Need for an Automotive Smart Manufacturing Innovation Center

RECOMMENDATIONS

An Automotive Smart Manufacturing Innovation Center (ASMIC) is key to ensuring future U.S. competitiveness and a strong manufacturing base. The following actions are recommended to support such a facility:

1. Create an Automotive Smart Manufacturing Center: Although OEMs (Original Equipment Manufacturers) and suppliers have facilities assessing individual smart manufacturing technologies, a truly purpose-built technology center that is pre-production, non-competitive, and public does not exist. Revitalizing an existing facility and equipment is a cost-effective and expedient means to set up a new center that would additionally benefit stakeholders beyond the automotive industry.
2. Include Required Capabilities in an Automotive Smart Manufacturing Center: a) Ability for technology providers to highlight and demonstrate how their corresponding technologies function integrated into actual equipment and plant-floor systems, b) Opportunities to innovate via collaborative development with OEMs and other suppliers, c) Manufacturing cells and/or complete lines where actual OEM or supplier parts and assemblies could be produced in limited quantities to validate systems like their own system buyoff protocols, and d) An environment to educate plant personnel through training and workforce development on how to utilize smart manufacturing technologies to realize the greatest value for OEMs and suppliers alike.

These activities are consistent with the U.S. National Strategy for Advanced Manufacturing and accelerate manufacturing capabilities and innovation in the automotive industry. The establishment of a center will help lower the risk and costs that collectively need to be borne by automotive OEMs and their suppliers.

USCAR members (Ford, General Motors, and Stellantis) share a common interest in achieving the manufacturing performance benefits promised by smart manufacturing. Manufacturers typically follow similar practices to designing, building, validating, and commissioning manufacturing lines to produce new vehicles. Still, despite more than ten years of industry-wide activity and efforts, the drive toward successful implementation of smart manufacturing has yet to be fully realized.

Recently, USCAR along with the Collaborative Ecosystems Smart Manufacturing Innovation Institute (CESMII), completed and publicly launched a smart manufacturing roadmap. The roadmap highlighted key strategies, focus areas, and imperatives needed to realize the value of deploying smart manufacturing in the automotive industry. Although the roadmap details important technologies, architectures, standards, and organizational success factors, **the next key milestone is the establishment of an Automotive Smart Manufacturing Innovation Center (ASMIC).**

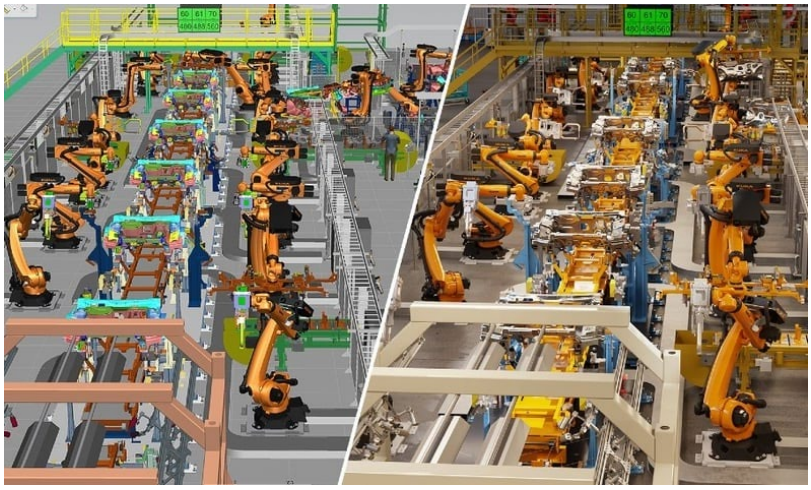

Figure 1 *– A digital twin simulation for demonstrating and validating manufacturing technologies. The vision is for an innovation and demonstration facility with various technologies for multiple users, including OEMs, suppliers, system integrators and equipment builders. Digital twin integration would be one aspect of the ASMIC.*

PURPOSE

This whitepaper introduces the basis of what the USCAR members (Ford, GM, and Stellantis) see as a critical need for U.S. automotive manufacturing - an automotive smart manufacturing innovation center. This paper describes the vision for a center and how it could serve multiple stakeholders beyond automakers seeking to improve their overall manufacturing capabilities through the realization of smart manufacturing objectives. This paper also considers high-level objectives, requirements, and foundational elements to facilitate further discussions necessary to generate a subsequent formal, detailed proposal for an automotive smart manufacturing center located near the heart of the U.S. automotive industry in Michigan.

The vision for a smart manufacturing center is a comprehensive manufacturing test and validation environment where smart manufacturing technologies can be proven and evaluated based on four high-level objectives: **demonstrate, innovate, validate, and educate.**

SMART MANUFACTURING

Smart manufacturing is the use of advanced technologies such as Artificial Intelligence (AI), Internet of Things (IoT), Big Data, Cloud Computing, and Automation to optimize manufacturing processes, a subset of advanced manufacturing. U.S. Automotive companies have relied on real-time data to improve plant productivity for several decades. These efforts were supported by Industry 3.0 technology that leveraged Programmable Logic Controllers (PLCs) and locally hosted applications to automate production and quality. The Automotive vision for smart manufacturing systems aligns closely with the migration from an Industry 3.0 strategy to an Industry 4.0 strategy to better maintain the competitiveness of the U.S. automotive industry.

Characteristics	Industry 3.0	Industry 4.0
Processes	Automation	Autonomous Decision Making
Industry Defining Technology	Industrial Robots	Collaborative Robots
Production Planning	Demand Forecasting	On-Demand Manufacturing
Alignment	Interconnection of Processes	Interconnection of the Whole Value Chain
Variation	Delimited Variation	Individually Unique Products
Goal	Efficiency	Flexibility
Base for Revenue	Selling Products	Products and Services

***Figure 2** –A comparison of the characteristics of Industry 3.0 and Industry 4.0 based systems. Source: https://uscar.org/download/361/manufacturing/13862/uscar-roadmap-for-automotive-smart-manufacturing_2023.pdf*

CURRENT MANUFACTURING TECHNOLOGY INTRODUCTION APPROACHES

Within the automotive industry, OEMs typically follow similar practices to design, build, validate, and commission manufacturing lines to produce new vehicles. These approaches involve working closely with equipment suppliers and systems integrators, whereby production lines are built, tested, and validated at supplier facilities before being disassembled and shipped to OEM plants for final installation and commissioning.

The integration process and launch of these new manufacturing equipment lines represents a critical opportunity for an OEM to introduce innovative technologies from their equipment builders and systems vendors. Alternatively, OEMs may also introduce and enhance the capabilities of their plants during normal production, however, this is risky and less desirable due to productivity requirements, process constraints, and financial payback hurdles that need to be overcome.

The existence and access to an automotive smart manufacturing center will provide OEMs and suppliers with a cost-effective, non-critical facility to observe and test potential smart manufacturing technologies without risks to launch timing, production stability, efficiency, and time to market. The publicly available facility will also benefit non-automotive applications.

VISION – SMART MANUFACTURING INNOVATION AND VALIDATION CENTER

The guiding vision for an automotive smart manufacturing center is to provide a comprehensive and true to manufacturing facilities test and validation environment where smart manufacturing technologies can be proven and evaluated based on four high-level objectives: demonstrate, innovate, validate, and educate. Although OEMs do have access to many facilities to assess individual smart manufacturing technologies whether in their own plants, at supplier sites, or other third-party sites such as at federal government agencies or in academic labs, a purpose-built smart manufacturing technology center does not exist. While OEMs can currently conduct individual technology trials on specific equipment or even production lines, an overall system performance testing integration, and validation environment would add numerous benefits for the industry. **This center would provide OEMs and suppliers with the ability to determine whether a given smart manufacturing technology could meet performance and implementation metrics under real-life automotive manufacturing launch and operational conditions.**

REQUIREMENTS AND FOUNDATIONAL ELEMENTS – WHAT MUST BE TRUE?

The establishment of the Automotive Smart Manufacturing Innovation Center (ASMIC) requires key foundational elements ranging from physical hardware and equipment to plant infrastructure and plant-floor systems. Interoperability is paramount to smart manufacturing, and connectivity in the form of robust and secure wired/wireless networking is foundational to this success. The infrastructure of this automotive smart manufacturing center must reliably connect all floor devices (PLCs, sensors, robots, etc.) and facilitate seamless data flow. The center must incorporate automotive manufacturing industry security standards, requiring robust measures to protect against cyber threats.

The ASMIC should help OEMs answer the question: What must be true for a given smart manufacturing technology to be incorporated successfully within our facilities? The answer to this question will incorporate groups of requirements or elements from four main categories: foundational infrastructure and management, human factors and considerations, core technologies, and system robustness and risk mitigation.

NEXT STEPS

Establishing a center that can highlight leading-edge technologies and best practices requires a comprehensive investment encompassing technology, people, and processes. The detailed steps and plans for developing a proposal to establish and launch an automotive smart manufacturing center to benefit industry needs to be created, discussed, and agreed upon by all relevant stakeholders, partners, and users. By adopting a strategic, phased approach, focusing on specific problems, and prioritizing employee training and collaboration, manufacturers can navigate the complexities and reap the significant rewards of smart manufacturing: increased efficiency, improved quality, enhanced productivity, reduced costs, greater flexibility, and improved safety. The journey is iterative; continuous improvement and adaptation are key to long-term success.

DESCRIPTIONS OF MAJOR ASPECTS OF THE CENTER

OBJECTIVES

In addition to mitigating direct plant-related risks to production, the ASMIC would satisfy four high-level objectives (Figure 3).

1. First, this automotive smart manufacturing center would provide the ability for technology providers to highlight and demonstrate how their corresponding technologies would function when integrated into production equipment and plant-floor systems.
2. The center would be a collaborative development space for OEMs and other suppliers to continue to innovate and advance smart manufacturing practices.
3. The center would have manufacturing cells and/or complete lines where production OEM and supplier parts and assemblies could be produced in limited quantities to validate systems.
4. The final objective is to educate plant personnel through training and workforce development on how to best utilize smart manufacturing technologies to realize the greatest value for the industry.

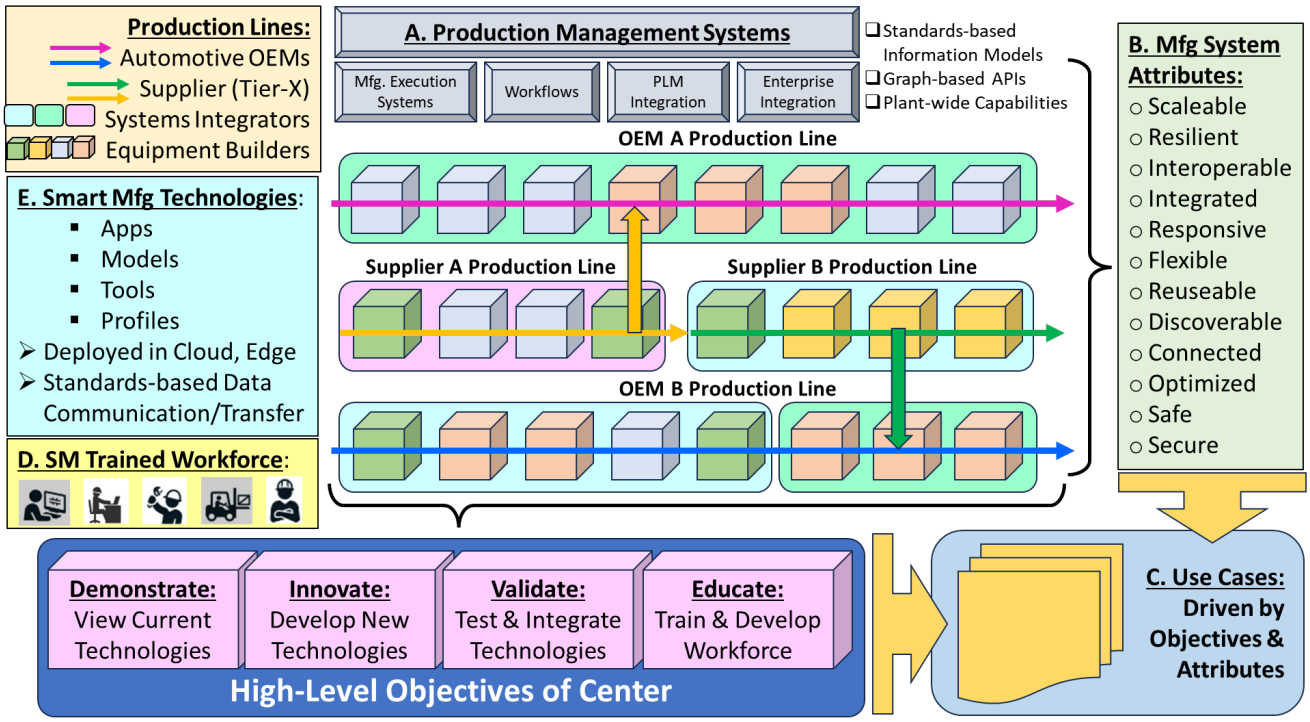

Figure 3 *– Vision for the interaction between stakeholders, technologies, and objectives of the center.*

DESCRIPTIONS OF MAJOR ASPECTS OF THE CENTER

PRODUCTION MANAGEMENT SYSTEMS

Production management systems are the command and control backbones for all the operational decisions for a factory. Today's complex manufacturing facilities require several systems to manage and oversee all production functions, from planning, scheduling, production monitoring, inventory control, quality control, and maintenance. The ASMIC would deploy a full suite of advanced, commercial production management systems with the latest smart manufacturing technologies showcasing real-time decision-making. The systems would have fully operational data collection databases, as would exist in any real factory. This is critical to demonstrate connectivity and interoperability from the plant floor to upper-level plant management decision-making.

MANUFACTURING SYSTEMS ATTRIBUTES

There are many features, characteristics, and benefits that smart manufacturing promises such as scalability, resiliency, interoperability, responsiveness, etc. (attributes listed in the green rectangle to the right in Figure 3). Technology implemented in the ASMIC would be measured and evaluated for how well this desired set of attributes is satisfied. A necessary task for this smart manufacturing center will be to develop and/or adopt the technical descriptions, methods, and standards by which these attributes can be understood and verified against any component of installed technology. This verification and assessment of attributes may be incorporated into use case definitions and applications described next.

USE CASES DRIVEN BY CENTER OBJECTIVES

A key method to deliver these smart manufacturing capabilities will be through the statement and definition of use cases, which are the narratives that describe how a given smart manufacturing technology or capability is demonstrated and validated. The advantage of a use case approach is that technical requirements are identified and communicated amongst all users and stakeholders. The use cases will be categorized under one or more of the four high-level objectives of the center: demonstrate, innovate, validate, and educate.

SMART MANUFACTURING TRAINED WORKFORCE

Smart manufacturing is not only concerned with implementing and integrating capabilities and tools, but also the vital human element, without which the promised productivity and quality gains would not be achieved. Therefore, a key element of the ASMIC is to provide a facility where people from the operator level to the plant manager can be trained on the latest in smart manufacturing technologies and how to run a smart manufacturing plant. Participating OEMs and suppliers will need to invest heavily in training programs to upskill the workforce. This training includes data analysis, programming, cybersecurity awareness, and the use of new tools and systems. A significant challenge that the smart manufacturing center will address lies in bridging the gap between traditional Operational Technology (OT) skills and increasingly important Information Technology (IT). Nevertheless, the objective of the ASMIC will be to provide participants with the skills and background to work effectively and productively in their own smart manufacturing plants.

SMART MANUFACTURING TECHNOLOGIES

The fifth foundational element concerns potential smart manufacturing technologies that are either commercially available or would be developed as a result of the use cases generating technology innovations. These technologies may come in the form of apps, process models, AI/ML-based algorithms, application-specific tools, etc. These technologies would also need to be evaluated against their ability to meet the attributes of smart manufacturing (described above). These smart manufacturing technologies may be embedded or integrated into production management systems or reside on low-level devices or equipment hardware.