Due: Schedule Preventive Maintenance Work Order

Etc.

SM Interoperable Apps

Remote Monitoring
Asset Performance Mgmt
Operator Rounds
AI Models
Analytics Management
Predictive Analytics
Quality
Additional Value-Added Services


SM Open Specification (created through a public RFC process) is based on SM Profile Discoverability, Knowledge Graphs, etc.
SM Open Spec
Platform vendors add (develop) API Compliance to their existing platform based on this open specification
SM API
API is used by APPs to discover SM Profiles and access data from the SMIP
SM App
API Compliant
SM API
SMIP
SM Profile
SM Profile
Connectors
Edge Devices
Sensors, OT systems
Apps compliant with SM Open Specification are made available through the SM Marketplace
SM Marketplace
SM App
API Compliant
OPC-UA Cloud Library
SM Profile
SM Profile
SM Profile
SM Profiles are made available for discovery through the SM Marketplace
Platform ingests SM Profile and structures the data in its Graph based information model
Edge devices use Profiles to define structure of data to be collected and sent to SMIP
OPC-UA Part 5
SM Profile is based on the OPC-UA Information Model Standards
SM Profile
SM Profile Designer is used to create new SM Profiles or extend/modify existing SM Profiles
SM Profile Designer