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| **National Electrical Manufacturers Association** |  |

NEMA Advanced Manufacturing

Standards Roadmap

June 2023

**Executive Summary**

In October 2021, the National Electrical Manufacturers Association (NEMA) was awarded a Market Development Cooperators Program (MDCP) grant from the International Trade Administration of the U.S. Department of Commerce. The award focused on expanding U.S. participation on technical standards related to advanced manufacturing systems and increasing U.S. exports of advanced manufacturing systems.

On February 9-10, 2022 NEMA and the International Trade Administration (ITA) hosted an Advanced Manufacturing Summit to discuss technical and trade challenges related to the implementation of advanced manufacturing systems. The summit aimed to begin developing a strategy to mitigate those challenges. Advanced manufacturing systems increase productivity and quality, reduce energy use, and enable manufacturers to improve manufacturing and supply chain resiliency.

During the Summit, participants indicated that advanced manufacturing standards are critically important for system interoperability and to ensure data can communicate across devices and companies in the supply chain. An important aspect of standards is that they can also ensure the safety of components and systems. There are significant opportunities in standardization related to advanced manufacturing systems. Topics in need of additional standardization include interoperability, communication protocols, blockchain, augmented reality, user guides, cybersecurity, and data. Additionally, participants encouraged NEMA to develop an Advanced Manufacturing Standards Roadmap.

A consensus-based standards roadmap will help drive action based on industry's vested interest in the business-case need for standards development and adoption. A roadmap requires input from a variety of relevant stakeholders including manufacturers, industry associations, and standards-related government agencies. The standards roadmap should begin with the end in mind to ensure that advanced manufacturing systems meet user needs.

Manufacturers, especially small and medium enterprises struggle with cost, complexity, and accessibility of advanced manufacturing systems. Interoperability and standardization can reduce some of the barriers to implementation. However, immediate challenges outside the scope of standards, such as workforce gaps, also need to be addressed.

This draft Advanced Manufacturing Standards Roadmap aims to identify gaps in standardization as well as key priority areas for participation. NEMA will continue to coordinate with relevant trade groups, the Advanced Manufacturing Council and interested U.S. government agencies in development and maintenance of the Roadmap.

**Acknowledgements**

NEMA’s Advance Manufacturing work is supported by a partnership with the International Trade Administration. The International Trade Administration (ITA)—a bureau within the U.S. Department of Commerce—engages with U.S. industry, foreign governments, and international bodies to identify and remove barriers to exports and ensure U.S. businesses compete on a level playing field. ITA also facilitates the [Market Development Cooperator Program](http://www.trade.gov/mdcp) (MDCP), the U.S. government’s most successful export assistance program. MDCP awards spur industry-led export-development projects through financial and technical assistance from ITA. NEMA was awarded an MDCP in October 2021 focused on expanding U.S. participation on technical standards related to advanced manufacturing systems and increasing U.S. exports of advanced manufacturing systems. The three-year award will allow NEMA to identify new experts for international technical standardization work, provide training for experts, and support participation in international standards meetings.

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1. **Introduction**
   1. **Roadmap Background and Objectives**
   2. **How the Roadmap was Developed**
   3. **Roadmap Structure**

**1.4 Overview of SDOs in the Smart Manufacturing Space**

The development of Smart Manufacturing Standards and specifications is a collaborative activity that engages a wide range of subject matter experts from academia, government, industry, professional societies, and Standards Development Organizations (SDOs). Below, we list some of the SDOs whose scope of work directly or indirectly relates to Smart Manufacturing standardization.

**1.4.1 Association for Advancing Automation**

The Association for Advancing Automation (A3) is an umbrella organization for the former Robotics Industries Association (RIA), Advancing Vision + Imaging (AIA), and Motion Controls and Motors Association MCMA), and A3 Mexico, represents organizations involved in robotics, artificial intelligence, machine vision and imaging, motion controls and motors and other related automation related technologies.

A3 is an ANSI Standards developer of Industrial Robotics Standards and serves as the administrator of the US Technical Advisory Group for the International Organization for Standardization (ISO) TC 299 Robotics.

**1.4.2 ASTM International**

ASTM International, formerly known as American Society for Testing and Materials, is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services.

ASTM is an ANSI Standards developer of materials and testing standards and serves as the administrator of the US Technical Advisory Group for the International Organization for Standardization (ISO) TC 261 Additive Manufacturing.

ASTM Technical Committees

F42 – Additive Manufacturing Technologies

F45 – Robotics, Automation, and Autonomous Systems

**1.4.3 International Electrotechnical Committee (IEC)**

The IEC is a global, not-for-profit membership organization, whose work underpins quality infrastructure and international trade in electrical and electronic goods. IEC facilitates technical innovation, affordable infrastructure development, efficient and sustainable energy access, smart urbanization and transportation systems, climate change mitigation, and increases the safety of people and the environment.

The IEC brings together more than 170 countries and provides a global, neutral, and independent standardization platform to 20,000 experts globally. It administers 4 Conformity assessment systems whose members certify that devices, systems, installations, services, and people work as required.

The IEC publishes around 10,000 standards which together with conformity assessment provide the technical framework that allows governments to build national quality infrastructure and companies of all sizes to buy and sell consistently safe and reliable products in most countries of the world. IEC standards serve as the basis for risk and quality management and are used in testing and certification to verify that manufacturer promises are kept.

IEC Technical Committees developing standards applicable to Smart Manufacturing:

TC 1: *Terminology* - sanctions the terms and definitions used in the different electrotechnical fields and to determine the equivalence of the terms used in the different languages. As a consequence, to prepare an International Electrotechnical Vocabulary aiming at the standardization and coordination of the terms relating to electrical sciences and techniques for use in the technical language and literature, in teaching, in technical specifications and in commercial exchanges, and at giving their equivalents in the different languages.

TC 2: *Rotating Machinery* - prepares International Standards regarding specifications for rotating electrical machines without limitations of voltage, output or dimensions with the exception of the following:

- Traction motors within the scope of TC 9: Electric railway equipment;

- Motors and generators within the scope of TC 69: Electric road vehicles and electric industrial trucks;

- Motors and generators for use in cars and commercial vehicles;

- Motors and generators for use in aeronautics or space applications.

TC 3: *Graphical Symbols for use on equipment* - Standardization in the field of documentation, graphical symbols, and representations of technical information, covering:

1) Rules, principles, and methods focusing on machine sensible representation of information. This includes but is not limited to:

- Definition and identification of classes and properties (e.g., sematic data),

- ontologies and data dictionaries (e.g., CDD),

- Information models for structuring of technical data and document management,

- information exchange based on existing communication means.

It includes definition, co-ordination and management of the information required during the whole life cycle of a device, system, or plant, also covering aspects of documentation.

2) Rules, principles, and methods focusing on human sensible representation of the information. This includes but is not limited to:

- presentation of information in documentation,

- graphical symbols for use in documentation,

- graphical symbols for the human interaction with equipment.

The standards deal with the presentations and graphical symbols as shown in documents or on equipment, independently of their forms of representation, analogue or digital, but may also include requirements for the development of documentation.

3) Rules, principles, and methods for general and safety related marking, identification and arrangement of information in electrical installations, equipment and man-machine interfaces. This includes but is not limited to:

- the meanings of colors and alternative means, when used for marking and identification,

- the arrangement of indicating devices and actuators,

- coding principles for indicating and actuating devices,

- terminal designation of electrical and electronic components, apparatus, and equipment,

- designation of certain designated conductors,

- marking of electrical and electronic equipment with ratings related to supply and to its properties,

- marking of bare and insulated conductors.

TC 22: *Power electronic systems and equipment* - prepares international standards regarding systems, equipment and their components for electronic power conversion and electronic power switching, including the means for their control, protection, monitoring and measurement.

Note 1.- Components which are comprised within the scope include electronic devices.

Note 2.- The scope does not include telecommunications apparatus other than power supplies to such apparatus.

Group Safety Function: Power electronic converter systems and equipment for solar, wind, tidal, wave, fuel cell or similar energy sources.

SC22G: *Adjustable Speed electric power drive systems (PDS)* - prepares international standards for electronic power conversion equipment in adjustable speed electric drive systems, including the means for their control, protection, monitoring and measurement. Excluded are traction applications and electric vehicles.

Horizontal Energy Efficiency Function:

To establish a clear and simple system methodology for the comparison of the energy performance of motor systems to help product and system improvement.

Note: This horizontal energy efficiency function is allocated in the context of the development of IEC 61800-9-1: General requirements for setting energy efficiency standards for power driven equipment using the extended product approach (EPA) and semi analytical model (SAM).

TC 44: *Safety of machinery – Electrotechnical aspects* – sets standards in the field of the application of electro-technical equipment and systems to machinery (including a group of machines working together in a coordinated manner, excluding higher-level systems aspects) not portable by hand while working, but which may include mobile equipment. The equipment covered commences at the point of connection of the electrical supply to the machinery. Standardization of interfaces (excluding local area networks and fieldbus) between control equipment and the electro- technical equipment of machinery. Standardization of electrotechnical equipment and systems relating to the safeguarding of persons from hazards of the machinery, its associated equipment, and the environment. To coordinate with ISO all matters concerning the safety of machinery.

TC 65: *Industrial-process measurement, control, and automation* - prepares international standards for systems and elements used for industrial process measurement, control, and automation. To coordinate standardization activities which affect integration of components and functions into such systems including safety and security aspects. This work of standardization is to be carried out in the international fields for equipment and systems.

TC 65 has a Cybersecurity horizontal function in accordance with IEC Guide 108, defined as follows: Cybersecurity for Operational Technologies which includes:

• Whole lifecycle from design to disposal (including supply chain, etc.)

• Technical, organizational, and procedural requirement

• Components, subsystems, and systems.

SC 65A: *Systems aspects* - prepares international standards regarding the generic aspects of systems used in industrial process measurement, control and manufacturing automation: operational conditions (including EMC), methodology for the assessment of systems, functional safety, etc. SC 65A also has a safety pilot function to prepare standards dealing with functional safety of electrical/electronic/programmable electronic systems.

SC 65B: *Measurement and control devices* - prepares international standards in the field of specific aspects of devices (hardware and software) used in industrial process measurement and control, such as measurement devices, analyzing equipment, actuators, and programmable logic controllers, and covering such aspects as interchangeability, performance evaluation, and functionality definition.

SC 65C: *Industrial networks* - prepares international standards on wired, optical and wireless industrial networks for industrial-process measurement, control, and manufacturing automation, as well as for instrumentation systems used for research, development and testing purposes. The scope includes cabling, interoperability, co-existence, and performance evaluation.

SC 65E: *Device integration in enterprise systems* - prepares international standards specifying:

(1) Device integration with industrial automation systems. The models developed in these standards address device properties, classification, selection, configuration, commissioning, monitoring and basic diagnostics.

(2) Industrial automation systems integration with enterprise systems. This includes transactions between business and manufacturing activities which may be jointly developed with ISO TC 184.

SyC Systems Committee for Smart Manufacturing - provides coordination and advice in the domain of Smart Manufacturing to harmonize and advance Smart Manufacturing activities in the IEC, other SDOs and Consortia.

**1.4.4 International Society for Automation (ISA)**

The International Society of Automation (ISA) is a non-profit professional association of engineers, technicians, and management engaged in industrial automation. As the globally trusted provider of foundational standards-based technical resources for the profession, ISA strives to build a better world through automation.

ISA serves as the administrator of US TAG IEC SC 65A: *Systems Aspects*.

ISA/IEC 62443 series of standards and technical reports providing a comprehensive framework to address and reduce existing and future security vulnerabilities in industrial automation and control systems (IACS) created by ISA 99 committee

**1.4.5 International Organization for Standardization (ISO)**

ISO is an independent, non-governmental international organization bringing together experts from 168 national standards bodies and to develop consensus-based, market relevant International Standards.

ISO consists of 816 committees and Subcommittees that develop and maintain 24,748 International Standards covering almost all aspects of technology, management, and manufacturing.

ISO TC 39: *Machine Tools* - Standardization of all machine tools for the working of metal, wood and plastics, operating by removal of material or by pressure.

ISO TC 184: *Automation Systems and Integration* - Standardization in the field of automation systems and their integration for design, sourcing, manufacturing, production and delivery, support, maintenance and disposal of products and their associated services. Areas of standardization include information systems, automation and control systems and integration technologies.

Note: There will be active collaboration with the relevant technical committees responsible for areas such as machines, manufacturing resources and facilities, robotics, electrical and electronic equipment, PLC for general application, quality management, industrial safety, information technologies, multi-media capabilities, and multi-modal communication networks.

ISO TC 261: *Additive Manufacturing* - Standardization in the field of Additive Manufacturing (AM) concerning their processes, terms and definitions, process chains (Hard- and Software), test procedures, quality parameters, supply agreements and all kind of fundamentals.

ISO TC 299: *Robotics* - Standardization in the field of robotics, excluding toys and military applications

ISO/IEC JTC1: *Information Technology*

ISO/IEC JTC1*SC27Informtion Security/Cyber Security and Privacy Protection*

ISO/IEC JTC1*SC41 Internet of Things and Digital Twin*

ISO/IEC JTC1/SC42, *Artificial Intelligence* - Standardization in the area of Artificial Intelligence

Serve as the focus and proponent for the JTC1 standardization program on Artificial Intelligence, and provide guidance to JTC1, IEC, and ISO committees developing Artificial Intelligence applications.

**1.4.6 National Electrical Manufacturers Association (NEMA)**

NEMA is an ANSI-accredited Standards Developing Organization made up of business leaders, electrical experts, engineers, scientists, and technicians. NEMA convenes a neutral forum for its members to discuss industry-wide concerns and objectives under a legal umbrella by trained NEMA Staff.

NEMA administers over 70 USNC Technical Advisory Groups including the following Technical Committees addressing smart manufacturing:

TC1: *Terminology*

TC 2: *Rotating Machinery*

TC 3: *Graphical Symbols for use on equipment*

TC 22: *Power electronic systems and equipment*

SC 22G: *Adjustable speed electric power drive systems (PDS)*

TC 44: *Safety of machinery – Electrotechnical aspects*

TC 65: *Industrial-process measurement, control, and automation*

SC 65A: *Systems aspects*

SC 65B: *Measurement and control devices*

SC 65C: *Industrial networks*

SC 65E: *Device integration in enterprise systems*

TC 121: *Low voltage switchgear and controlgear and their assemblies*

SC 121A: *Low voltage switchgear and controlgear*

SC 121B: *Low voltage switchgear and controlgear assemblies*

SyC SM: *Systems Committee for Smart Manufacturing*

**1.4.7 OPC Foundation**

**Open Platform Communications (OPC)**

OPC is the interoperability standard for the secure and reliable exchange of data in the industrial automation space and in other industries. It is platform independent and ensures the seamless flow of information among devices from multiple vendors. The OPC Foundation is responsible for the development and maintenance of this standard.

The OPC standard is a series of specifications developed by industry vendors, end-users and software developers. These specifications define the interface between Clients and Servers, as well as Servers and Servers, including access to real-time data, monitoring of alarms and events, access to historical data and other applications.

When the standard was first released in 1996, its purpose was to abstract PLC specific protocols (such as Modbus, Profibus, etc.) into a standardized interface allowing HMI/SCADA systems to interface with a “middle-man” who would convert generic-OPC read/write requests into device-specific requests and vice-versa. As a result, an entire cottage industry of products emerged allowing end-users to implement systems using best-of-breed products all seamlessly interacting via OPC.

Initially, the OPC standard was restricted to the Windows operating system. As such, the acronym OPC was borne from OLE (object linking and embedding) for Process Control. These specifications, which are now known as OPC Classic, have enjoyed widespread adoption across multiple industries, including manufacturing, building automation, oil and gas, renewable energy and utilities, among others.

With the introduction of service-oriented architectures in manufacturing systems came new challenges in security and data modeling. The OPC Foundation developed the OPC UA specifications to address these needs and at the same time provided a feature-rich technology open-platform architecture that was future-proof, scalable and extensible.

**1.4.8 UL Solutions**

A global leader in applied safety science, UL Solutions transforms safety, security, and sustainability challenges into opportunities for customers in more than 100 countries. UL Solutions delivers testing, inspection and certification services, together with software products and advisory offerings, that support our customers’ product innovation and business growth.

**1.5 Overview of Organizations Promoting the Use of Smart Manufacturing Technology**

Promoting the use of Smart Manufacturing Technologies, educating manufactures and their workforces, and promoting the development of new technologies engages a wide range of subject matter experts from academia, government, industry, professional societies, and Standards Development Organizations (SDOs). Below, we list some of the organizations whose scope of work directly influences the adoptiona and development of Smart Manufacturing technologies.

**1.5.1 America Makes – Additive MFG**

America Makes members from industry, academia, government, workforce and economic development organizations, work together to accelerate the adoption of AM and the nation’s global manufacturing competitiveness.

Founded in 2012 as the Department of Defense’s national manufacturing innovation institute for AM and first of the Manufacturing USA network, America Makes is based in Youngstown, Ohio, and managed by the not-for-profit National Center for Defense Manufacturing and Machining (NCDMM).

**1.5.2 CESMII The Smart Manufacturing Institute**

CESSMIIis a non-profit organization addressing Smart Manufacturing and Digital Transformation More information Needed

**1.5.3 Digital Twin Consortium**

Digital Twin Consortium drives the awareness, adoption, interoperability, and development of digital twin technology. Through a collaborative partnership with industry, academia, and government expertise, the Consortium is dedicated to the overall development of digital twins. We accelerate the market by propelling innovation and guiding outcomes for technology end-users.

**1.5.4 5G Alliance for Connected Industries and Automation (5G-ACIA)**

The objective of 5G-ACIA is to maximize the applicability of 5G technology in connected industries, in particular the manufacturing and process sectors. 5G-ACIA works to ensure that 5G standardization and regulation efforts adequately consider the interests and unique characteristics of the industrial domain.

**1.5.5 The International Council on Systems Engineering (INCOSE)**

INCOSE is a not-for-profit membership organization founded to develop and disseminate the transdisciplinary principles and practices that enable the realization of successful systems.

**1.5.6 InterNational Committee for Information Technology Standards (INCITS)**

INCITS is the central U.S. forum dedicated to creating technology standards for the next generation of innovation. INCITS members combine their expertise to create the building blocks for globally transformative technologies.

**1.5.7 National Association of Manufacturers (NAM)?**

**1.5.8 National Institute of Standards (NIST)**

NIST, through its Office of Advanced Manufacturing (OAM), serves as the headquarters for the interagency Advanced Manufacturing National Program Office to coordinate [Manufacturing USA](https://www.manufacturingusa.com/), a network of manufacturing innovation institutes across the country that brings together industry, academia, and the public sector to advance American manufacturing. OAM is also responsible for the NIST-sponsored manufacturing innovation institute, NIIMBL, other NIST-funded awards to Manufacturing USA.

**1.5.9 SME – Formerly known as the Society of Manufacturing Engineers**

SME is a nonprofit association of professionals, educators and students committed to promoting and supporting the manufacturing industry. SME helps manufacturers innovate, grow, and prosper by promoting manufacturing technology, developing a skilled workforce and connecting the manufacturing industry. SME supports manufacturing based on our core belief: Manufacturing is key to economic growth and prosperity.

1. **Gap analysis of standards and specifications**

This section provides an in-depth description of key issues related to standardization in advanced manufacturing, as well as relevant published standards and specifications, an indication of those in development, and recommendation for additional research and development (R&D) and/or standards and specifications needed. The gap analysis is divided into sections that reflect various aspects of advanced manufacturing.

Each of the gaps identified will be assigned a priority based the addition of a value score, an effort score, and an impact score based upon the following matrices. The priority score will range from 3-15, with 15 being the highest priority score available. Scores from 3-8 will be considered low priority; scores from 8-12 will be considered medium priority; scores from 12-15 will be considered high priority.

**Value Score**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Frequently creates issues | Sometimes creates issues | Rarely creates issues |
| Huge Problem | 5 | 4 | 3 |
| Moderate Problem | 4 | 3 | 2 |
| Minor Problem | 3 | 2 | 1 |

Table 1 Value Score

**Effort Score**

|  |  |
| --- | --- |
| Effort | Score |
| Small effort with no needed resources | 5 |
| Small effort | 4 |
| Medium effort | 3 |
| Large effort | 2 |
| Herculean effort | 1 |

Table 2 Effort Score

**Impact Score**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Most AM products impacted | Many AM products impacted | Some AM products impacted |
| High return on investment | 5 | 4 | 3 |
| Medium return on investment | 4 | 3 | 2 |
| Low return on investment | 3 | 2 | 1 |

Table 3 Impact Score

Gap template:

Gap Title: *describe gap in a few words*

Abstract: *provide information related to the gap and its importance*

Needed R&D: *identify any needed R&D to close this gap.*

Recommendation: *make a recommendation on next steps for closing the cap*

Priority: *include score based upon the scoring system described above*

Status of Progress:

Potential Standards Organization(s): *identify standards organizations that are developing or could develop standards and specifications to close the gap.*

Suggested Sections:

1. Devices

Covers standards and specifications related to specific devices that would be included in advanced manufacturing systems, including robotics and sensors

1. Device management and interoperability

Covers standards and specifications related to device control and management and the interoperability of devices included in an advanced manufacturing system.

1. Communication

Covers standards and specifications related to communication protocols used in advanced manufacturing systems.

1. Data analytics

Covers standards and specifications related to data analytics used in advanced manufacturing systems.

1. Application and integration

Covers standards and specifications related to application and integration of advanced manufacturing systems.

**3 Summary of Gaps and Recommendations**

See attached Excel Spreadsheet.

Table will be imported when Spread Sheet is Completed

* 1. **Smart Manufacturing General**

**Smart Manufacturing Technology Standards Gaps - General**

**SM1 Smart Manufacturing Standards – US Participation**

**GAP SM1.1:** Participation of US experts in many TAGs addressing Smart Manufacturing related standards is declining.

**Recommendation:**

Step 1: Promotion of ANSI and IEC Young Professional Programs.

Step 2: Work with Accademia to educate on the importance or standards in trade schools and colleges.

Step 3: Develop a funding mechanism for participation by small and medium sized companies.

**Priority:** High

**Status of Progress:** Unknown

**Organizations:** US SDOs , US Government,

**Smart Manufacturing Terminology**

**GAP SM2:** Currently there is no standard defining Smart Manufacturing terms to aid users in adoption. IEC TC 1 is not addressing this problem.

**Recommendation:**

Step 1: Develop a US Smart Manufacturing Terminology Standard by reviewing existing academic, industry resources, and consultation with the US Industry.

Step 2: Adoption of the Smart Manufacturing Terminology Standard as an ANSI Standard.

Step 3: Adoption of the US Smart Manufacturing Terminology Standard as section in the IEC International Electrotechnical Vocabulary (IEV) IEC 60050 Series for posting to the IEC Electropedia.

Step 4: Recruit US professionals to participate in IEC TAG TC1 directly or indirectly through Joint Working Groups within their Smart Manufacturing related TAGs.

**Priority:** Medium

**Status of Progress:** Not Started

**Organization:** NEMA, ISA, SME, IEC TC 1 Terminology

**Smart Manufacturing Graphic Symbols**

**GAP SM3:** Missing a guidance document outlining graphic symbols used in smart manufacturing.

**Recommendation:** Create a guidance document directing users to existing resources and recruit US professionals to participate in IEC TC 3 TAG directly or indirectly through Joint Working Groups within their Smart Manufacturing related TAGs.

**Priority:** Medium

**Status of Progress:** Not Started

**Organization:** NEMA, ISA, SME

* 1. **Devices**

**Robotics**

**GAP D1:** Missing Robotics Application Guidance

**Recommendation:** Identify existing Industrial Robotics Guidance Documents from ISO and A3 other SDOs for inclusion in the roadmap.

**Priority:** High

**Status of Progress:** Need to Identify a lead and participants

**Relevant Organizations:** NEMA, , ISA, SME, A3 - Association for Advancing Automation

**Internet of Things**

**GAP D2:** Missing IOT Guidance

**Recommendation:** Identify existing Sensor and Internet of Things Standards from IEC, ISO, and other SDOs for inclusion in the roadmap.

**Priority:** High

**Status of Progress: Project** Lead Needed.

**Relevant Organizations:** NEMA and ISA

**D3 Industrial Controllers**

**GAP D3.1:** Missing Industrial Controllers and industrial computing devices other than drive controls, PLCs and IOT

**Recommendation:** Identify existing standards for industrial computing devices such as oven controllers, CNC Controllers, and other IT equipment used on the manufacturing floor that fall outside the scope of drive controllers, PLCs and IOT devices for inclusion in the roadmap.

**Priority:** Medium

**Status of Progress: Project** Lead needed.

**Organization:** NEMA, US TAG SyC SM, ISA, SME

**GAP D3.2:** Missing design guidelines for custom applications.

**Recommendation:** Create a design guidance document identifying principle of customer controller design and with references to physical electrical, electromagnetic compatibility, and electromagnetic interference standard.

**Priority:** Medium

**Status of Progress:** Not Started

**Organization:** TBD

**Industrial Vision Systems**

**GAP D4:** Missing Standards and Guidelines for Industrial Vision Systems

**Recommendation:** Identify existing Standards and Guidelines for Industrial Vision Systems

**Priority:** Medium

**Status of Progress:** Not Started

**Organization:** A3

**3.3 Device Management**

**DM1 Management General**

**GAP DM1:** Missing Device Management Standards

**Recommendation:** Identify existing standards for Smart Manufacturing Device Management

**Priority**: Medium

**Status of Progress:** Not Started

**Organization:** ISA 108 Intelligent Device MGT

**3.4 Communication**

**Computer Network Technology Terminology**

**GAP C1.1:** Missing US Experts for Computer Network Technology Terminology on IEC TC 1 MT300

**Recommendation:** Identify US Expert to serve on TC 1 MT300 and participate in the periodic maintenance of IEC 60050-732 and IEC 60050-741.

**Priority**: Medium

**Status of Progress:** Not Started

**Organization:** TBD

**Non-Public Cellular Networks for Industrial Control**

**GAP C2.1:** Identify non-public cellular network standards applicable to the manufacturing space.

**Recommendation:** Identify non-public cellular network standards applicable to the manufacturing space Since Cellular Network Standards Fall outside the scope of NEMA and the IEC an organization that operates in this field needs to be identified to contribute.

**Priority:** Medium

**Status of Progress:** Not Started

**Organization:** TBD

* 1. **Data Analytics**

**GAP DA1.1:** Identify Data Analytics Standards

**Recommendation:** Identify Data Analytics Standards applicable to the manufacturing space and recruit US Professionals to serves as experts on ISO/IEC Joint Technical Committees

**Priority:** Medium

**Status of Progress:** Not Started

**Organization:** TBD

* 1. **Application and Integration**
     1. **Supervisory Control and Data Acquisition (SCADA)**

**GAP SCADA1.1:** Identify SCADA Systems Standards

**Recommendation:** Identify Data Analytics Standards applicable to the manufacturing space and recruit US Professionals to serves as experts on ISO/IEC Joint Technical Committees

**Priority:** Medium

**Status of Progress:** Not Started

**Organization:** ISA, SME

* + 1. **Artificial Intelligence (AI)**

**GAP AI2.1:** Identify AI Systems Standards

**Recommendation:** Identify AI Standards applicable to the manufacturing space and recruit US professionals to serve as experts on ISO/IEC JTC1/SC 42: *Artificial intelligence*

**Priority:** Medium

**Status of Progress:** Approximately 20 documents under JTC1/SC42 published. Approximately 20 more are at the CD or DIS stage.

**Organization:** [**INCITS**](https://www.incits.org/)

* + 1. **Cybersecurity in Smart Manufacturing**

**GAP CyB3.1:** Identify Cybersecurity Standards as they apply to Smart Manufacturing

**Recommendation:** Identify Cybersecurity Standards applicable to the manufacturing space

**Priority:** Medium

**Status of Progress:** Not Started

**Organization:** NEMA, NIST,