



PROCESS STANDARDS

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Motivations for Standards in Manufacturing

- Complex **interactions/relationships** within manufacturing systems **make it challenging to determine the specific influences** on the health and degradation of equipment and processes
- Increasing interest and ability to leverage data and analysis to **generate actionable intelligence** about system interactions/relationships for control
- **No uniform process exists** that guides sensing, monitoring, and control at all levels from the component to the system
- **Proprietary solutions exist**, but they apply to specific systems from one vendor and are often **expensive** and **inaccessible** to many manufacturers.



Standards Subcommittee Meeting on Advanced Monitoring, Diagnostics, and Prognostics for Manufacturing Operations



Committee Charter

*Develop standards and guidelines that advance the design and implementation of monitoring, diagnostic, and prognostic capabilities, along with ways of verifying and validating their performance, to **enhance adaptive maintenance and operational control strategies** within manufacturing.*



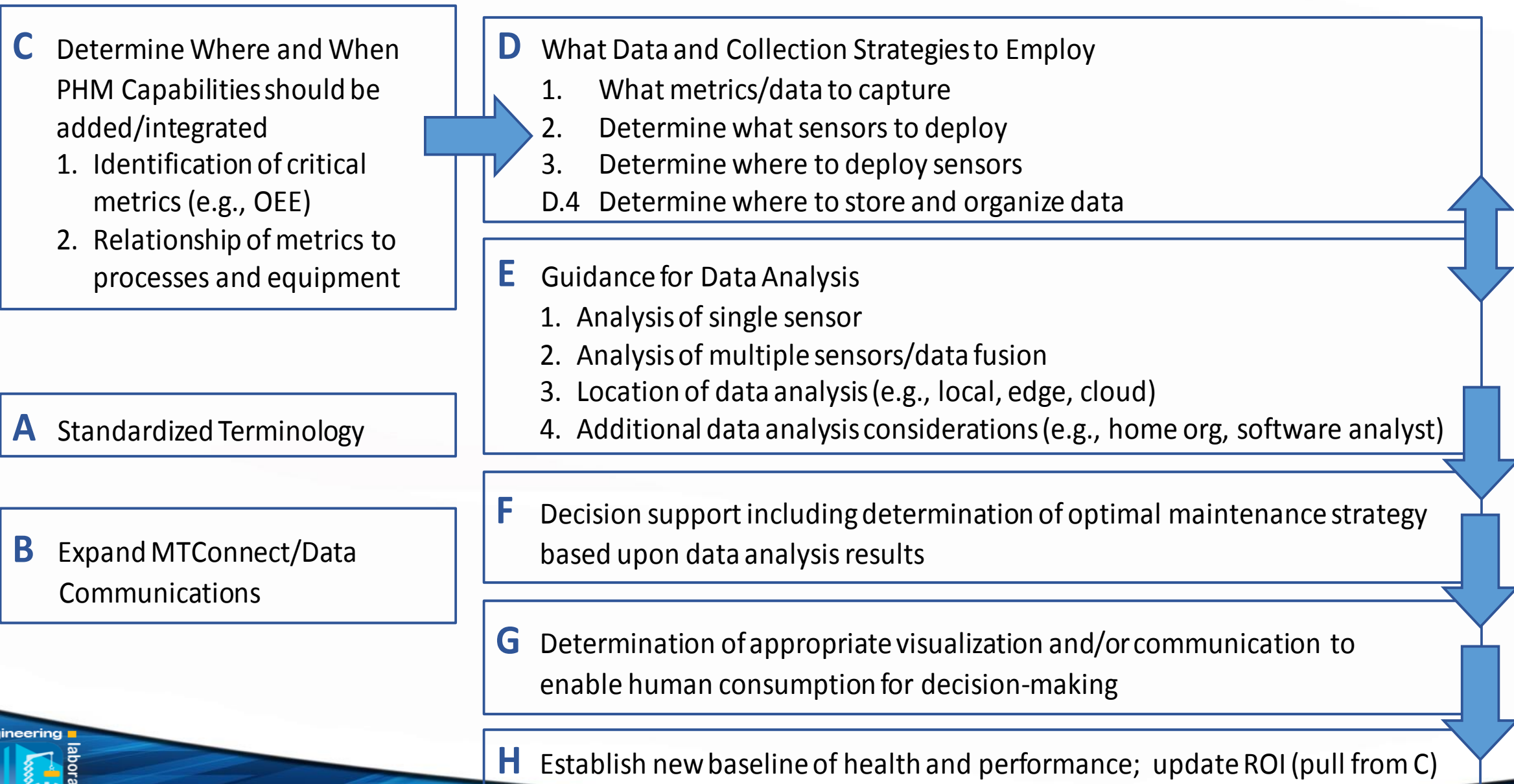
Guideline Action Plan	
DESCRIPTION: The envisioned goal is to develop a document outlining standardized terminology necessary to draft the corpus of guidelines to be developed within this PHM sub-committee. This document is expected to contain a list of defined terms relevant and important to monitoring, diagnostic, and prognostic capabilities and technologies within manufacturing. This guideline could contain a relational map to correlate relevant manufacturing and PHM terms so the larger manufacturing community can easily communicate with one another. The terminology can be in a hierarchical structure. Basic terms could initially help to setup basic concepts. Wider and/or deeper terms separated into different categories and sub-categories would provide greater context.	
TIME	GUIDELINE ACTION PLAN STEPS
NEAR (<1 YR)	<ul style="list-style-type: none"> Develop base manufacturing operational use cases to minimize downtime What are minimum requirements for availability Define secondary severity of fault/failure) manufacturing operational use cases Define approach to return-on-investment for base use cases Define roles for functions responsible for data collection Define approach to analysis to determine informational requirements for PHM and gather data
MID (2-3 YRS)	<ul style="list-style-type: none"> Define process for data collection for aspects of process Define approach to company maturity addition/integration Define approach to PHM addition/integration maturity
LONG (4-5 YRS)	<ul style="list-style-type: none"> Develop process management, including "data" as it occurs
STAKEHOLDERS & POTENTIAL ROLES	
Industry: OEM "large and small"	
Association/Trade Groups: PHM Society	
Academia: IMS; AI and smart manufacturing	
Standards Dev. Organization: ASME, SAE, ASTM, ISO 108, OIIML, IEC	
Government: NIST, AFRL, NASA	

Guideline to Determine	
DESCRIPTION: The parameters that affect the health of a process is also relevant to the manufacturing community in determining what health data to obtain; next steps are failure analysis, process helps identify what health data	
TIME	GUIDELINE ACTION PLAN STEPS
NEAR (<1 YR)	<ul style="list-style-type: none"> Examine the manufacturing standards and identify high-risk standards may support Reference existing standard terminology and definitions (ASME, ASTM, ISO, IEC) Determine all potential data captured, regardless of availability; consider data system interdependencies Determine data priorities Determine necessary parameters Collect health specific data from manufacturer, including actual/historical usage
MID (2-3 YRS)	<ul style="list-style-type: none"> Assess state/events (of process) and context Devise and conduct advanced strategies; include characterization equipment relative to health modeling Determine data that need of tools available to capture the data Develop health data capture Test guidelines with process
STAKEHOLDERS & POTENTIAL ROLES	
Industry: Manufacturers – Small, medium, and large; technology developers, technology integrators, process engineers	
Association/Trade Groups: OSHA, NIOSH, IEEE, PHM Society	
Academia: Those involved in industrial and process engineering R&D, and data collection	
Standards Development Organizations: convene, organize, and identify what is needed	
Government: Laboratories – provide data	

Guideline Action Plan for Topic 7 – Guideline	
DESCRIPTION: Manufacturers need a guideline to provide direction for ownership and governance of the data processing, etc. and who is responsible for the PHM and data. This requires an understanding of the benefits and disadvantages. This also provide direction for ownership and governance of the data	
TIME	GUIDELINE ACTION PLAN STEPS
NEAR (<1 YR)	<ul style="list-style-type: none"> Assess the pros and cons of local, edge, or cloud data processing for PHM, and ownership and governance of the data (e.g., who conducts analysis, has expertise; data anonymity; who owns the data and governs it) Determine how to structure the data and whether data should be real time, historical, etc. Determine how much data is needed and how it should be structured (<i>MTConnect and data strategy considerations</i>)
MID (2-3 YRS)	<ul style="list-style-type: none"> Examine/develop monitoring methods for data collection - "instantaneous, periodically, etc." Determine how analysis needs to be conducted (real-time, after-the-fact, etc.) Determine differences for PHM between various process types (i.e., batch, discrete, continuous)
STAKEHOLDERS & POTENTIAL ROLES	
Industry: Cloud service providers, hardware companies, scientists/engineers, PHM analysts	
Association/Trade Groups: V4I	
Academia: Data scientists; AI experts	
Standards Dev. Organizations: MIMOSA, OASIS, FRC	
Government: NIST, DoD	

Priority Guideline Action Plan – Standardized Terminology for Availability and Maintenance of Manufacturing Operations			
DESCRIPTION: This presents the action plan to develop a document outlining standardized terminology necessary to draft the corpus of guidelines to be developed within this PHM sub-committee. This document is expected to contain a list of defined terms relevant and important to monitoring, diagnostic, and prognostic capabilities and technologies within manufacturing. This guideline could contain a relational map to correlate relevant manufacturing and PHM terms so the larger manufacturing community can easily communicate with one another. The terminology can be in a hierarchical structure. Basic terms could initially help to setup basic concepts. Wider and/or deeper terms separated into different categories and sub-categories would provide greater context.			
TIME	GUIDELINE ACTION PLAN STEPS	MILESTONES/KEY DELIVERABLES	PERFORMANCE TARGETS
NEAR (1 YR)	<ul style="list-style-type: none"> Create a skeleton outline of the terminology document Identify monitoring, diagnostic, and prognostic terms that are expected to be used within the development of the suite of guidelines based upon input from the subcommittee Survey existing PHM and Manufacturing standards to identify additional terms that can complement the list created based upon the subcommittee's input Group/cluster terms based upon overlap (e.g., predictive maintenance = condition-based monitoring) Update the skeleton outline to add/amend the required sections based upon the work done to date. Review existing roadmap action plans and guidelines under development 	<ul style="list-style-type: none"> Spreadsheet listing identified terms including any existing standards they are already defined, terms they are related or synonymous, and their priority of expected usage Draft/skeleton outline of what the terminology document is expected to look like 	<ul style="list-style-type: none"> Standard terminology covering 80% (or more) words that are expected to be referenced in the suite of guidelines developed in the PHM subcommittee Promotion of standard terms to enhance communication of PHM guidelines within the subcommittee and throughout the manufacturing community to promote greater adoption.
MID (2 YRS)	<ul style="list-style-type: none"> Prioritize (e.g., high, medium, low) the terms with respect to their expected likelihood of usage in the suite of guidelines Define high priority terms with associated context/mapping to specific guidelines and/or come to agreement on definitions that will be leveraged from existing standards Incorporate the high priority terms into the skeleton terminology outline -> document Define medium priority terms and/or come to agreement on existing definitions that will be leveraged from existing standards. Incorporate medium priority terms into the terminology document Repeat with low priority terms 	<ul style="list-style-type: none"> Updated spreadsheet listing all of the relevant PHM terms, their priority for definition, and the standard(s) that are referenced (if applicable) Terminology document defining and referencing, PHM terms that are expected to be relevant to the overall guidelines development effort of the PHM subcommittee 	
STAKEHOLDERS & POTENTIAL ROLES			
Industry: Manufacturers – Small, medium, and large; operators, maintenance personnel, PHM system developers and technology developers, technology integrators, process engineers			
Association/Trade Groups: IEEE, PHM Society			
Academia: Those involved in industrial and process engineering R&D, and data collection			
Standards Development Organizations: ASME, SAE, ASTM, ISO 108, OIIML, IEC			
Government: NIST			

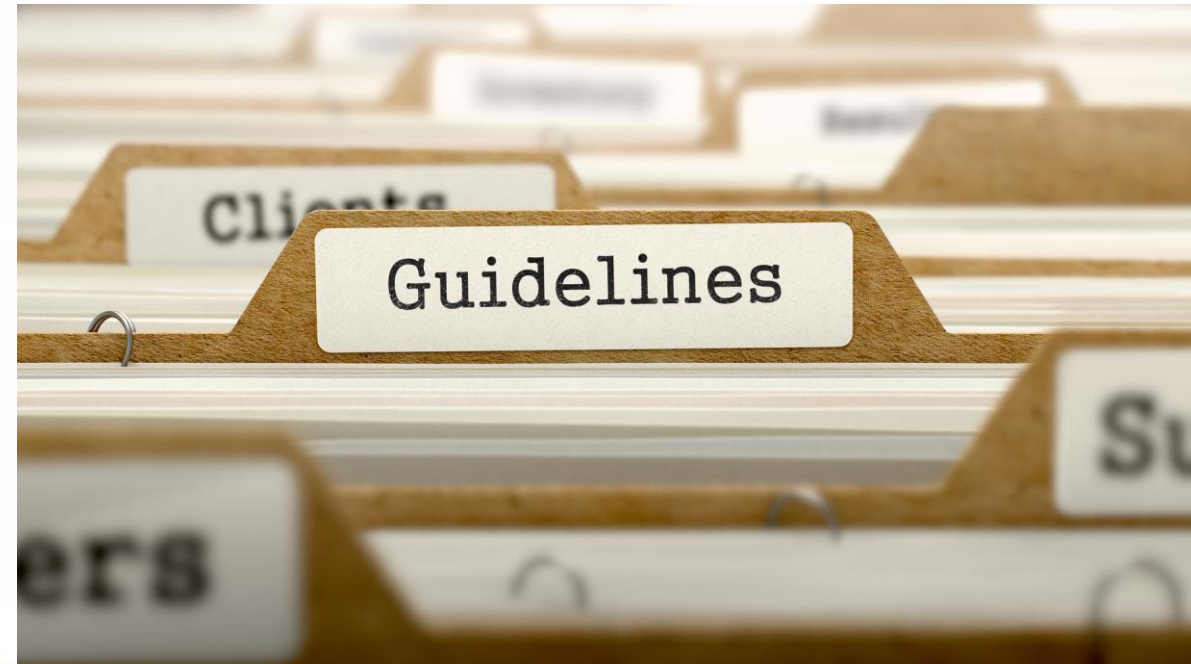
Guidelines Flow





Priority Topic Areas

1. Standardized Terminology for PHM Guideline
2. Guideline to Determine Where and When PHM Capabilities should be added/integrated
3. Guideline to Determine What Health Data to Capture and Collection Strategies to Employ
4. Guideline to Determine What Sensors and Where They Should Be Deployed to Inform on Process/Equipment Health
5. Guideline for Implementing Sensor Data Fusion/Multi-Modal Data Fusion
6. Expand MTConnect/Data Communications
7. Guideline to Determine Where to Perform PHM Data Analyses
8. Natural Language Analysis for Maintenance Documents
9. **YOUR IDEAS??**



- Does the standards process need to evolve to address the speed of advancing digital technologies?
- What community contributions are most critical to realize standards for these emergent technologies?



