

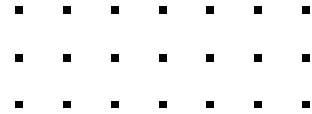


MODEL-BASED ENTERPRISE (MBE) MATURITY INDEX

GUIDEBOOK

2025 / 2026

Version



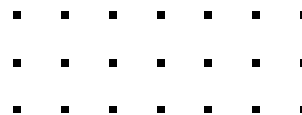
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1	9/3/2025	SteelToad	Provided additional updates and re-sorted sections
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Introduction



This Model-Based Enterprise (MBE) Maturity Index Guidebook is designed to familiarize organizations with the MBE Maturity Index tool and demonstrate how it can serve as a practical tool to support and accelerate their digital transformation journey. Using the Index tool helps to maximize organizational value by integrating MBE principles to streamline digital workflows, enhance product lifecycle management, and drive precision, agility, and innovation across operations. The Index tool is designed as a rubric to enable an organization to assess its current state of digital maturity across core enterprise functions and identify areas where improvements are needed.

Applying the Index tool empowers organizations to better understand their capabilities, readiness, and adoption levels within each functional area, and set realistic targets for progress. This Guidebook is not intended as a theoretical overview, but as a working reference to help organizations apply the Index tool in a way that generates clear and actionable outcomes to provide value. The Guidebook provides context on how assessments are conducted, what the Index measures, and how the results can be translated into a roadmap for digital adoption.

The MBE Maturity Index is tool-agnostic and not aligned to any specific vendor, product, or proprietary technology. Its purpose is to objectively assess an organization's current MBE capabilities in adopting model-based enterprise practices, without promoting or requiring the use of particular software or product data management solutions. This neutrality ensures the tool can be applied across diverse industries, technology environments, and organizational sizes. Rather than prescribing a one-size-fits-all approach, the index is built on a foundation of industry best activities, gathered from leading organizations, standards bodies, and subject matter experts. It provides a structured assessment method for identifying strengths, gaps, and opportunities for improvement, enabling organizations to chart a customized path toward digital model-based enterprise transformation based on proven methods rather than commercial interests.

¹ Title: NSE MBE Maturity Index (UUR), Issue C.0, December 12, 2024, © 2024

Creator: Model-Based Integrated Team (MBIT), MBE Committee, lead editor Mr. Curtis W. Brown, Kansas City Nuclear Security Complex (KCNSC). This document is Issue C of the NSE MBE Maturity Index and approved for public distribution via report NSC-614-6820, dated 20241212, and is designated as Unclassified Unlimited Release (UUR). License grant: Creative Commons CC BY-SA: <https://www.sandia.gov/mbit-mbe/category/index/>

How To Use This Guidebook Component

The Guidebook is organized to mirror the structure of the MBE Maturity Index, allowing readers to move easily between the assessment tool and the supporting explanations. Each major section corresponds to a key element of the Index, such as categories, topics, and facets, and provides the definitions, context, and instructions necessary for applying them. To support digital use, each category section includes its own table of contents. These internal navigation points enable readers to quickly locate the information most relevant to their role or task, without having to navigate through the entire document sequentially.



The intent is to make the Guidebook functional as a reference and a working manual. An organization may choose to read it in full during initial orientation. Still, in practice, most users will return to specific sections as needed, whether to review definitions during an assessment, clarify how facets are applied, or revisit examples when developing a roadmap. Navigation supports this pattern of use, reducing the time required to find relevant content and supporting the consistent use of the Guidebook as a companion resource to the Index during assessments.

Model-Based Enterprise Challenges

For over 70 years, document-centric, 2D drawing-based approaches have dominated engineering and manufacturing workflows, with drawing model-centric practices emerging over the past 30 years. However, these legacy methods present systemic challenges that hinder efficiency and innovation. Decision-making often relies on disconnected data sources, leading to duplication, unstructured information, and a lack of trust in data integrity. Multiple systems store redundant data without integration, requiring significant human intervention and imposing a high cognitive load on teams. This frequently results in inconsistent outcomes and delays. Furthermore, while files may be configuration-managed, they are not treated as digital objects and remain disconnected from the underlying models, limiting traceability, automation, and scalability. Addressing these issues is critical for organizations aiming to transition toward a model-based enterprise and fully leverage digital engineering capabilities.

Leadership Challenges

The industry is undergoing a rapid digital transformation, requiring organizations to adapt both culturally and operationally. To remain competitive, leadership must focus on attracting and retaining a digitally skilled workforce, while responding to increasingly compressed development timelines and evolving customer expectations. U.S. competitors are advancing quickly, and maintaining pace demands strategic agility, innovation, and a willingness to evolve MBE processes—even in environments traditionally resistant to change. Aligning organizational MBE culture with industry trends is essential for long-term success.

Engineering, Manufacturing, and Quality Challenges

Teams are facing growing pressure to deliver faster, more responsive solutions in a rapidly digitizing industry. As competitors accelerate development and customers demand quicker turnarounds with minimal risk, engineers must embrace model-based practices and digital tools to stay ahead. Adapting to change, improving collaboration, and optimizing product data management and workflows are key to meeting compressed timelines and evolving product requirements. Staying aligned with industry trends and organizational culture is critical to maintaining technical relevance and impact.

External Stakeholders Challenges

(e.g., partners, suppliers, investors)

The global shift toward digital engineering and model-based practices is reshaping how organizations operate and compete. Enterprises must evolve to meet compressed development cycles, heighten customer expectations, and increase responsiveness to product changes while managing risk and maintaining process integrity. To address the systemic inefficiencies of legacy document-centric and drawing-based practices, transitioning to a digital, part-centric, model-based enterprise offers a transformative solution. This approach aligns with the principles of a Digital Enterprise, an organization using Digital Threads to conduct business activities that are interconnected through a robust digital infrastructure. The Digital Thread is the logical and physical infrastructure that links data from authoritative sources for interconnecting a digital enterprise. A Model-Based Enterprise (MBE) is a digital enterprise using digital models and associated datasets as the foundation within the product lifecycle.

By leveraging Digital Threads across all product realization activities, organizations can achieve faster cycle times, greater responsiveness to change, and foster a culture of innovation. In this paradigm, trusted models serve as the authoritative source of truth, forming the foundation of the digital thread and enabling consistent, reliable decision-making. Configuration management shifts from file-based control to part-centric governance, allowing dynamic access to product and process definitions as needed. This model-based approach is essential for organizations seeking to remain competitive, agile, and aligned with the evolving demands of modern industry.

Quick Start an MBE Assessment

The quick start is designed to help users begin performing an assessment with minimal effort and time. Its primary purpose is to provide clear, concise instructions focusing on the most essential steps needed to get started, including setup procedures, basic functions, and key features. Unlike the full Model-Based Enterprise (MBE) Maturity Index Guidebook a quick start avoids overwhelming detail and instead prioritizes simplicity and accessibility, making it ideal for users who want to start using something right away without reading the Guidebook documentation. A quick start is especially useful for users who are already experienced in conducting assessments. For first-time users of the Model-Based Enterprise (MBE) Maturity Index tool may find a read of the full Guidebook helps to build confidence and familiarity.

1. Define Scope and Objectives

Clearly defining the assessment's scope and objectives ensures alignment with the organization's strategic goals.

2. Engage Stakeholders

Involving stakeholders from management, engineering, manufacturing, quality, and IT provides a comprehensive view of assessment practices.

3. Select Categories to Assess

Select all 5 Categories C1: Product Design Activities, C2: Product Data/Lifecycle Management Activities, C3: Product Manufacturing Activities, C4: Product Quality Activities, and C5: Enterprise Enabling Activities or tailor select Categories to assess.

4. Download MBE Maturity Index Tool

The MBE Maturity Index Tool is a Microsoft Excel spreadsheet. To download the latest version from Sandia.gov, visit: <https://www.sandia.gov/mbit-mbe/category/index/>

5. Conduct. Score and Document Findings

Assess and score the current and target state of MBE abilities, best practices, and activities against Capability: Tools are available? Readiness: Processes are ready? and Adoption: People are using?

6. Develop MBE Roadmap for Improvement

Develop a roadmap and continuous improvement plan based on the assessment results. The improvement roadmap outlines a clear vision with strategic objectives and phased milestones to guide the transition from MBE current practices to desired future states. Continuous improvement is embedded in this roadmap through regular feedback loops, data-driven decision-making, and iterative refinement of MBE processes. Foster a culture of MBE learning and adaptability. Organizations can respond to emerging challenges, leverage best practices, and ensure long-term success.

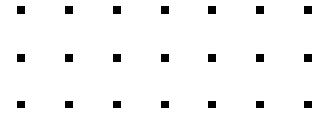
What is a Model-Based Enterprise (MBE)?

A Model-Based Enterprise (MBE) is an approach to manufacturing and engineering in which a digital three-dimensional model becomes the central source of truth throughout the entire product lifecycle. In this model-centric environment, all information necessary for designing, producing, inspecting, and supporting a product is embedded within the digital model, eliminating the dependency on traditional two-dimensional drawings and reducing the risks associated with conflicting or outdated documentation. The defining characteristic of an MBE is its ability to maintain a single source of truth. Geometry, dimensions, tolerances, materials, manufacturing instructions, and inspection criteria are stored within the 3D model. Because the model contains all relevant product data, it is the authoritative reference across design, production, quality, and enterprise functions.

An MBE also relies on Digital Thread integration, where the model is connected across various systems, including Product Data Management (PDM), Product Lifecycle Management (PLM), Enterprise Resource Planning (ERP), and Manufacturing Execution Systems (MES). The integration creates continuity from initial design through production and into sustainment, allowing information to flow consistently across processes and organizational boundaries. By using a shared model and an integrated digital thread, MBE improves collaboration within the enterprise and with external partners. Designers, manufacturing engineers, quality specialists, and suppliers can all access and interact with the same model, which reduces miscommunication, eliminates redundant translation of information, and speeds up problem resolution.

The use of a model-based definition also enables higher levels of automation. Computer numerical control (CNC) machines and additive manufacturing systems can derive instructions from digital models. Automated inspection systems can compare physical parts against the model without requiring separate 2D drawings. These capabilities reduce manual interpretation, minimize errors, and shorten production cycles. MBE supports compliance with industry standards and regulatory requirements. Embedding requirements within the model enables organizations to demonstrate traceability, consistency, and control over design and production data. This strengthens quality management and helps the enterprise to meet the evolving digital manufacturing standards across various industries.

About the Maturity Index



The MBE Maturity Index is a self-assessment tool to help organizations assess their progress toward becoming a Model-Based Enterprise. It provides a rubric to allow organizations to measure their current capabilities and adoption across five categories of (C1: Product Design Activities, C2: Product Data/Lifecycle Management Activities, C3: Product Manufacturing Activities, C4: Product Quality Activities, and C5: Enterprise Enabling Activities). Within each of these categories, organizations assess the availability of tools, the readiness of supporting processes, and the degree to which the workforce has adopted these practices. The Index does not prescribe a single path or assume every organization should strive for the highest maturity levels in all areas.

Drawing-Centric (L0)	Drawing Model-Centric (L1)	Validated Model-Centric (L2)	Formalized Model-Based Definition (L3)	Trusted Model-Based Definition (L4)	Integrated Model-Based Enterprise (L5)	Extended Model-Based Enterprise (L6)
Drawing-Centric	Drawing Model-Centric	Validated Model-Centric	Formalized Model-Based Definition	Trusted Model-Based Definition	Integrated Model-Based Enterprise	Extended Model-Based Enterprise
L0	L1	L2	L3	L4	L5	L6
2D Drawings used for all activities	2D Drawings derived from models	2D Drawings and other derivatives from validated 3D model	Semantic PMI included within 3D model	Certified, Authorized MBD	MBD product definition dataset (PDD) made useable for all lifecycle activities throughout Enterprise	Product definition system model made useable for all lifecycle activities

Expectations

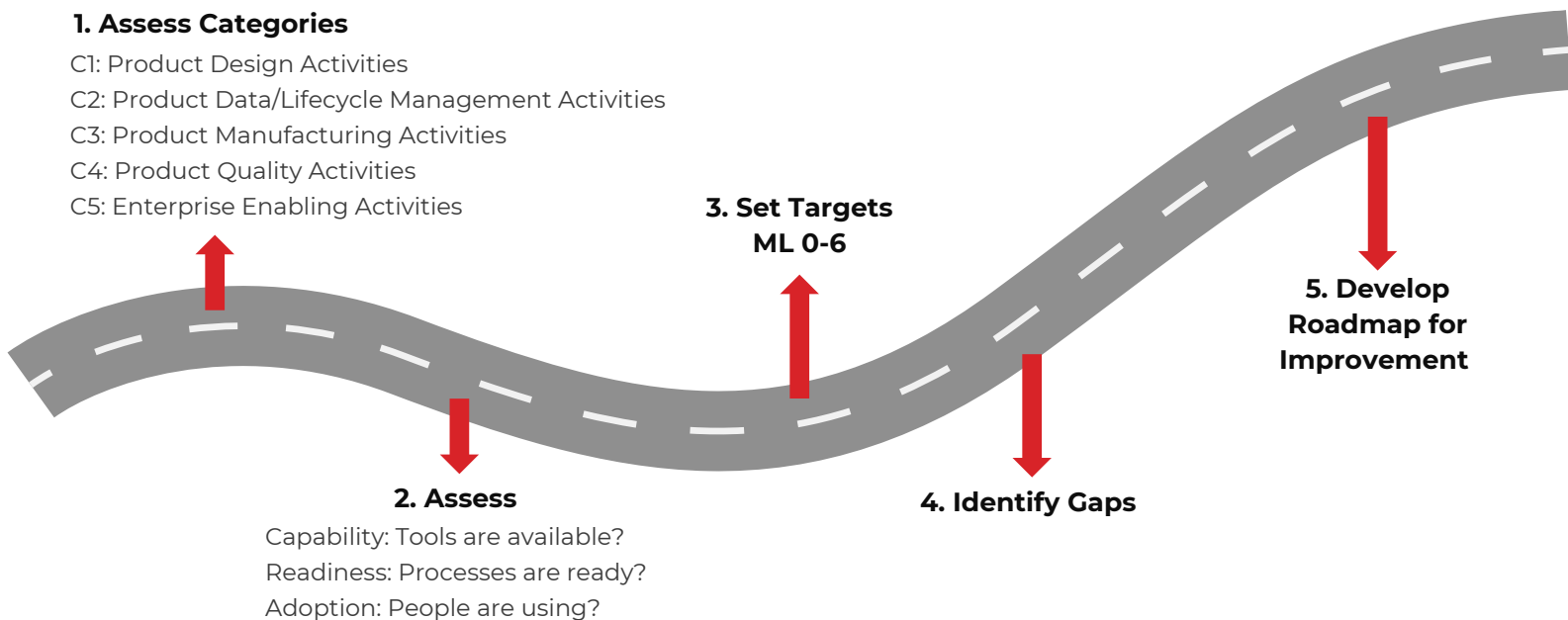
For individuals who have not previously participated in an assessment, the process may initially seem daunting. However, gaining a clear understanding of what to expect can help alleviate apprehension and foster a more confident approach. An MBE Maturity Index assessment and an audit serve distinct purposes within organizational evaluation processes. An MBE assessment is a collaborative and developmental exercise aimed at understanding current capabilities, identifying areas for improvement, and guiding strategic growth. It is voluntary, internally driven, and focused on continuous improvement rather than compliance.

The MBE Maturity Index Tool is not used to audit an organization. An audit is a formal and objective process conducted to verify adherence to established standards, regulations, or contractual obligations. Audits are usually mandatory, performed by certified auditors or external bodies, and result in documented findings that may require corrective actions. MBE assessments foster learning and innovation; audits ensure accountability and conformance.

ROADMAP FOR TRANSFORMATION

1. Assess Categories

- C1: Product Design Activities
- C2: Product Data/Lifecycle Management Activities
- C3: Product Manufacturing Activities
- C4: Product Quality Activities
- C5: Enterprise Enabling Activities



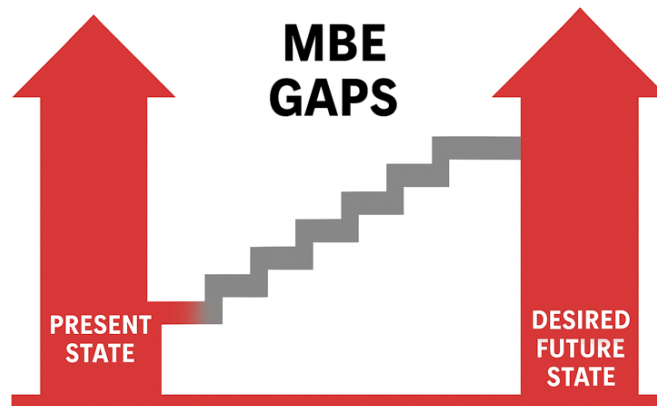
A company's size, resources, regulatory environment, and strategic goals all influence which maturity levels are appropriate. For some organizations, remaining at an intermediate Maturity level in one area may be the most practical and valuable choice, while advancing Maturity further in another area may be critical for competitiveness or compliance. A mid-sized organization, for example, may target intermediate maturity in category C5: Enterprise Enabling Activities while prioritizing a higher maturity in another category, C1: Product Design Activities, to meet customer demands and bring more value to the organization.

The purpose of the Index is not to deliver a score for comparison's sake, but to create a visibility roadmap into an organization's current digital practices and to identify meaningful gaps between the present state and the desired future state. This clarity enables leaders to establish priorities, allocate resources, and implement targeted improvements to align with business objectives. The Index grounds maturity assessments in the realities of each organization, helping avoid unrealistic expectations and supporting sustainable progress toward digital transformation.

Value Proposition

The MBE Maturity Index offers organizations a practical means of assessing their current position and identifying their desired future state. Examining their practices across design, product data management, manufacturing, quality, and enterprise functions, organizations can uncover specific gaps between current performance and desired targets. These gaps form the foundation for meaningful decision-making. Rather than offering a generic checklist, the Index enables organizations to create tailored roadmaps to reflect their own environment, readiness, and available resources. This allows organizations to pursue realistic and achievable improvements, thereby avoiding wasted effort and inefficiencies that result from applying a one-size-fits-all model. The result is a roadmap that is actionable, prioritized, and aligned with the organization's broader strategy.

In practice, this means the Index serves as a diagnostic and a planning tool. It highlights the areas where investment of time, training, or technology will deliver the most value, helping to avoid overextending in areas where readiness is low or returns are limited. For leadership, it provides a basis for setting priorities and allocating resources. For practitioners, it provides a means to connect their day-to-day activities with the organization's broader digital transformation objectives.



Misconceptions

Model-Based Enterprise (MBE) Maturity Index tool misunderstandings are common and can lead to its misapplication or a misinterpretation of its intended purpose and value.

It is a One-Size-Fits-All MBE Maturity Index tool must be applied uniformly across an entire organization.

False. It is designed to support variability across departments, programs, suppliers, and individual projects. Different areas of the enterprise can be assessed independently, enabling a more tailored and context-sensitive evaluation.

My organization will never get to Maturity Level 6, so the MBE Maturity Index is not worthwhile.

False. The value of MBE is not in achieving the highest maturity level, but in the incremental improvements made throughout the MBE journey. Rather than focusing on the MBE endpoint, it is more productive to focus on the value of the journey and the strategic advantages gained along the way.

Someone who is familiar with the assessment and tool needs to facilitate the assessment.

False. Having a knowledgeable MBE facilitator can be helpful; it is not a strict requirement. The assessment process is designed to be collaborative and educational; teams can learn and grow through the experience itself. In fact, involving a broader group, including those who are less familiar with the tool, can lead to more honest insights, better cross-functional understanding, and stronger organizational buy-in.

Achieving a high maturity level requires a complete digital transformation upfront.

False. The MBE Maturity Index supports incremental progress. Organizations can start small, build on existing capabilities, and evolve over time. Success is measured by continuous improvement, not by immediate full-scale transformation.

The MBE tool is for Large organizations only with extensive resources.

False. The MBE Maturity Index can be applied to small and medium-sized enterprises (SMEs). It helps any organization assess its digital maturity and plan improvements, regardless of size.

The MBE tool is only relevant to engineering.	False. MBE practices impact multiple functions, including manufacturing, quality, product data management, and MBE governance. The Maturity Index encourages cross-functional collaboration and alignment to improve enterprise-wide performance.
Small and medium-sized organizations do not have IT people and cannot use the MBE assessment tool to improve.	False. Small design and manufacturing organizations can gain efficiency, traceability, and quality improvements by assessing their current state and adopting model-based activities incrementally. Initially, a small business did not grasp the concept of the MBE Maturity Index tool; the MBE name provided no meaning. Once they started to work with the tool and scored and completed all 5 categories, they found the MBE Maturity Index tool to be “forward thinking” and very worthwhile to provide them with an MBE roadmap to a future state.
The MBE tool requires expensive tools and infrastructure.	False. Although MBE tools help increase maturity, the MBE Maturity Index is tool-agnostic and emphasizes organizational capabilities rather than specific technologies. MBE organizations can leverage systems, such as Product Data Management (PDM) or Product Lifecycle Management (PLM), to make meaningful progress by optimizing processes and improving product data practices.
The MBE tool is for DoD organizations only.	False. The framework is broadly applicable across industries and organization types, offering value to any enterprise seeking to improve its model-based practices and digital engineering capabilities.

Maturity Levels

Model-Based Enterprise (MBE) maturity levels describe the progressive stages an organization goes through in adopting model-based enterprise practices and activities to manage product lifecycle data digitally. At the lower levels of maturity, organizations rely heavily on 2D drawings and disconnected systems, which often leads to inefficiencies, errors, and miscommunication between design, manufacturing, and quality teams.

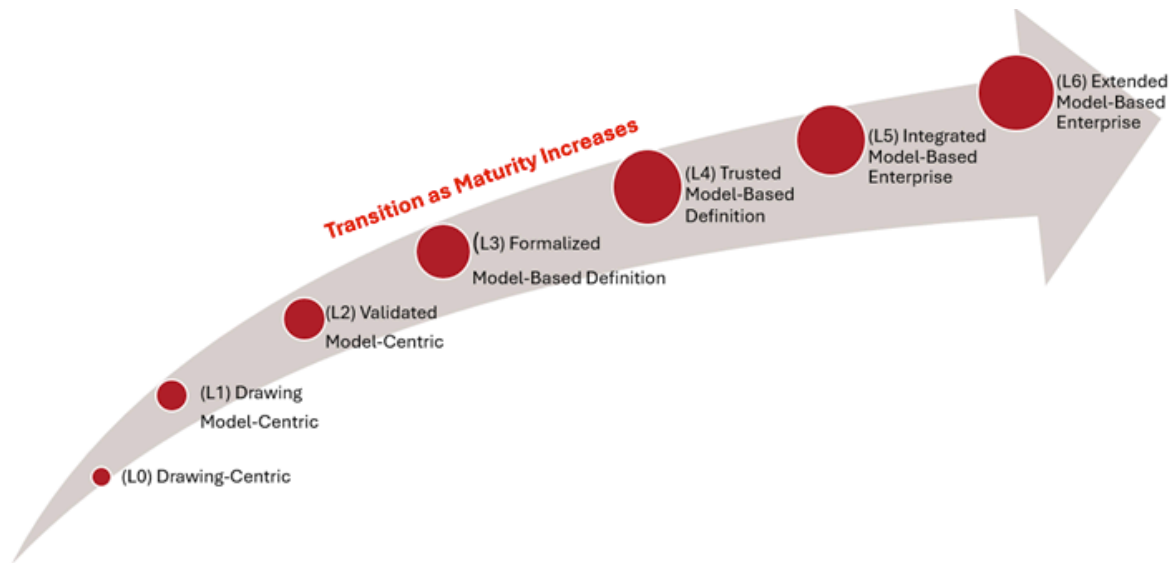


Figure 1. As maturity increases, the organization's MBE processes become more standardized, data-driven, and strategically aligned with its long-term goals. For example, in a low-maturity organization, MBE practices might rely heavily on individual initiative and ad-hoc decision-making. However, as maturity grows, formal MBE methodologies are adopted, and performance metrics are consistently tracked to guide improvements.

As maturity increases, organizations begin integrating 3D models as the authoritative source of product definition, reducing reliance on traditional drawings and enabling better collaboration across internal departments (e.g., design, engineering, manufacturing, quality).

At higher maturity levels, the enterprise achieves full digital continuity, where all stakeholders, including engineering, manufacturing, supply chain, and service, access and use a single, authoritative digital model throughout the product lifecycle. This enables advanced capabilities such as automated manufacturing, real-time quality validation, and predictive maintenance. A mature MBE environment supports faster product development, improved accuracy, and reduced costs by leveraging a seamless flow of model-based data across the enterprise. Transition to the next Maturity Level: As maturity increases, the organizations. Capability: MBE Tools are available, Readiness: processes are maturing, and Adoption: people are using both tools and processes.

Maturity Level	Maturity Level Designation	Maturity Level Description
L0	Drawing-Centric	No model exists
L1	Drawing Model-Centric	Derive 2D drawings from 3D Models. 3D models are introduced, but primarily for visualization. Drawings remain the official source of truth. Limited integration with downstream processes.
L2	Validated Model-Centric	Validate the 3D model before deriving 2D drawings
L3	Formalized Model-Based Definition	Begin to achieve an MBE state by creating Model-Based Definition (MBD) and authorizing 3D drawings. (approved by an authority for use in a lifecycle activity) instead of 2D.
L4	Trusted Model-Based Definition	Authorize 3D Model-Based Definitions (MBD). Represent a complete Model-Based Enterprise.
L5	Integrated Model-Based Enterprise	Model-Based Enterprise best practices across the enterprise.
L6	Extended Model-Based Enterprise	Extends reach to external partners and extends capabilities using state-of-the-art practices and technologies.

A goal of MBE is to follow an organizing principle to enable product data management (PDM) to relate all product lifecycle data to a single point of reference, which is the concept of a centralized product master record or single source of truth (SSOT). This principle ensures every piece of data, ranging from design specifications, engineering changes, to manufacturing processes, inspection, and service documentation, is linked back to a unified, authoritative reference point. By anchoring all lifecycle information to this central record, organizations can maintain consistency, reduce errors, and improve collaboration across departments. It also facilitates traceability, compliance, and efficient decision-making throughout the product's lifecycle, from conception to retirement.

Part-Centric Manifesto

The Part-Centric Manifesto developed by the Models-Based Integration Team MBE Committee² follows an organizing principle that enables product data management (PDM) to relate all product lifecycle data to a single point of reference, which is the concept of a centralized product master record or single source of truth (SSOT). This principle ensures every piece of data, ranging from design specifications and engineering changes to manufacturing processes, inspection, and service documentation, is linked back to a unified, authoritative reference point. By anchoring all lifecycle information to this central record, organizations can maintain consistency, reduce errors, and improve collaboration across departments.

As organizations evolve through the maturity levels, they shift from traditional document-centric approaches to integrated, enterprise-wide digital models. At the early stages, organizations operate in a document-centric manner, relying heavily on 2D drawings and disconnected systems. As they mature, they become part-centric, where digital models of individual parts become the authoritative source of truth, improving data consistency and enabling automation.

Further progression leads to a product-part centric approach, where product data is managed at the part level across the entire lifecycle, enhancing traceability and collaboration. The lifecycle dimension becomes increasingly important as validated digital models are reused across design, manufacturing, and quality processes, reducing errors and accelerating development. At the highest levels of MBE maturity, the focus shifts to the enterprise, where all departments and external partners are integrated through trusted digital models, enabling seamless collaboration, strategic decision-making, and optimized operations. Each of these shifts of MBE maturity, document to part, part to product, product to lifecycle, and enterprise part, increases in digital maturity, readiness, and adoption, driving the organization toward full MBE maturity.

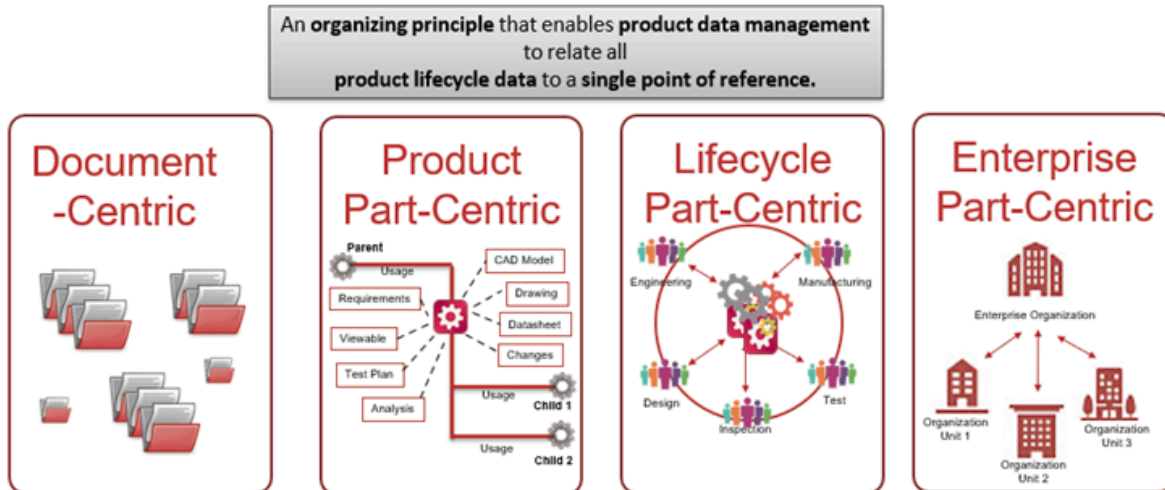
MBE maturity facilitates traceability, compliance, and efficient decision-making throughout the product's lifecycle, from conception to retirement. The manifesto includes:

Part-Centric Definition—An organizing principle that enables product data management to relate all product data and process data to a single point of reference.

Objective—A part-centric approach unites the broad set of product development information, enabling enterprise users (typically within internal company operations) to access the right information at the right time. Part-centric is considered a foundational (build block) requirement for the transition to Model-based Enterprise (MBE).

² <https://www.sandia.gov/mbit-mbe/2022/04/05/part-centric-manifesto>

Purpose—Establish the foundations of a Part-Centric approach to product lifecycle management. Motivate the transformation from document-centric, drawing-based practices to a digital, part-centric, model-based paradigm.



MOVE AWAY FROM THESE PRACTICES	BEST PRACTICE GOALS
Product data <i>is organized by file or document identification.</i>	Product data organized about a <i>part object</i> .
Product data is accessed from <i>disconnected</i> stores that can have <i>uncontrolled copies</i> .	Product data accessed from trusted, <i>connected, authoritative sources</i>
Data is <i>duplicated</i> manually in disparate systems.	Data is entered once and reused for upstream/downstream use as a <i>traceable</i> artifact,
Fragmented, <i>manually</i> entered, single-level bills of materials (Bill of Materials).	Complete, digitally connected, hierarchical <i>product structure</i> with bills of materials (Bill of Materials).
Product information is accessed through <i>multiple</i> entry points, each providing a distinct and partial view of the overall product data.	All product information is accessed through the part object as a <i>single entry point</i> .
Product's identification is <i>human-readable</i> and inconsistent between sites.	A product's identification is <i>machine-readable, consistent</i> , and persists throughout the enterprise.
Using data in <i>unverified derivative</i> forms.	Using data in its <i>native</i> form.
Product data <i>organized as specialized</i> setups.	Product information <i>schemas</i> are consistent throughout the enterprise.
<i>Disconnected</i> silos <i>react manually</i> to change through documents.	Responsive part <i>change management</i> common throughout product lifecycle.

Document-Centric

Document-centric in the Model-Based Enterprise (MBE) maturity model refers to a stage where organizations still rely heavily on traditional documents, such as 2D drawings, PDFs, spreadsheets, and text-based specifications, to communicate product information. At this level, digital tools may be used to create and store these documents, but the 3D model is not yet the authoritative source of truth. Instead, the model is often treated as a visual aid, while the actual manufacturing and inspection instructions are derived from separate documentation. This approach can lead to data silos, version control issues, and miscommunication, especially when documents are manually updated or interpreted differently across departments.

Document -Centric

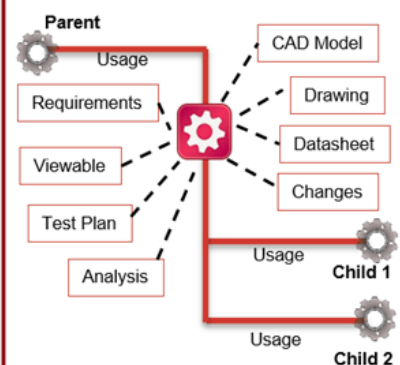


While Level 2 may offer some digital efficiencies compared to paper-based workflows, it lacks the integration and automation benefits that come with higher MBE maturity levels. Transitioning beyond this stage involves shifting toward model-based definitions (MBD), where the 3D model itself contains all necessary product and manufacturing information.

Product, Part-Centric

A part-centric approach unites the broad set of product development information, enabling enterprise users to access the right information at the right time. Part-centric is considered a foundational requirement for transition to Model-Based Enterprise (MBE) and refers to a stage in the MBE maturity model where the focus shifts from general documentation to managing individual parts and products as distinct digital entities. At this level, organizations begin to associate digital models and data directly with specific components or assemblies, rather than treating them as generic or disconnected files. This approach enables better traceability, configuration control, and lifecycle management of each part. It supports more accurate versioning, clearer communication between engineering and manufacturing, and improved integration with systems like Product Lifecycle Management (PLM).

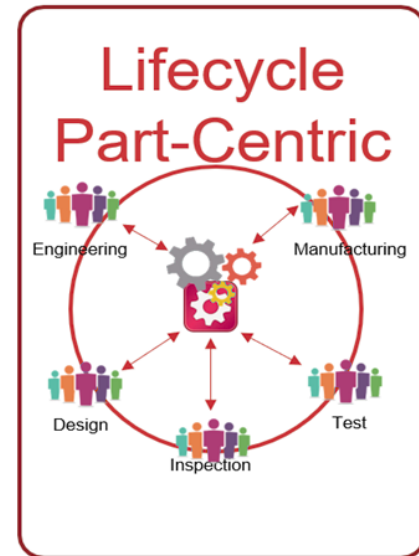
Product Part-Centric



While not yet fully model-based, this stage lays the groundwork for transitioning to Model-Based Definition (MBD) by organizing and structuring product data around the actual parts being designed and built.

Lifecycle Part-Centric

Lifecycle Part-Centric refers to a more advanced stage in the Model-Based Enterprise (MBE) maturity model where the focus is not only on individual parts, assemblies, or products, but also on managing their entire lifecycle, from design engineering, manufacturing, test, inspection, to service and disposal, using integrated digital models and data. At this level, each part is treated as a digital entity with traceable attributes, version history, and contextual relationships to other components and systems. This approach enables organizations to maintain continuity of data across departments and systems, ensuring that changes made in design are reflected in manufacturing, quality control, and maintenance. It supports the Digital Thread, allowing access to part-specific information throughout its lifecycle. Lifecycle Part-Centric maturity improves decision-making, reduces errors, and enhances collaboration by ensuring that everyone, from engineers to suppliers, works from a consistent, up-to-date source of truth.



Enterprise Part-Centric

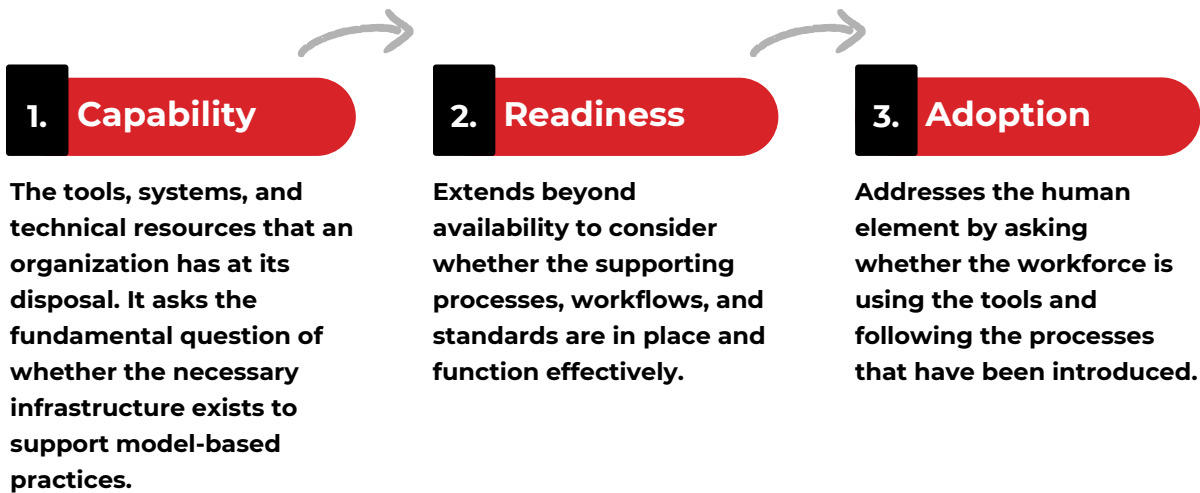
Enterprise Part-Centric represents one of the highest maturity levels in the Model-Based Enterprise (MBE) framework. At this stage, the organization manages parts and products as fully integrated digital entities across the entire enterprise, and extended organization (supply chain, partners). This means every organizational unit, department, including engineering, manufacturing, quality, and service accesses and interacts with a single, authoritative digital model of each part throughout its enterprise lifecycle.

Unlike earlier stages where part data may be siloed or limited to specific functions, Enterprise Part-Centric maturity ensures digital part-related information is interoperable, traceable, and consistent across the enterprise systems and teams.



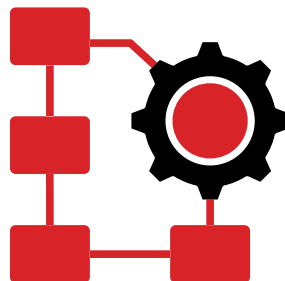
Assessment Method

The MBE Maturity Index is applied through a stepwise process that enables an organization to take a clear look at its current practices and compare them against its desired state. The assessment begins by examining each of the five major Categories of Model-Based Enterprise activities (e.g., design, data and lifecycle management, manufacturing, quality, and enterprise enabling) through the lens of the Index. Within each category, specific topics are reviewed, and each topic is evaluated across three distinct perspectives: capability, readiness, and adoption.



Capability

Indicates whether the necessary tools and systems are in place.



Readiness

Measures whether processes, standards, and workflows are established to support the use of those tools.



Adoption

Refers to how consistently the workforce applies the tools and processes in day-to-day work.



Target

Defines the future maturity level that the organization seeks to achieve within a chosen timeframe.

Taken together, these three perspectives provide a realistic picture of the current state, avoiding the common pitfall of assuming that the mere presence of technology equates to transformation. In addition to rating the present state, the assessment requires setting a target for each area. Targets are future-state maturity levels that reflect where the organization wants to be at a defined point in time. They provide a benchmark against which progress can be measured and serve as anchors for planning. Importantly, these targets are determined by organizational context, not by an external standard. A small or mid-sized organization may set different targets than a large enterprise, and what is ambitious for one company may be unnecessary for another.

Once as-is ratings and targets are established, the difference between the two creates a clear picture of the maturity gap. These gaps represent the areas where change is necessary for the organization to achieve its desired state. Some gaps may involve technology acquisition, such as having a Product Data Management tool; others will include workforce development, and still others may point to the need for governance structures or process redesign. Identifying these gaps with precision enables organizations to prioritize which changes are most urgent and feasible, given their strategic objectives.

Tailoring is a critical feature of the Index and should be applied throughout the assessment. Not every organization needs to assess every facet or pursue every possible level of high maturity. Instead, the assessment should be scoped to include the areas that provide the most outstanding value for the organization. For example, a company that relies heavily on supplier collaboration may focus more attention on activities that enable the enterprise to function effectively. At the same time, another that is already strong in design practices may place greater emphasis on manufacturing or quality. Tailoring allows the Index to remain relevant and practical across organizations of different sizes, industries, and maturity levels.

The Index provides a repeatable method for organizations to understand their current position, their desired destination, and the obstacles that stand in their way. Digital transformation can often feel like an abstract concept, but the Maturity Index translates it into a concrete, actionable framework that guides decision-making and resource allocation across the enterprise.

Tailoring Guidance



The MBE Maturity Index is flexible, allowing organizations to focus their assessments on the activities most relevant to their business needs. Not every facet or topic carries the same importance for every organization, and there is no requirement to complete the tool in its entirety. Instead, organizations are encouraged to select the elements of the Index that will provide meaningful insight into their digital maturity and support practical planning for future improvements. Tailoring ensures that the assessment results accurately reflect the organization's realities, rather than following a generic or idealized standard. . If an organization is unsure what to assess, consider all the MBE Categories C1: Product Design Activities, C2: Product Data/Lifecycle Management Activities, C3: Product Manufacturing Activities, C4: Product Quality Activities, C5: Enterprise Enabling Activities.

A smaller organization, for example, may choose to focus on core design and product data management practices, setting aside advanced enterprise-enabling topics for later in its transformation. Conversely, a company with a strong foundation in model-based design may choose to focus its assessment on manufacturing and quality, where there are greater opportunities for improvement. Tailoring the scope of the assessment helps each organization create a more accurate picture of its current state and avoids investing time in areas that will not influence its immediate goals.

The same principle applies to the selection of target maturity levels. Higher levels of maturity are not inherently better; they are only meaningful when they align with the organization's objectives, workforce capacity, and available resources. Setting unrealistic targets across all categories can lead to wasted effort and abandoned initiatives. A tailored assessment enables leadership teams to establish priorities and sequence improvements in a manner that is achievable and aligned with the broader strategy. Ultimately, tailoring transforms the Index from a static assessment tool into a planning mechanism that reflects each organization's unique environment. Focusing on the areas that generate the greatest value can create roadmaps that align with available resources and can be sustained over time.

Tailoring the Assessment



The MBE Maturity Index tool is designed to be flexible, allowing it to be applied meaningfully across organizations of varying sizes, industries, and levels of digital maturity. Tailoring refers to the process of adjusting the scope, depth, and elements of the assessment to fit the specific context of the organization being reviewed. Rather than treating the Index as a one-size-fits-all framework, tailoring allows each enterprise to focus on the areas that provide the most value and to avoid expending resources on dimensions that have little relevance to its goals.

Tailoring begins with setting the scope of the assessment first. Not every organization needs to assess every category, topic, or facet in equal depth. For example, a company in the early stages of model-based adoption may focus its initial assessment on C1: Product Design Activities and C2: Product Data/Lifecycle Management Activities, while postponing an exhaustive review of enterprise-enabling activities. Similarly, an organization already strong in design practices may choose to place more emphasis on manufacturing or quality, where larger gains can be made. Focusing on the scope creates assessments that are manageable and aligned with their priorities.

Organizations should always consider assessing Category C5: Enterprise Enabling Activities. Senior management sponsorship of C5: Enterprise Enabling Activities is essential as these topics often serve as the backbone for strategic transformation, operational efficiency, and long-term value creation across the organization. Without executive support, enabling activities, such as MBE governance, leadership, and commitment to change by delivering the funding, training, and tools for MBE collaboration across the organization to ensure MBE activities meet business objectives and add value, risks are underfunded, deprioritized, or misaligned with broader business goals.

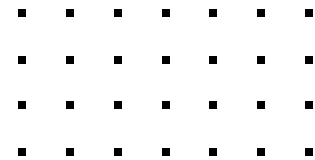
Sponsorship ensures MBE foundational efforts receive the necessary resources, visibility, and cross-functional collaboration to succeed. Moreover, when senior leaders champion these activities, it signals their importance to the entire organization, fostering a culture of accountability and MBE innovation that drives sustainable enterprise-wide impacts.

ORGANIZATION SIZE	MBE Capabilities Performed	Tailoring MBE Categories to Assess
Small, Medium, Large	When the Organization provides any MBE capability, it should always assess.	C5: Enterprise Enabling Activities
Small, Medium, Large	The Organization provides full MBE lifecycle services through design, manufacturing, and quality activities.	C1: Product Design Activities C2: Product Data/Lifecycle Management Activities C3: Product Manufacturing Activities C4: Product Quality Activities C5: Enterprise Enabling Activities
Small, Medium, Large	The Organization provides design services only.	C1: Product Design Activities, C2: Product Data/Lifecycle Management Activities C5: Enterprise Enabling Activities
Small, Medium, Large	The Organization provides manufacturing, product data management, and quality services only.	C2: Product Data/Lifecycle Management Activities C3: Product Manufacturing Activities, C4: Product Quality Activities, C5: Enterprise Enabling Activities
Small, Medium, Large	The Organization provides manufacturing and quality services only.	C2: Product Data/Lifecycle Management Activities C3: Product Manufacturing Activities, C4: Product Quality Activities, C5: Enterprise Enabling Activities
Small, Medium, Large	The Organization provides quality services only.	C4: Product Quality Activities C5: Enterprise Enabling Activities

Assessment capability depth is another consideration. Some topics may require only a high-level review, while others demand detailed investigation. For instance, if an enterprise has already invested heavily in PLM, the assessment of data management topics may require more thorough exploration of configuration management, metadata standards, or integration across systems. On the other hand, if a facet such as governance is less mature, the assessment might focus on a broader level to capture baseline information without unnecessary detail.

Tailoring also applies to the selection of Categories and Topics within the Index. Organizations may choose to emphasize specific facets, such as workforce training under the “people” facet or compliance requirements under “governance,” when those areas are critical to their environment. In doing so, they still use the normalized vocabulary and rating structure of the Index, but they emphasize the elements most relevant to their specific situation. This flexibility ensures that the assessment results are meaningful and actionable. Tailoring the Index enables organizations to avoid assessments that are either too generic to provide meaningful insight or too exhaustive to be practical. The goal is not to fill out the Index in its entirety but to create a relevant picture of maturity that informs a realistic roadmap for improvement.

MBE Maturity Index Assessment Overview



A Model-Based Enterprise (MBE), self-assessment is conducted by individuals or teams within the organization to evaluate capabilities against established best practices. This internal approach enables internal participants to identify gaps, monitor progress, and make informed decisions in real time, fostering a culture of continuous improvement and ownership. In contrast, a third-party assessment offers an objective and impartial review of the organization's MBE maturity. These external evaluations verify that systems, policies, processes, and tools align with industry best practices, providing credibility and an unbiased perspective that may be difficult to achieve internally.

To perform a Model-Based Enterprise (MBE) Maturity Index assessment, the following phases represent a structured approach to assess an organization's current and target capabilities in implementing MBE practices..

1. Plan the Assessment

This phase involves defining the scope, objectives, and criteria for the MBE assessment. Key activities include identifying stakeholders, participants, selecting the maturity model Categories to be assessed, and gathering preliminary data about current MBE processes and tools. Preparation ensures the assessment is aligned with organizational scope and goals, and all participants understand the purpose and expected outcomes.

See *Defining the Organizational Scope and Assessment Planning*.

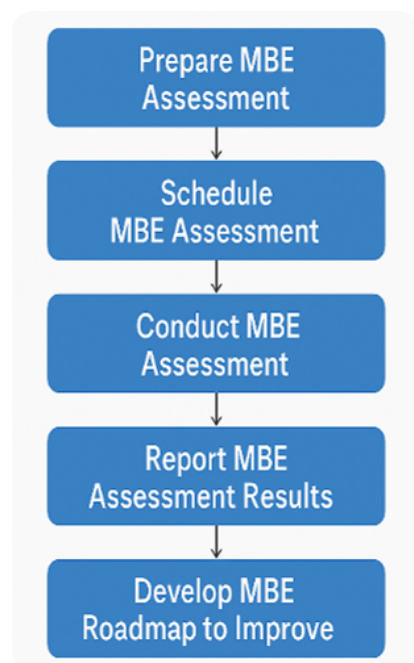
2. Schedule the Assessment

Once preparation is complete, the next step is to schedule the assessment sessions with all relevant stakeholders and participants, including design, engineering, manufacturing, quality, and IT teams. This phase involves setting timelines, assigning roles, and ensuring resource availability. Proper scheduling minimizes disruptions to operations and ensures the right people are present to provide accurate information.

See *Assessment Scheduling*.

3. Conduct the Assessment

During this phase, the actual assessment takes place. Assessment participants review and analyze MBE's current practices and activities to determine the organization's current and target MBE maturity level. The goal is to identify gaps, strengths, weaknesses, and improvement opportunities for an MBE organization.



4. Report the Assessment Results

After the assessment, findings are compiled into a comprehensive report. This report typically includes the current and target maturity levels, detailed observations, identified gaps, and recommendations for improvement. Presenting these results to leadership and stakeholders ensures transparency and provides a foundation for strategic MBE decision-making.

5. Develop the Improvement Roadmap

Based on the assessment results, a roadmap is created to guide the organization toward higher MBE maturity levels. This roadmap outlines prioritized initiatives, timelines, resource requirements, and measurable milestones. It serves as a strategic plan for implementing model-based practices, improving digital integration, and achieving long-term business objectives.

MBE Maturity Index Assessment Phases

The MBE Assessment typically progresses through a series of structured phases designed to evaluate an organization's current maturity and guide its transformation toward a model-based enterprise. It begins with Planning, where stakeholders align objectives, scope, and context. This involves developing an assessment schedule, gathering data through interviews, documentation reviews, and system analysis to understand existing practices. Next is the Assessment Phase, where findings are mapped against the MBE Maturity Index to identify strengths, gaps, and opportunities. This phase provides insights to determine readiness levels and prioritize areas for improvement. Finally, the Reporting and Road mapping Phase delivers a comprehensive summary of results, including tailored recommendations and a strategic roadmap to advance model-based enterprise capabilities.

Defining the Organizational Scope

Before beginning an MBE assessment, it is essential to establish clear boundaries (scope) for the organization under review. The MBE Maturity Index provides a set of standardized Organization definitions that help distinguish between different organizational levels and relationships. These definitions prevent ambiguity during the assessment and create consistency when comparing results across enterprises. Use the Organizations tab to populate the columns (free form) to define the scope. The example below shows the Organizations tab in the index tool to define the scope to assess the ACME Corporation.

How to Identify The Organizations Within Your Enterprise			Term Definitions for Convenience (also re
The Row 13 terms found at the tops of the lists are used throughout the index, usually to indicate the scope of a particular facet.			Organization
Typically, as the maturity score increases, the particular facet expands in scope to include more organizations.			Organization Under Assessment
This sheet is used to list those organizations that are, or may become, part of your Model-Based Enterprise.			Organization, Peer
Fill out light blue cells in columns 1, 2, 3, and 5 below. (See Term Definitions for Convenience)			Organization, Supra
The light orange cells in columns 4 and 6, auto-populate to demonstrate that the Enterprise and Extended Enterprise are a combination from others.			Enterprise
Optionally, fill out the blue cell above list 4 if your Enterprise has an explicit name. This will override the combination of the prior lists.			Organization, Extended
The organizational related definitions from the MBE Lexicon are repeated to the right for convenience.			Enterprise, Extended
1	2	3	4
Organization Under Assessment (OUA)	Peer-Organizations	Supra-Organization	Enterprise
ACME Corporation			ACME Corporation

Organization Scope Definitions

Organization—defined as an autonomous group of people who work together for a common purpose. This is the baseline unit of analysis and can represent anything from a small business to a division within a larger enterprise.

Organization Under Assessment (OUA)—the specific entity that is the subject of the evaluation. All ratings, commentary, and targets are applied to this unit. Clarity about the OUA is critical because it determines the scope of the maturity results and ensures that the assessment reflects the correct level of the enterprise.

Peer Organization—exists at the same level as the OUA under a shared higher authority. For example, two manufacturing plants within the same corporation may be considered peers. Understanding peers provides context for comparing maturity results within the larger structure.

Supra-Organization—the entity hierarchically above the OUA and its peers. This may be a corporate headquarters, a holding company, or another governing body that oversees multiple organizations. The supra-organization is essential when considering governance, strategy, and policies that shape the adoption of model-based practices across numerous units.

Enterprise—encompasses the OUA, its peers, and the supra-organization as a collective whole. It represents the complete set of organizational entities that are connected by common ownership, governance, or mission. Assessments conducted at the enterprise level provide a holistic picture but may not capture local detail.

Extended Organization—refers to entities outside the enterprise, such as suppliers, customers, or partners, who are connected and coordinated with it. When the enterprise and its extended organizations are viewed together, they form the Extended Enterprise, which reflects the broader network in which most manufacturers operate today.

Applying these definitions can establish an assessment scope and avoid confusion about whether the maturity ratings apply to a plant, a business unit, the entire corporation, or the broader supply chain. Clarity is essential for accurately interpreting results and aligning improvement plans with the correct organizational level.

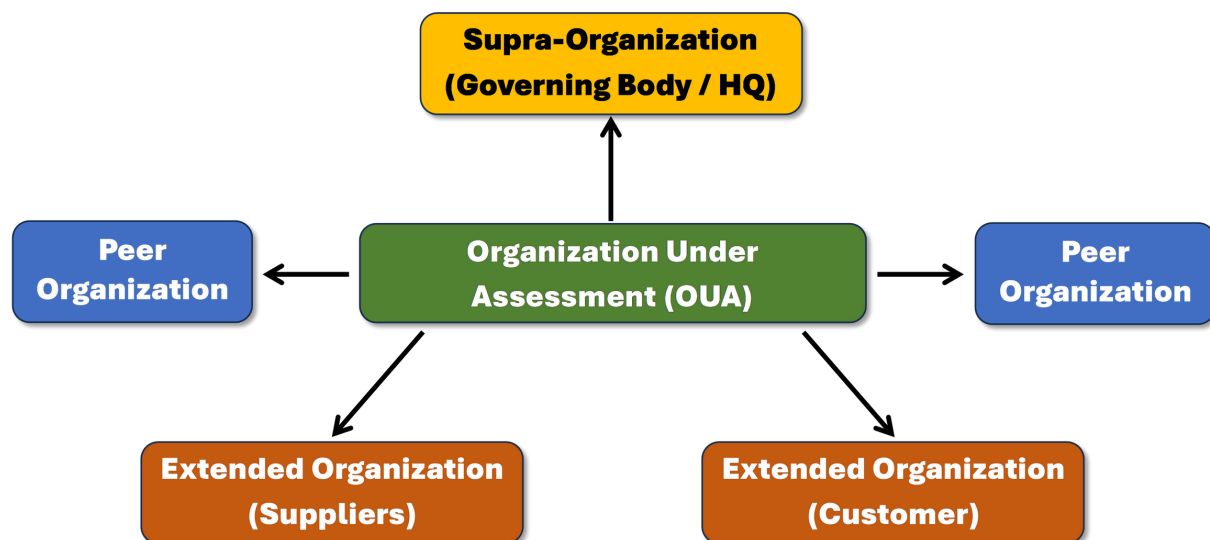


Figure 2. Example of Organizational Scope Relationships.

Scope Setting

Once the organizational definitions are established, the next step is to determine the boundaries of the assessment. This decision has a significant impact on the results and a direct influence on how the findings are interpreted. The Organization Under Assessment (OUA) should be identified at the outset, along with which parts of the enterprise and extended enterprise will be included or excluded. Without this clarity, assessments risk producing results that are either too narrow to be useful or too broad to act upon. In many cases, the OUA may be a single business unit, such as a design engineering department or a specific production facility. In other cases, the assessment may span multiple units under a common supra-organization, such as several plants managed by a regional headquarters.

Some small to medium organizations should choose to evaluate the enterprise as a whole, including all five MBE Categories, incorporating C1: Product Design Activities, C2: Product Data/Lifecycle Management Activities, C3: Product Manufacturing Activities, C4: Product Quality Activities, and C5: Enterprise Enabling Activities across all peer organizations. While a large organization may want to assess only two categories with a specific team, C1: Product Design Activities, C2: Product Data/Lifecycle Management Activities.

The decision should reflect the goals of the assessment and the level at which improvement actions will be planned and resourced. Consideration should also be given to whether external partners will be included. Extended organizations, such as key suppliers or customer-facing units, often play a role in the product lifecycle and in the flow of digital data. Including them in the scope can reveal essential gaps in interoperability and collaboration. However, when external entities are involved in the assessment, expectations must be managed carefully, and data-sharing arrangements may need to be formalized before the results can be used.

Organizations are encouraged to include a diagram in their assessment materials that illustrates the relationships between the Organization Under Assessment (OUA), its peers, the supra-organization, and extended organizations. This visual should be simple; a layered or hierarchical chart is sufficient. The OUA should be placed at the center, with peers at the same level, the supra-organization above, and extended organizations, such as suppliers, customers, or partners, positioned around the perimeter, connected by lines representing coordination or data flow. Creating this diagram before the assessment begins provides all participants with a shared understanding of the evaluation boundary.

Defining scope in this deliberate manner provides context for interpreting the maturity results. It enables organizations to avoid confusion about whether scores apply only to one department, to the entire enterprise, or to a broader supply chain network. Most importantly, it creates a clear link between the assessment and the roadmap that follows, ensuring that improvement actions are tied to the correct level of the organization. When the scope is unclear, organizations risk creating roadmaps that are either too narrow to drive enterprise change or too broad to implement effectively.

Assessment Planning

Effective use of the MBE Maturity Index depends on careful preparation before the assessment begins. Planning involves identifying the right participants, assigning responsibilities, and establishing a schedule that allows the assessment to be conducted without disrupting daily operations. Participant selection is one of the most important steps. Because the Index encompasses design, data management, manufacturing, quality, and enterprise-enabling activities, no single person will have complete visibility across all categories.

A cross-functional team may be required to provide accurate input. Design engineers should participate in speaking about CAD practices and model-based definition. Product data managers or PLM/PDM administrators may address lifecycle control and digital continuity. Manufacturing supervisors or process engineers may provide insight into how models are used on the shop floor. Quality specialists may contribute to ratings on inspection, traceability, and feedback loops. Senior managers or enterprise leaders may represent enabling functions such as governance, training, and supplier integration. Selecting participants who are directly involved in or accountable for these areas ensures that the assessment is grounded in practice rather than assumption.

Assigning responsibilities within the team helps maintain focus and efficiency. An assessment lead, often referred to as the MBE point of contact, should coordinate the process, facilitate discussions, and consolidate the results. Subject matter experts should prepare relevant information in advance, such as system inventories, process documentation, or examples of digital artifacts, to facilitate collaboration. Other participants should be tasked with validating observations, providing context, and recording commentary. Clarifying these responsibilities prevents overlaps, ensures that gaps in coverage are avoided, and creates accountability for each area of the Index.

Assessment Schedule

Creating a simple assessment plan and schedule is key to success. Assessments work best when they're planned ahead, not done informally. The schedule should include time for orientation on the MBE Index tool, where participants learn how it works and how scoring is done.

Identify the MBE Categories to be assessed. You can choose a timeframe to conduct the sessions over several consecutive days or spread sessions out over a few weeks. This can be done by allocating a set number of hours for each day. Below are simple examples of how to organize the assessment schedule and assign participants to each assessment session.

It is important to provide sufficient time for consolidating scores, reviewing feedback, and validating results with the assessment participants. A well-defined schedule communicates to the participants the assessment is aligned with enterprise goals, which helps increase engagement and improve the quality of input. Below is a sample two-day schedule to access all MBE Categories.

On the first day, the MBE Assessment kickoff/orientation is designed to align all participants around the goals, expectations, and processes of scoring MBE practices. It typically begins by explaining the MBE Maturity Index tool and the strategic reasons for the shift, such as improving efficiency, reducing scoring errors, and enhancing collaboration across the product lifecycle. The kickoff/orientation reviews the assessment schedule, including timelines and key milestones. The example below provides an Assessment schedule with identified participants for each MBE Category.

	Start	End	Duration	MBE Session	Participants
Plan for Assessment	9:00 AM	5:00 PM	8:00	First, start by developing an MBE Assess Plan, Set the Scope, Identify Participants, and Develop an Assessment Schedule	List Participants Welcome
Assessment Week Monday Day 1	Start	End	Duration	MBE Session	Participants
	9:00 AM	10:00 AM	1:00	MBE Assessment Kickoff Presentation	All Welcome
	10:00 AM	10:15 AM	0:15	Break	

Assessment Week Monday Day 1	Start	End	Duration	Onsite Session	Participants
	10:15 AM	12:15 PM	2:00	C1: Product Design Activities assessment workshop	• MBE Implementation Lead • Model Authors Design Engineers • MBE Integrator / Digital Thread Engineer • Simulation Analyst • Manufacturing Engineer • PDM/PLM Administrator • Configuration Management
	12:15 PM	1:00 PM	0:45	Lunch	
	1:00 PM	3:00 PM	2:00	C2: Product Data/Lifecycle Management Activities assessment workshop	• MBE Implementation Lead • Model Authors • Design Engineers • MBE Integrator / Digital Thread Engineer • Simulation Analyst • Manufacturing Engineer • Product Lifecycle Manager • PDM/PLM Administrator • Configuration Management • Change Management • Compliance & Standards Officer
	3:00 PM	3:15 PM	0:15	Lunch	

Assessment Week Monday Day 1	Start	End	Duration	Onsite Session	Participants
	3:15 PM	5:00 PM	1:45	C3: Product Manufacturing Activities assessment workshop	• MBE Implementation Lead • Manufacturing Manager/Engineer • Production Technician • Operator • Tooling Engineer
	5:00 PM	5:15 PM	0:15	Wrap-up	

Assessment Week Tuesday Day 2	Start	End	Duration	Onsite Session	Participants
	9:00 AM	10:30 AM	1:30	C3: Product Manufacturing Activities assessment workshop	
	10:30 AM	10:45 AM	0:15	Break	
	10:45 AM	12:15 PM	1:30	C4: Product Quality Activities assessment workshop	• Quality Engineer • Inspection Technician / Metrologist • Quality Data Analyst • Supplier Quality Engineer • Non-Conformance Analyst • Configuration Management • Change Management • Compliance & Standards Officer
	12:15 PM	12:30 PM	0:15	Break	

Assessment Week Tuesday Day 2	Start	End	Duration	Onsite Session	Participants
	12:30 PM	1:15 PM	0:45	C5: Enterprise Enabling Activities assessment workshop	• Senior Management • MBE Implementation Lead • MBE Program Manager • Change Management Lead • Compliance & Standards Officer
	1:15 PM	1:30 PM	0:15	Wrap-up	

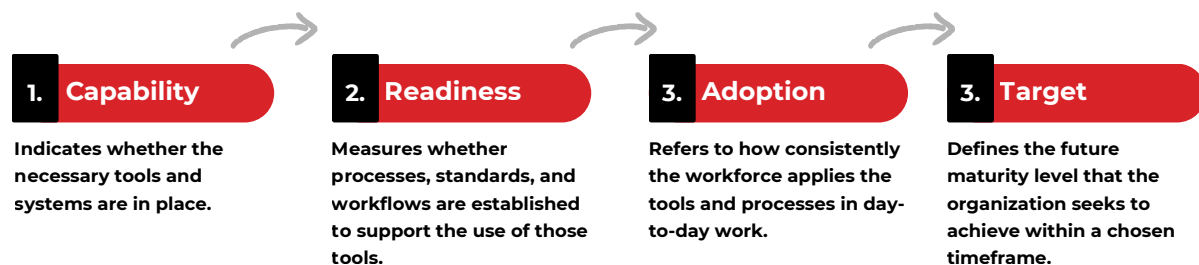
Assessment Week Wednesday Day 3	Start	End	Duration	Onsite Session	Participants
	9:00 AM	5:00 PM	8:00	Compile all MBE assessment results	

Assessment Week Thursday Day 4	Start	End	Duration	Onsite Session	Participants
	10:00 AM	12:00 PM	2:00	Present MBE assessment results and schedule a future roadmap planning session for prioritization and improvements	List Participants Welcome

Conduct the Assessment

The MBE Maturity Index is a tool that organizes the evaluation into categories, topics, and facets, each of which contributes to a detailed understanding of digital maturity. The five categories (e.g., design, engineering, data and lifecycle management, manufacturing, quality, and enterprise) form the core domains of the assessment. Within each category, topics break these domains into specific areas of practice that can be observed and rated, such as CAD standards, PMI integration, or digital quality records. Facets such as technology, processes, people, governance, and metrics provide additional perspectives that cut across all categories and topics, ensuring that the assessment reflects the existing tools and how they are applied, managed, and measured.

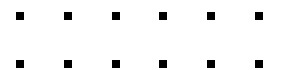
Each topic is rated using the four maturity perspectives: capability, readiness, adoption, and target.



Recording scores across these dimensions creates a balanced view of current performance and future aspirations, forming the foundation for identifying gaps and planning targeted improvements.

In preparation for an assessment, participants will need to gather information that spans technical systems, organizational processes, and workforce practices, including an inventory of the tools currently in use (such as CAD platforms, PLM systems, or digital inspection equipment), documentation of processes and standards that govern those tools, and insights into actual adoption patterns by teams and individuals. Collecting this information ensures that ratings are based on evidence rather than assumptions, providing a foundation for meaningful discussion during assessment sessions. To be effective, preparation should also include identifying the individuals who can provide accurate input for each area of the Index. For example, design engineers may be best positioned to discuss CAD practices, while manufacturing supervisors offer insight into how digital work instructions are utilized on the shop floor. Ensuring that the right participants are involved allows the assessment to capture an accurate cross-section of organizational practice.

As-Is Ratings



The MBE Maturity Index captures the current state of an organization through three dimensions: capability, readiness, and adoption. Together, these dimensions provide a balanced view of where the organization stands today, moving beyond the simple question of whether a tool exists to consider whether it is supported and in use.

Capability

Capability reflects the availability of tools, systems, and technologies that enable model-based practices. It is the most straightforward dimension, focused on whether the technical foundation is in place. For example, an organization may own a CAD platform capable of embedding PMI, or a manufacturing execution system that can consume model-based work instructions. Capability scores indicate what is possible given the organization's current tool set, but they do not measure how those tools are being used.

Readiness

Readiness examines whether the supporting processes, standards, and workflows are in place to put those tools into action. Having a PLM system is one thing; having defined version control procedures and standardized workflows for using that system is another. Readiness captures the degree to which the organization has built a structure around its tools that allows them to be applied consistently and repeatably. Without readiness, technology investments often remain underutilized or applied inconsistently across teams.

Adoption

Adoption measures whether people are using the tools and processes in their daily work. Even when capability and readiness are strong, adoption may lag due to a lack of training, resistance to change, or competing priorities. This dimension highlights the cultural and behavioral aspects of digital maturity. For instance, if PMI is embedded in 3D models but shop floor staff continue to rely on printed 2D drawings, adoption levels would be low despite high capability and readiness.

When assessed together, these three dimensions provide a layered picture of current maturity. An organization may demonstrate strong capability and readiness but weak adoption, signaling a need for cultural change or workforce development. Another may show adoption of informal practices despite limited tools, indicating an opportunity to formalize and strengthen its technical foundation. Distinguishing between capability, readiness, and adoption, the Index prevents an incomplete view of maturity and enables organizations to pinpoint the specific factors that must be addressed to move forward.

Target Setting

In addition to recording capability, readiness, and adoption, the MBE Maturity Index requires organizations to define a target maturity level, establishing the desired future state and providing a benchmark for measuring progress. Targets are deliberate statements of intent that define the future state and establish benchmarks that guide roadmap development. Target setting begins by examining the results of the as-is ratings and considering the business objectives that drive transformation. For example, a company facing regulatory pressure may set a higher target in quality-related topics to meet compliance requirements, while a firm seeking faster design-to-production cycles may prioritize targets in product design and lifecycle management. The targets chosen should be connected to business value, making it clear why achieving them is important.

Unlike capability, readiness, and adoption, which measure current conditions, targets represent a point in time where the organization intends to be. They are forward-looking and aspirational, but they must also be realistic. A small or mid-sized manufacturer may set a moderate target in certain areas, acknowledging resource limitations, while still aiming higher in areas where digital practices improve competitiveness. Setting targets across all categories creates a roadmap for maturity. These benchmarks clarify where improvement is needed, as well as where stability may be acceptable. An organization does not need to pursue the highest maturity level in every category; attempting to do so can lead to wasted effort or abandoned initiatives. Instead, targets should allow leadership to decide where investments will yield the greatest return and to sequence efforts accordingly. Target setting gives meaning to the assessment. Without targets, the results remain a snapshot of current conditions. With them, the assessment becomes directional, pointing the organization toward a defined future state and providing the basis for gap analysis and roadmap development.

The assessment is the step that connects an organization's current state with its desired future state. Once capability, readiness, and adoption have been assessed and a target maturity level has been defined for each category and topic, the difference between the two becomes the gap. The assessment represents the shortfall that must be addressed if the organization is to progress toward its intended maturity goals. The process begins by recording the as-is ratings for capability, readiness, and adoption within each topic of the Index. These values create a baseline that reflects the organization's current condition. Next, the target level is set, establishing the point the organization intends to reach within a given timeframe. Comparing the as-is ratings against the target reveals the size and nature of the gap.

For example, suppose a design group has the tools and processes in place for model-based definition (high capability and readiness) but has not yet achieved workforce-wide adoption. In that case, the gap lies primarily in adoption rather than in technology. Conversely, if adoption is high but capability is limited, the gap points to the need for investment in systems and tools.

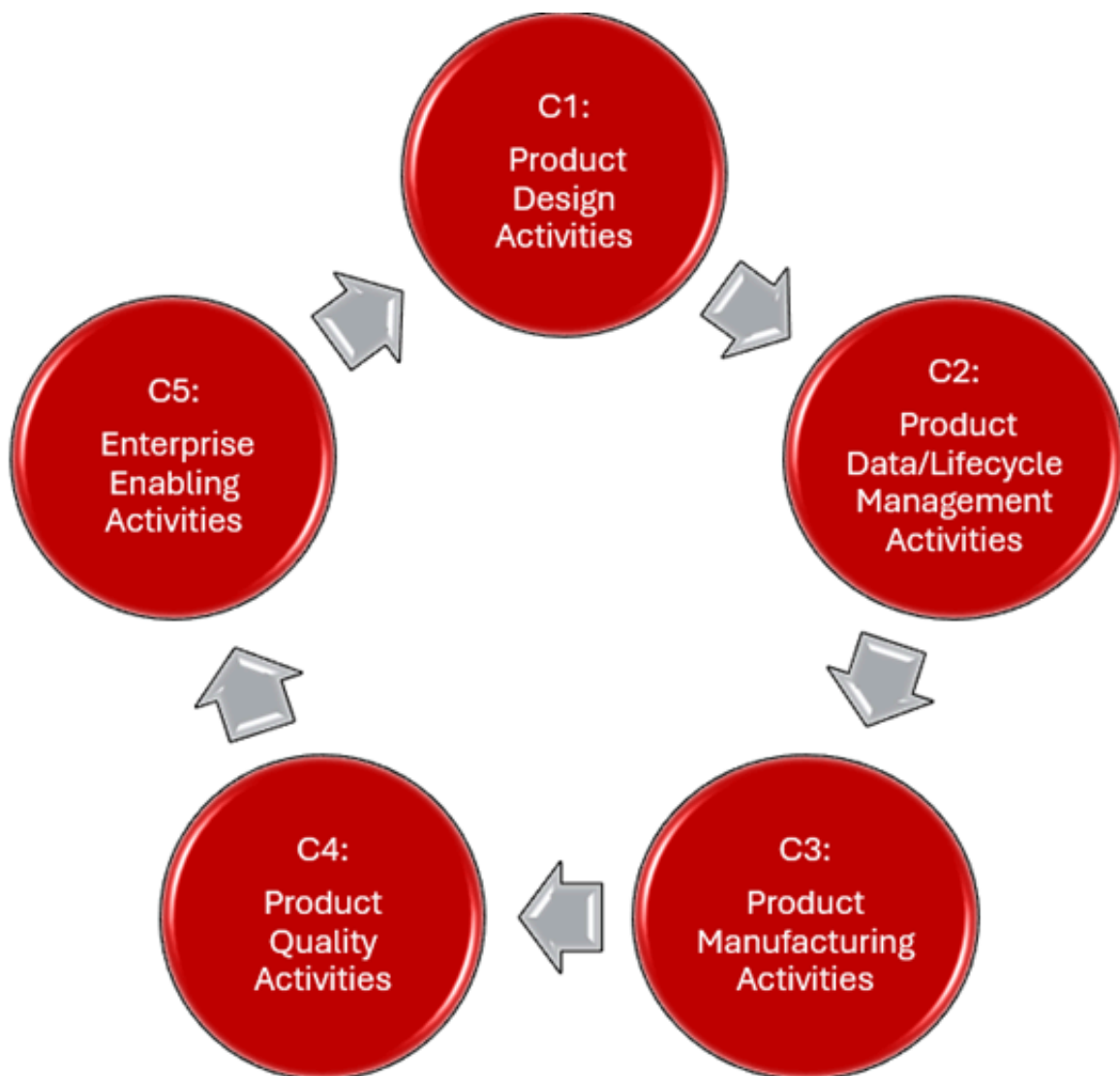
Recording these gaps is critical. Documenting them in detail ensures that they can be analyzed, prioritized, and tracked over time. Gaps should be captured as specific observations tied to categories, topics, and facets, and not as abstract statements. A well-documented gap might read: “Adoption of digital inspection is limited to one production line due to lack of training across other facilities,” rather than simply “low adoption.” This level of detail enables organizations to revisit the assessment in future cycles and determine whether the same issues persist or have been resolved. Gap analysis also provides the foundation for building an improvement roadmap.

Understanding where the most significant shortfall lies enables organizations to allocate resources, design targeted interventions, and establish milestones that address their key barriers to maturity. Without gap analysis, results remain descriptive; with it, they become actionable, guiding organizations toward specific improvements.

Conceptual Framework

Categories

The MBE Maturity Index is organized into five categories that represent the core domains of a Model-Based Enterprise. Each category captures a distinct area of activity within the product lifecycle, and together they provide a complete view of how digital practices are adopted across an organization. Evaluating maturity within each of these domains enables organizations to identify their strengths, weaknesses, and opportunities for improvement in a controlled manner.



C1: Product Design Activities

Category C1 evaluates how an organization creates and manages its product designs using digital models. It considers the degree to which 3D models serve as the authoritative source of product definition, how Product and Manufacturing Information (PMI) is applied, and whether standards such as model-based definition are consistently adopted. A higher level of maturity in this category reflects a shift from drawings and disconnected files to integrated digital models that drive design intent throughout the enterprise.

C2: Product Data and Lifecycle Management Activities

Category C2 focuses on how product information is organized, controlled, and accessed over time. It examines practices related to Product Data Management (PDM) and Product Lifecycle Management (PLM), including version control, access permissions, and integration across systems. Mature organizations in this category demonstrate strong digital continuity, ensuring that the product model and associated data remain consistent and accessible during the lifecycle.

C3: Product Manufacturing Activities

Category C3 addresses the use of digital models to plan, execute, and monitor manufacturing processes. It includes how models are leveraged for CNC programming, additive manufacturing, process simulation, and other model-driven production activities. As maturity increases, the model becomes the direct input for manufacturing systems, enabling greater automation, reducing translation errors, and improving process efficiency.

C4: Product Quality Activities

Category C4 evaluates the integration of digital models into inspection and quality assurance. It examines how organizations utilize models to establish inspection requirements, guide automated measurement, and verify conformance to standards. Higher maturity in this category reflects the use of model-based inspection, digital quality records, and closed-loop feedback systems that tie inspection results back to design and manufacturing.

C5: Enterprise Enabling Activities

Category C5 covers the broader enterprise functions that support the adoption of model-based practices. It includes governance, training, IT infrastructure, supplier integration, and compliance with standards. These activities create an environment in which design, manufacturing, and quality practices can operate in a model-based framework. Maturity in this category reflects the degree to which the enterprise has aligned policies, systems, and people to support a sustainable digital transformation.

Altogether, these five categories form the backbone of the Index. Assessing maturity across five categories provides organizations with a balanced perspective, demonstrating technical capability and the supporting enterprise functions necessary to sustain model-based practices. Advancing one category while neglecting others can create gaps in continuity.

Topics

Within each of the five categories, the MBE Maturity Index is further organized into seven topics that make the categories actionable. While the categories define the broad domains of a Model-Based Enterprise, the topics break those domains into more specific areas of practice that can be measured and improved, allowing organizations to move beyond general observations, such as whether they are “using digital models” and instead assess maturity in concrete, detailed terms. Within the Product Design category for example, topics may include the use of CAD standards, the application of Product and Manufacturing Information (PMI), and the integration of 3D annotations into models. Evaluating maturity at the topic level clarifies how consistently these practices are applied and whether they are embedded into daily workflows. In this way, topics act as the bridge between the conceptual framework of categories and the practical activities that occur within an organization.

The same principle applies across all categories. In Product Data and Lifecycle Management, topics might include configuration management, metadata standards, or data exchange methods with suppliers. In Manufacturing, topics could focus on model-based process planning, digital work instructions, or simulation-driven validation. Quality topics may include model-based inspection, nonconformance management, and digital traceability of records. Enterprise enabling topics often address training programs, IT infrastructure readiness, and governance structures that support the adoption of model-based practices. By dividing categories into topics, the Index provides a lens that captures the complexity of digital transformation without overwhelming the assessment process. Each topic can be rated individually across the dimensions of capability, readiness, and adoption, which allows organizations to identify targeted gaps. A company may find, for instance, that its Product Design category shows mid-level maturity overall; however, a closer look at the topics reveals that CAD modeling practices are strong while PMI integration lags significantly. These distinctions are critical when setting improvement priorities and developing a tailored roadmap.

Topics provide the operational detail that allows the Index to move from conceptual domains to measurable practices. They take the broad areas defined by the categories and translate them into practical, measurable elements that reflect how model-based practices are being applied in the organization.

Facets

In addition to categories and topics, the MBE Maturity Index incorporates facets that span the entire framework. Facets are dimensions that influence how model-based practices are implemented and sustained, regardless of the specific category or topic being assessed. They ensure that the evaluation does not focus narrowly on tools or processes alone but instead considers the broader ecosystem that determines whether adoption will succeed.

Technology

Technology is one of the most visible facets. It addresses the software, hardware, and digital infrastructure required to support model-based practices. Assessments in this area examine whether the necessary platforms exist, whether they are integrated, and whether they can help the organization's future maturity goals. Technology by itself, however, is not enough.

Processes

Processes form a second critical facet, even when tools are available. The maturity of model-based practices depends on whether consistent workflows, standards, and procedures are in place. Process maturity reflects the organization's ability to translate technical capability into reliable, repeatable outcomes.

People

People are a third dimension. This facet considers workforce skills, training, and adoption behaviors. Model-based practices require new competencies in areas such as 3D annotation, data management, and digital inspection. Without a workforce that understands and applies these practices, technology and process improvements remain underutilized.

Governance

Governance provides oversight and direction. It addresses the policies, standards, compliance requirements, and leadership support that shape the adoption process. Governance ensures that practices are implemented in alignment with enterprise priorities, industry standards, and regulatory obligations, and includes compliance with external standards (e.g., ASME, ISO, DoD guidelines).

Metrics

Metrics complete the framework by supplying the means to measure outcomes. They connect model-based practices to tangible results such as cycle time reductions, defect rates, cost avoidance, or return on investment. Metrics allow organizations to evaluate whether progress is being made, whether investments are yielding value, and where further improvement is needed.

Incorporating these cross-cutting facets provides multiple perspectives on implementation. They remind organizations that success is not determined solely by technology, but by the interplay of tools, processes, people, governance, and measurable outcomes. Assessing maturity through these lenses leads to a more accurate diagnosis of gaps and produces a more straightforward path for sustainable adoption.

Progression

The strength of the MBE Maturity Index lies in the way categories, topics, and facets together illustrate progression along the journey to becoming a Model-Based Enterprise. Each element of the framework provides a different level of detail. When viewed as a whole, they show how organizations evolve from basic digital practices to advanced levels of integration and automation. At the broadest level, the five categories define the core domains of activity that must be addressed. They establish the foundation for evaluating maturity in design, data management, manufacturing, quality, and enterprise support. Assessing progress across all categories ensures MBE transformation is balanced, rather than concentrated on a single function, leaving others behind. Within each category, the seven topics provide a more granular view. They transform the high-level domains into specific, observable practices. A company may begin by digitizing its design data but gradually incorporate PMI, adopt 3D annotations, and transition from file-based exchanges to connected lifecycle data. These incremental improvements reflect a clear progression within a category, demonstrating how digital adoption deepens over time.

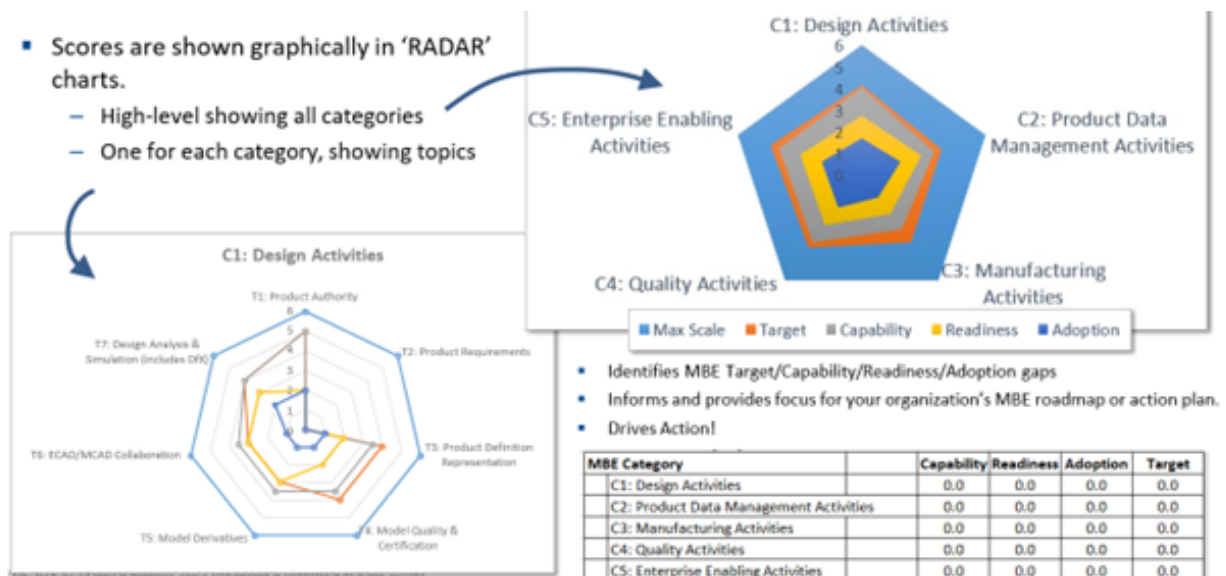
The facets cut across both categories and topics, offering a way to view progression from multiple perspectives. For example, an organization may initially focus on technology, such as acquiring new software or equipment; however, as it matures, it must also strengthen its processes, train its personnel, establish governance structures, and track outcomes through metrics. Progression in these dimensions demonstrates model-based practices are becoming deep-rooted rather than applied in isolation.

Together, categories, topics, and facets illustrate a path toward more digital, integrated, and automated operations. Early stages often involve digitization of existing practices, while later stages demonstrate the use of models to drive collaboration, automation, and continuous improvement. The Index Tool enables organizations to identify their current position on this path, anticipate the steps ahead, and understand how their existing capabilities relate to a more advanced future state, while reinforcing that maturity is not a final destination, but a continuous cycle of ongoing improvement.

Report the Assessment Results

The MBE Maturity Index generates charts that help organizations visualize their results. Among the most useful are radar charts, which present a comparative picture of maturity across categories. Each axis of the chart represents one of the five categories: design, data and lifecycle management, manufacturing, quality, and enterprise enabling activities. Ratings for capability, readiness, and adoption can be plotted along these axes, creating a visual profile of the organization's current state. At a glance, the strength of radar charts lies in their ability to show variation across categories. For example, a chart may reveal that an organization scores relatively high in design and data management but lags in manufacturing and quality. This pattern would be difficult to recognize by reviewing numbers in a table, but when displayed as a shape on a chart, the imbalances become immediately visible. The chart provides an immediate sense of where the enterprise is strong, where it is weak, and where attention should be focused.

In addition to radar charts, the tool generates score summaries that present the same data in tabular form. These tables list the ratings for capability, readiness, adoption, and target for each topic within each category. While less visually striking than the radar chart, the score summary offers precision. It allows participants to see precisely how a score was recorded, compare across topics, and reference details during roadmap development. The chart gives the big picture; the table supplies the detail. When used together, radar charts and score summaries create a complete view of the assessment results. Charts highlight patterns and trends, while tables provide a concrete foundation for those visuals. Both should be included in the assessment output so that leadership has an intuitive understanding of overall maturity and practitioners have the detail needed to plan improvements. For example, two organizations may display similar radar chart profiles in the manufacturing sector. Still, their score summaries may reveal very different reasons: one with strong capability but weak adoption, the other with moderate adoption but limited readiness.



These charts and tables are also valuable for comparison. Within an organization, different business units or facilities can be assessed separately, and the score summaries provide a straightforward way to contrast their results. Over time, repeating the assessment and comparing score summaries from different periods shows whether gaps have narrowed, whether adoption has increased, and whether targets are being met. For enterprises operating with peers and extended organizations, score summaries also enable the alignment of maturity levels across the supply chain by identifying where interoperability challenges may arise. In practice, the score summary functions as a reference and a planning tool. It preserves the detail of the assessment in a form that can be shared, evaluated, and revisited. It also provides the basis for prioritization, as organizations can quickly identify which topics scored lowest, where the gaps to target are largest, and which areas should be prioritized as the foundation for an improvement roadmap.

Peer Review

The MBE Maturity Index includes a peer review section that captures commentary and feedback from colleagues, partner organizations, or other stakeholders who have reviewed the assessment results. While the score summary and charts provide quantitative data, peer review adds qualitative insight that helps validate findings and identify nuances that numbers alone may not reveal. Peer review comments can serve several purposes. Internally, colleagues from different departments may use the section to verify whether ratings accurately reflect practices in their respective areas. For example, if a design team scores capability for model-based definition at a high level, a manufacturing engineer may add a comment noting that the downstream use of those models remains inconsistent. This type of commentary strengthens the assessment by highlighting gaps between intent and practice that could otherwise be overlooked.

Externally, when assessments are shared with suppliers, customers, or partner organizations, peer review provides a way to capture their perspective. These stakeholders may offer valuable insights into data exchange, interoperability, or communication practices that are crucial to the digital thread but may not be readily apparent within the OUA. Their feedback can help organizations understand how their maturity affects and is perceived by the extended enterprise. Documenting peer review commentary ensures that future users of the Index can trace how ratings were challenged, supported, or refined. When assessments are repeated, comments provide context for changes in scores, clarifying whether shifts represent genuine improvement or a reassessment of earlier interpretations. The commentary is also a record that organizations can revisit when developing action plans, ensuring that internal and external perspectives are considered in roadmap development. The Index captures a more complete picture of digital maturity.

Quantitative results reveal the organization's standing, while qualitative commentary explains why those results are significant and how they are experienced throughout the enterprise.

Gap Prioritization

Once the gaps between current ratings and target levels have been identified, the next step is to determine which of them should be addressed first. Not all gaps carry the same weight. Pursuing all gaps at once can overextend resources and slow progress. Gap prioritization enables organizations to focus their attention on areas where improvement will have the most significant impact, aligning actions with business goals, available resources, and the most pressing barriers. The first consideration is alignment with organizational objectives. If a company is pursuing faster time-to-market, gaps in design and lifecycle management may take precedence. If regulatory compliance is a priority, quality-related gaps may become more apparent. Tying prioritization to strategic goals, the assessment results move beyond technical observations and become actionable drivers of enterprise performance. Resource requirements also shape prioritization. Some gaps may be addressed with modest investment in training or process development, while others may require significant capital outlay for new systems or equipment. Organizations should weigh the expected benefit against the resources needed, sequencing lower-cost, high-value improvements early while planning for larger investments over a longer horizon. This balancing act helps maintain momentum while building the case for more resource-intensive projects.

Barriers must also be factored into the prioritization process. A gap may be critical, but if adoption is hindered by deep-seated cultural resistance or by dependencies on legacy systems, addressing it immediately may not be realistic. In such cases, it can be more effective to sequence other improvements first, building capability and credibility that will make it easier to tackle harder barriers later. Conversely, if a barrier threatens to undermine multiple categories, it may need to be prioritized despite the difficulty, since progress elsewhere will be limited until it is resolved.

Several approaches can be used to prioritize gaps systematically. Some organizations use scoring matrices that consider impact, cost, and difficulty, ranking gaps based on a weighted score. Others rely on facilitated workshops with cross-functional teams to debate and agree on priorities. Regardless of the method, the goal is to move from a long list of identified gaps to a focused set of improvement initiatives that are meaningful and achievable. Prioritizing gaps transforms results into a practical agenda, creating a staged path forward that builds momentum while making progress manageable.

Develop the Improvement Roadmap

The value of the MBE Maturity Index lies in turning identified gaps into tangible improvements. Once gaps have been documented and prioritized, they must be translated into specific actions that an organization can take to move closer to its target maturity levels. This process transforms the assessment into a practical roadmap for digital adoption. Translating gaps into actions begins with clarity. Each gap should be stated in concrete terms that describe the shortfall and its impact. For example, “low adoption of PMI on the shop floor due to reliance on 2D drawings” is a gap that can be linked to an action such as “develop and deliver PMI training for shop floor operators.” Similarly, a gap identified as “limited interoperability between PLM and ERP systems” can be addressed through the action “integrate PLM and ERP data exchange workflows.” The goal is to connect observations to interventions that are specific, achievable, and measurable.

Prioritization plays a central role in sequencing these actions. High-impact gaps that align with business goals should be addressed first, while actions requiring significant resources or cultural change may be scheduled as longer-term initiatives. In some cases, quick wins, such as minor improvements that can be implemented with minimal effort, should also be included early in the roadmap. These demonstrate progress, build confidence, and create momentum for tackling more complex challenges. Each action should also include ownership and accountability. Assigning responsibility to a role or team ensures that the action does not remain an abstract recommendation. Timelines, resource requirements, and success criteria should be defined so that progress can be monitored and evaluated. When possible, actions should be linked to metrics that demonstrate tangible outcomes, such as reductions in rework, improved cycle time, or increased adoption of digital tools. Translating gaps into prioritized actions with clear ownership creates a roadmap that moves beyond assessment to implementation. The roadmap becomes a living document that guides digital transformation efforts, provides accountability for progress, and connects maturity improvement to enterprise performance.

Roadmap Development

Developing a roadmap is the step that connects assessment results to long-term transformation. Once gaps have been translated into specific actions, the roadmap provides a way to organize those actions into a sequence that leads from the current state to the defined target state. Without this step, actions remain isolated and risk being pursued without a clear sense of priority, timing, or interdependency. The roadmap begins by aligning actions with the categories, topics, and facets of the Index. Each gap originates within a specific category, such as design or quality, and often indicates deficiencies in a particular area, such as CAD standards or model-based inspection. These categories and topics serve as natural guideposts for grouping related actions.

Facets then add another dimension by helping organizations consider the balance of technology, processes, people, governance, and metrics within their plan. For instance, implementing a new PLM system (technology) may be ineffective without corresponding actions to establish configuration control procedures (processes) and train staff (people). Using the framework of categories, topics, and facets ensures that actions are comprehensive in scope and connected to the overall maturity model.

Sequencing is the next step in roadmap development. Some actions can be taken immediately, while others depend on enabling conditions. For example, model-based inspection cannot be adopted until product models consistently include PMI. The roadmap should reflect these dependencies by placing foundational improvements earlier and building progressively toward more advanced capabilities. This staged progression enables organizations to achieve steady, incremental gains without overextending resources or setting unrealistic expectations.

Roadmaps must also define timeframes. Actions can be distributed across near-term, mid-term, and long-term horizons, typically spanning months to several years. Apparent time horizons help leadership allocate resources appropriately and provide milestones against which progress can be measured. Linking these milestones to business objectives, such as reducing design cycle times or improving first-pass yield, ensures that the roadmap remains connected to enterprise outcomes. The roadmap should not be a static plan; it should be adaptable. It must be revisited regularly as progress is made and as conditions change. New technologies, shifts in customer expectations, or lessons learned from early implementation may alter priorities and require adjustments to the sequence of actions. Maintaining the roadmap as a living document keeps organizations aligned with their targets while adapting to evolving challenges and opportunities. Structuring improvement initiatives around categories, topics, and facets, sequencing them logically, and anchoring them to measurable outcomes makes the roadmap a practical guide for moving from the current state to the target state. It transforms the maturity assessment from an evaluation tool into a forward-looking plan for digital adoption across the enterprise.

Roadmap Guidance

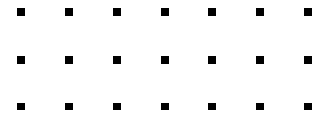
A roadmap becomes actionable when it identifies what needs to be done and explains how to transition from one level of maturity to the next. Transition guidance provides this detail by outlining best practices, offering concrete examples of activities, and identifying the triggers that signal readiness to advance. These elements help organizations avoid vague aspirations and instead focus on the specific steps that enable real progress. Best practices are proven methods organizations can adapt to their own context. For instance, in design activities, a best practice at early maturity levels may involve adopting CAD standards across all engineering teams to establish consistency in model creation. At higher levels, best practices may include embedding PMI into models and validating them against industry standards such as ASME Y14.41.

In manufacturing, early practices often focus on piloting model-based work instructions for a single production line. In contrast, later practices emphasize the integration of models into MES systems for automated scheduling and execution. Example activities provide organizations with a sense of the concrete actions they can take to implement these best practices. For instance, in data management an early activity may be the migration of legacy CAD files into a PDM system to establish a baseline of digital control. A later activity may involve linking the PDM system with ERP to enable seamless transfer of part metadata from design to procurement. Similarly in quality, an early activity may involve training inspectors to interpret digital annotations, while later activities may include deploying automated inspection equipment tied to the digital model.

Transition triggers are the signals that indicate an organization is ready to advance to the next level of maturity. These triggers can include the completion of specific activities, demonstrated consistency in practice, or achievement of defined performance outcomes. For instance, an organization may be ready to transition from basic adoption of PMI to full model-based inspection when a sufficient percentage of designs incorporate PMI, when inspectors demonstrate proficiency in reading digital annotations, and when error rates associated with 2D drawings have been reduced. These triggers help organizations determine when they have genuinely achieved consolidated gains and are ready for the next step, rather than advancing prematurely.

Combining best practices, activities, and transition triggers provides organizations with a clear direction on how to progress, avoiding the common pitfall of treating maturity levels as abstract benchmarks. Instead, it turns them into practical stages that can be achieved through deliberate effort. It also allows organizations to celebrate and validate progress at each step, reinforcing adoption and sustaining momentum throughout the digital transformation journey.

Roles and Responsibilities



Conducting and sustaining an MBE maturity assessment requires the involvement of multiple roles across the organization. Each role carries distinct responsibilities, taken together, provide the coverage and accountability needed to make the assessment meaningful and actionable. Identifying these roles in advance ensures that the right perspectives are represented and that the assessment process produces results that can be trusted.

MBE Point of Contact—the coordinator for the entire effort, responsible for organizing assessment sessions, communicating with participants, consolidating ratings, and correctly documenting all outputs. The point of contact does not provide all the input but acts as the facilitator who keeps the process on track and aligned with organizational goals. The MBE Point of Contact is accountable for managing the assessment process from start to finish, including scheduling sessions, coordinating with subject matter experts, ensuring that all categories and topics are addressed, and consolidating results into charts, tables, and commentary. Beyond the assessment itself, the point of contact is responsible for communicating findings to leadership, tracking progress against the roadmap, and maintaining continuity across future assessment cycles.

Assessment Participants—the subject matter experts are drawn from across design, data management, manufacturing, quality, and enterprise enabling functions. They provide the information and context needed to rate each category and topic. Participants may include design, engineers, manufacturing, supervisors, quality inspectors, IT specialists, or trainers, depending on the scope of the assessment. Their role is to contribute accurate insights from their areas of responsibility and to record commentary that explains the reasoning behind each rating. Assessment participants are accountable for providing accurate, experience-based input within their domains of expertise. Participants are expected to prepare information in advance, such as system inventories, process documentation, or adoption metrics, and to engage in discussions. Their accountability extends to recording commentary and capturing the reasoning behind ratings and to validating the results accurately reflect the organization's current state.

Configuration Management Roles—focus on the control of product data across its lifecycle. These participants ensure that version control, traceability, and change management practices are accurately represented in the assessment. Their involvement is critical in evaluating maturity within the data and lifecycle management category and in verifying whether practices align with the digital thread. Configuration Management Roles are accountable for maintaining control over product data and for ensuring that the digital thread is preserved across lifecycle stages.

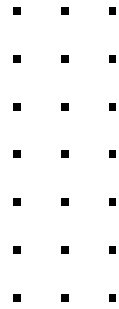
In the context of the assessment, they verify the accuracy of ratings related to version control, traceability, and change management. After the assessment, they play a critical role in sustaining adoption by implementing the governance practices needed to prevent data fragmentation and to maintain consistency in product definition.

PDM/PLM Administrators—represent the technical stewards of product data systems. They provide visibility into how PDM and PLM systems are configured, integrated, and used in practice. Their expertise helps determine capability and readiness within data management, identifying gaps in interoperability with other enterprise systems, such as ERP or MES. PDM/PLM Administrators are accountable for the technical integrity of product data systems. During the assessment, they provide authoritative input on system configuration, integration points, and user practices. Following the assessment, they are responsible for implementing system changes identified in the roadmap, monitoring usage, and supporting users to increase adoption. Their accountability also includes aligning PLM and PDM systems with governance policies and ensuring interoperability with other enterprise platforms.

Senior Managers—provide strategic oversight and connect the assessment to broader organizational objectives. They validate whether targets align with business priorities and ensure that the roadmap developed from the assessment is actionable at the enterprise level. Senior managers also play a role in governance, authorizing resources, and reinforcing the importance of adoption across the workforce. Senior Managers are accountable for linking assessment results to enterprise objectives. They validate that targets align with organizational priorities and authorize the necessary resources to close identified gaps. Senior managers are also responsible for governance: setting policy direction, reinforcing the importance of adoption, and holding teams accountable for progress. Their role in sustainment is to ensure that maturity improvements are embedded into the organization's operations and are not treated as one-time initiatives.

Together, these roles form a cross-functional team that combines technical detail with enterprise-level decision-making. Without this balance, assessments risk being too narrow or disconnected from the realities of implementation. Defining these roles creates accountability for adoption, governance, and sustainment, ensuring that the assessment leads to identified gaps and measurable progress in becoming a Model-Based Enterprise.

Sustaining Adoption and Continuous Improvement



For the results of the MBE Maturity Index to have a lasting impact, they must be embedded into the organization's operating framework rather than treated as a one-time assessment. Institutionalization is the process of integrating maturity findings into policies, governance structures, and everyday processes so that the practices introduced during adoption become part of standard operations. The first step in institutionalization is to translate assessment results and roadmap actions into formal policies and procedures. These policies may define expectations for how models are created, managed, and used across the enterprise. For example, a policy might mandate that all new product designs include PMI, or that all product revisions be controlled within a PLM system. Codifying expectations enables organizations to reduce the risk of practices being abandoned when leadership changes or short-term pressures arise.

Governance is equally important. Assessment findings should be reflected in governance structures that assign accountability and provide oversight. This may involve establishing a digital transformation steering committee, designating data stewards, or creating escalation paths for addressing barriers to adoption. Governance mechanisms ensure that maturity improvements are reinforced at the enterprise level and that progress continues beyond the initial enthusiasm of the assessment phase. Institutionalization also requires embedding results into operational processes. This can include updating standard operating procedures to incorporate model-based practices, integrating maturity metrics into performance reviews, or linking adoption milestones to project management frameworks. Embedding maturity expectations into daily processes makes them part of standard practice, rather than an additional burden.

Institutionalization depends on communication. Leaders must articulate why maturity goals are essential and how they contribute to the organization's overall strategy. Regular updates on progress against roadmap milestones, tied to enterprise outcomes such as reduced cycle times or improved quality, reinforce the importance of sustaining adoption. Embedding results into policy, governance, and processes creates the conditions for maturity improvements to endure. Institutionalization ensures that the benefits of digital transformation are sustained and expanded, preventing regression and establishing a stable foundation for ongoing improvement.

Reassessment

Digital transformation is a continuous progression, not a one-time event. For this reason, organizations should treat the MBE Maturity Index as a recurring activity rather than a one-time exercise. Periodic re-assessment allows leadership and practitioners to measure progress, validate whether roadmap actions are closing identified gaps, and refine priorities as conditions evolve. The cadence of reassessment will vary depending on the pace of change within the enterprise. For organizations in the early stages of adoption, annual assessments can provide the right balance between allowing improvements to take root and maintaining momentum. For more mature enterprises or programs tied to regulatory or customer requirements, shorter cycles, such as semiannual reviews, may be appropriate. Regardless of timing, consistency is more important than frequency. Using the same categories, topics, and facets across assessment cycles ensures that results are comparable over time.

Re-assessment provides several benefits. It provides a means of validating progress against targets, indicating whether capability, readiness, and adoption have improved since the last evaluation. It highlights areas where actions have been successful, providing evidence of return on investment, and it also identifies where gaps remain or where new barriers have emerged. This feedback is crucial for refining the roadmap, redirecting resources, and adjusting targets to align with the organization's evolving context. Equally important, re-assessment reinforces accountability. When participants know that results will be revisited, there is a greater incentive to follow through on commitments and sustain adoption. It also maintains visibility for leadership, providing a regular forum for reviewing progress and confirming that transformation efforts remain aligned with enterprise objectives. Committing to periodic re-assessment embeds the Index into their continuous improvement cycle. Each new assessment becomes a measurement of maturity and a checkpoint that informs strategy, validates progress, and renews focus on the journey to becoming a Model-Based Enterprise.

Scaling

Once model-based practices are established within the Organization Under Assessment, the next challenge is to extend their adoption beyond a single unit or facility. True digital maturity requires coordination across the entire enterprise, as well as with the broader network of suppliers, customers, and partners. Scaling is the process of taking what has been proven locally and extending it horizontally to peers and vertically across the extended enterprise. Scaling within the enterprise often begins by sharing lessons learned with peer organizations that operate under the same supra-organization. A business unit that has successfully implemented PMI in design, for example, can provide templates, training materials, and metrics that accelerate adoption in other units. Horizontal scaling reduces duplication of effort and promotes consistency, ensuring that digital practices are uniform across all sites.

Vertical scaling extends adoption up to the supra-organization and down to extended organizations. At the supra level, governance structures can incorporate assessment results from multiple units to create an enterprise-wide view of maturity. The consolidated perspective allows leadership to identify systemic gaps, align investments, and set enterprise targets that guide all organizations under its authority. At the extended level, suppliers and customers can be invited to participate in assessments or align their practices with those of the enterprise. For instance, a manufacturer may collaborate with suppliers to adopt common CAD standards or integrate PLM data exchange protocols, strengthening the digital thread across organizational boundaries.

Scaling requires deliberate effort. Practices proven in one context may not transfer to another without adjustment, and cultural, technical, or contractual differences may present barriers. To address this, organizations should use the MBE Maturity Index as a common framework for comparison and alignment. Applying the same categories, topics, and facets across different entities provides a shared language that facilitates scaling while respecting local differences. The benefit of scaling is it magnifies the value of digital transformation. Improvements in design or quality at one site which can create incremental gains, but when those improvements are extended across the enterprise and into the supply chain, they improve interoperability, reduce errors in handoffs, and allow faster responses to customer needs. In this way, scaling turns isolated progress into enterprise-wide and industry-level advancement.

Knowledge Sharing

Sustaining progress in model-based adoption requires more than conducting assessments and closing gaps. Organizations must also capture the knowledge they gain during the process and make it accessible to others. Knowledge sharing ensures that lessons learned, artifacts, and best practices are not confined to a single team or site but are made available to support the entire enterprise and, when appropriate, the extended enterprise. Documenting lessons learned is a critical first step. Each assessment cycle reveals maturity gaps, as well as the challenges encountered when attempting to address them. Recording what worked, what failed, and what adjustments were required provides a reference for future efforts. If a pilot project in model-based inspection uncovered resistance due to inadequate training, documenting this barrier and the corrective actions taken allows other units to anticipate and avoid the same problem. Artifacts produced during adoption efforts are equally valuable. These may include templates for embedding PMI into CAD models, checklists for data migration, or process maps that describe how digital work instructions are created and consumed. Preserving these artifacts reduces the need to reinvent tools and practices each time a new unit or partner begins its maturity journey.

Best practices should also be highlighted and disseminated. Practices that lead to measurable improvements, such as integrating PLM with ERP to reduce errors in part ordering or using digital twins for predictive maintenance, are examples that others can replicate. Sharing these practices within governance structures, training programs, and enterprise communication channels accelerates adoption and promotes consistency across the organization. Case examples add further value by contextualizing lessons learned and best practices in real-world scenarios. A case example might describe how a design team successfully transitioned from 2D drawings to MBD, including the steps taken, resources used, and outcomes achieved. Such examples make abstract concepts tangible, showing how maturity improvements were realized in practice and providing inspiration for others embarking on similar initiatives. Capturing and sharing lessons learned, artifacts, best practices, and case examples creates a knowledge base that strengthens institutional memory and accelerates transformation. Knowledge sharing converts isolated experiences into enterprise-wide capabilities, ensuring that progress in one area contributes to the overall maturity of the organization.

MBE Lexicon and Specialization

While the MBE Lexicon within the tool establishes a set of normalized definitions, the MBE Maturity Index also recognizes that each organization operates in a unique environment with its own terminology, cultural context, and technical nuances. For this reason, the Index provides space for refining terms in a way that preserves local relevance while maintaining consistency with broader vocabulary. This balance allows organizations to adapt to the language without undermining the comparability and clarity that the shared lexicon is intended to provide.

The “specialized” column in the workbook is where organizations can capture these refinements. For example, a company may adopt the standard definition of Product and Manufacturing Information (PMI) but add clarification that, within its operations, PMI also includes supplier-specific annotations that are required for regulatory reporting. Another organization may refine the definition of digital thread to reflect the specific systems it has integrated, such as a proprietary manufacturing execution system, while still recognizing the broader concept of connected lifecycle data. Refining terms in this way helps to resolve ambiguity during assessments. Team members from different functions may interpret terms differently, especially when disciplines such as engineering, manufacturing, and quality use overlapping vocabulary. Documenting local refinements ensures that all participants share the same interpretation, which leads to more accurate ratings and a clearer picture of maturity.

Although specialization adds value by making the definitions meaningful in context, organizations must maintain alignment with the baseline definitions provided in the Index. The normalized terms are anchors, allowing assessments to remain comparable across different organizations and industries. Specialized refinement should be built upon, rather than replace, the standard definitions to preserve the integrity of the tool while still enabling flexibility for individual use.

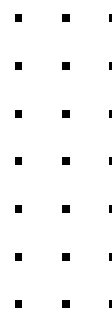
Organizational Commentary

In addition to using the standardized MBE Lexicon tab in the tool, the tab provides a method to record specialized refinements. Organizations are encouraged to document their own commentary during assessments to capture the reasoning, context, and examples behind the ratings that participants assign. Without these notes, the assessment results may appear as numbers on a chart, but they lack the necessary context to be interpreted correctly or to inform future actions.

Suppose a team rates the adoption of model-based definition at a mid-level. Commentary might explain that while the design group regularly embeds PMI into 3D models, the manufacturing team continues to rely on 2D drawings due to legacy equipment constraints. Capturing this detail provides clarity on why the score was selected and identifies a specific barrier that must be addressed to improve adoption. Commentary also helps resolve ambiguity when assessments are repeated over time. As leadership or participants change, written notes allow new assessors to understand the reasoning behind prior scores and to distinguish between genuine progress and differences in interpretation. In this way, commentary acts as an institutional memory that strengthens the reliability of longitudinal assessments.

The Index provides a column for “organization comments” alongside each definition. Space should be used to document clarifications, examples, or caveats that reflect the enterprise’s unique environment. Organizations may also choose to supplement the workbook with more detailed records, especially when assessments involve multiple business units or extended enterprise partners. Commentary turns an assessment from a static scorecard into a richer record of the organization’s digital maturity. It captures the nuance behind the ratings, provides context for decision-making, and offers a narrative thread that connects one assessment cycle to the next. Commentary carries equal weight to the ratings themselves, as it provides the reasoning and evidence that make the results credible and repeatable.

MBE Maturity Index Tool Vocabulary



The MBE Maturity Index relies on a common vocabulary to promote clarity and consistency during assessments. Without standardized definitions, the same term can carry different meanings across organizations, disciplines, or even departments within a single enterprise. To address this, the Index incorporates a lexicon of normalized definitions for key concepts central to model-based practices. These definitions provide a baseline understanding and can be refined further by each organization to reflect its unique environment.

Adoption—Adoption measures the degree to which the workforce is actively using the tools and processes in daily operations. It emphasizes behaviors and cultural uptake, recognizing that tools and methods have little value if they are not applied in practice.

Capability—Capability is the availability of tools, systems, or technologies that support model-based practices. It answers the question of whether the technical foundation exists, regardless of whether those tools are being used consistently.

Configuration Management—Configuration management is the discipline of maintaining consistency of a product's performance and design information throughout its lifecycle. In an MBE, configuration management ensures that model-based data, baselines, revisions, and variants are adequately controlled and traceable. Configuration management (CM) practices in Product Data Management (PDM) and Product Lifecycle Management (PLM) systems ensure product information is accurate, consistent, and traceable throughout its lifecycle. In a PDM system, CM focuses on managing engineering data such as CAD files, drawings, and Bills Of Materials (BOMs). CM ensures version control, track changes through Engineering Change Requests (ECRs) and orders (ECOs) and maintains record trails to support compliance and traceability.

Using CM in PLM systems extends this functionality across the entire product lifecycle, from C1: Product Design Activities, C2: Product Data/Lifecycle Management Activities, C3: Product Manufacturing Activities, C4: Product Quality Activities, and C5: Enterprise Enabling Activities. The PLM enables configuration identification, baseline management, change control, and status accounting, allowing organizations to manage product variants, revisions, and approvals across departments. CM within PDM and PLM systems helps organizations reduce errors, maintain regulatory compliance, and improve collaboration by providing a structured approach to managing complex product data and changes.

Digital Thread—The digital thread is the connection of data across the entire product lifecycle, linking design, production, quality, and sustainment. It ensures all stakeholders have access to consistent and up-to-date information through systems such as PLM, PDM, ERP, and MES. The digital thread enables changes in design to be reflected in downstream manufacturing and inspection activities, closing the loop between engineering intent and execution.

Digital Twin—A digital twin is a virtual representation of a physical product, process, or system that is kept synchronized with real-world performance through data feedback. Within an MBE, digital twins enable predictive analysis, maintenance planning, and continuous improvement.

Enterprise Resource Planning (ERP)—ERP systems manage core business functions, including finance, supply chain, procurement, and logistics. When connected to the digital thread, ERP links enterprise-level planning and resource allocation with model-based definitions and manufacturing execution. In an MBE, ERP manages core business functions and is the point where enterprise-level planning intersects with model-based product definitions.

Manufacturing Execution System (MES)—MES refers to the systems used to monitor, control, and optimize manufacturing operations. In an MBE context, the MES integrates with the digital model to deliver instructions to the shop floor and collect production data that feeds back into the digital thread. MES integrates with digital models to deliver instructions to the shop floor and return production data, closing the loop in the digital thread.

Model-Based Definition (MBD)—MBD refers to the practice of embedding all necessary product and manufacturing information into the 3D model, which includes geometry, dimensions, tolerances, materials, surface finishes, and assembly instructions. MBD captures this information in the model itself, eliminating the need for separate 2D drawings and reducing the possibility of misinterpretation or errors caused by multiple sources of documentation.

Model-Based Enterprise (MBE)—An MBE is an organization that uses digital models as the primary source of information across the product lifecycle. Instead of relying on documents or drawings, the enterprise uses model-based data to drive design, manufacturing, quality, and enterprise decision-making.

Model-Based Systems Engineering (MBSE)—MBSE extends model-based principles into systems engineering, where digital models are used to define requirements, behaviors, and architectures. It strengthens alignment between engineering design and product development, especially for complex systems with multiple interacting subsystems.

Product and Manufacturing Information (PMI)—PMI encompasses the annotations, symbols, and metadata that define how a part should be manufactured and inspected. Examples include geometric dimensioning and tolerancing, weld symbols, surface textures, and material specifications. In an MBE, PMI is not an add-on or separate artifact; it is integrated within the digital model, making the model the authoritative reference for production and quality functions.

Product Data Management (PDM)—PDM controls engineering data, including CAD models, drawings, and product structures. While often considered a subset of PLM, PDM plays a critical role in version control and access management for model-based information.

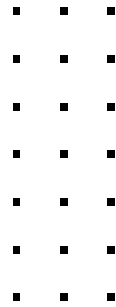
Product Lifecycle Management (PLM)—PLM is the discipline and associated systems used to manage product-related data and processes throughout the lifecycle, from C1: Product Design Activities, C2: Product Data/Lifecycle Management Activities, C3: Product Manufacturing Activities, C4: Product Quality Activities, and C5: Enterprise Enabling Activities. Within an MBE, PLM acts as a central backbone for the digital thread, ensuring that product models, metadata, and revisions remain consistent and accessible.

Readiness—Readiness considers whether the supporting processes, workflows, and standards are established and functional. It reflects the extent to which the organization has built the infrastructure, process, and tools to enable consistent and repeatable practices.

Target—Target defines the future maturity level an organization intends to achieve within a given timeframe. It establishes a benchmark against which current ratings can be compared and provides a directional goal for improvement planning. Targets are determined by organizational priorities and context rather than by external expectations.

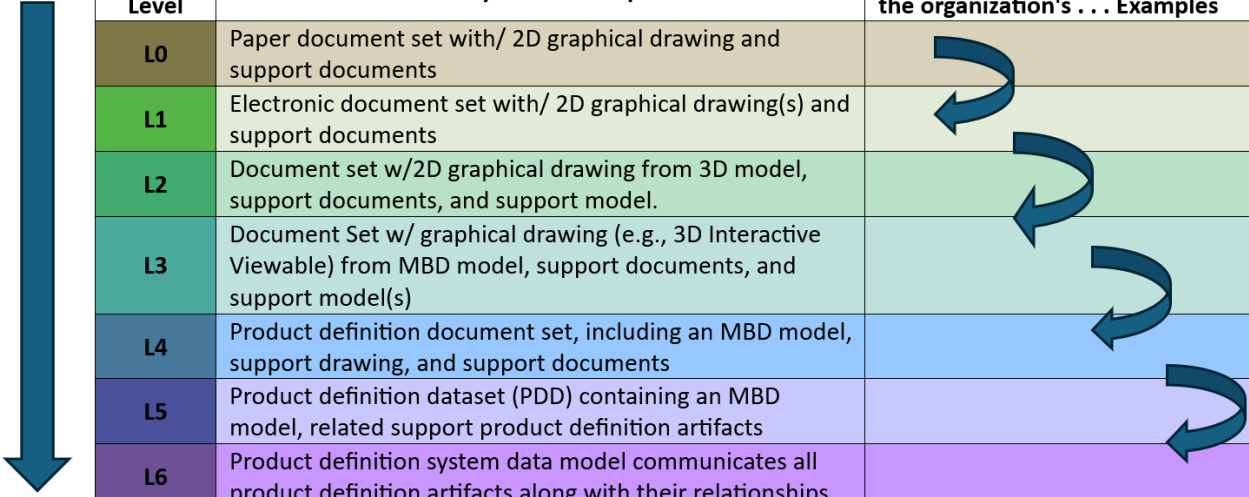
These terms, along with others included in the whole lexicon, establish a shared language that enables organizations to communicate clearly during assessments and to benchmark their practices against common standards. Each organization is encouraged to record its own interpretations or refinements of these definitions. However, the normalized vocabulary provided in the Index is the anchor for consistent use of the tool. While these definitions provide a standardized foundation, the Index recognizes that each organization will adapt certain terms to its environment. This practice of specialization allows the vocabulary to remain relevant without losing consistency.

Appendix



Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0		
L1		
L2		
L3		
L4		
L5		
L6		

C1: Product Design Activities
T1: Product Definition Authority
F1: Authorized Product Definition

Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper document set with/ 2D graphical drawing and support documents	
L1	Electronic document set with/ 2D graphical drawing(s) and support documents	
L2	Document set w/2D graphical drawing from 3D model, support documents, and support model.	
L3	Document Set w/ graphical drawing (e.g., 3D Interactive Viewable) from MBD model, support documents, and support model(s)	
L4	Product definition document set, including an MBD model, support drawing, and support documents	
L5	Product definition dataset (PDD) containing an MBD model, related support product definition artifacts	
L6	Product definition system data model communicates all product definition artifacts along with their relationships.	

CATEGORY 1: PRODUCT DESIGN ACTIVITIES

C1: Product Design Activities T1: Product Definition Authority F1: Authorized Product Definition		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper document set with 2D graphical drawing and support documents	Example: Traditional engineering drawing package printed for shop floor use. Artifacts: - Printed 2D Computer-Aided Design drawings - Bill of Materials (BOM) - Specifications and tolerances - Inspection sheets Work Product Activities: - Manual drafting and annotation - Physical distribution and archiving - Manual revision tracking - Human interpretation for manufacturing and inspection
L1	Electronic document set with 2D graphical drawing(s) and support documents	Example: PDF or digital CAD drawings shared via Product Lifecycle Management (PLM) or email. Artifacts: 2D Computer-Aided Design files (e.g., DWG), DWG (Drawing) is a proprietary file format developed by Autodesk for storing two-dimensional and three-dimensional design data - Drawing Exchange Format (DXF) is an open file format also developed by Autodesk to enable data exchange between different CAD programs. - Portable Document Format (PDF) - Bill of Materials in Excel or PLM - Digital specifications Work Product Activities: - CAD drafting and digital annotation - Electronic distribution and version control - Manual interpretation for Computer-Aided Manufacturing and Quality Assurance - Limited automation potential
L2	Document set w/2D graphical drawing from 3D model, support documents, and support model.	Example: Digital drawing files (e.g., PDF or DWG) stored in a shared drive or document management system. Artifacts: - Two-dimensional computer-aided design files - Electronic bill of materials - Digital specifications and inspection criteria Work Product Activities: - Computer-aided drafting - Electronic review and markup - Version control via document management systems

C1: Product Design Activities T1: Product Definition Authority F1: Authorized Product Definition		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
		Email-based collaboration
L3	Document Set w/ graphical drawing (e.g., 3D Interactive Viewable) from MBD model, support documents, and support model(s)	Example: Interactive three-dimensional viewable files (e.g., 3D PDF) with embedded product manufacturing information. Artifacts: - Three-dimensional annotated model - Interactive viewer files - Linked support documents (e.g., analysis, inspection plans) Work Product Activities: - Creation of annotated three-dimensional models - Generation of interactive viewables - Integration with downstream systems (e.g., manufacturing, inspection) - Digital collaboration and review
L4	Product definition document set, including an MBD model, support drawing, and support documents	Example: A hybrid package where the model is the authority, but drawings and documents are included for legacy or supplemental use. Artifacts: - Model-based definition model with embedded annotations - Reference drawings - Supporting documentation (e.g., compliance reports, material specifications) Work Product Activities: - Model-based definition creation - Drawing generation for legacy systems - Document linking and traceability - Validation of model annotations
L5	Product definition dataset (PDD) containing an MBD model, related support product definition artifacts	Example: A fully digital dataset where the model is the sole source of truth, and all supporting artifacts are digitally linked. Artifacts: - Model-based definition model - Digital bill of materials - Process plans, inspection criteria, and analysis results Work Product Activities: - Dataset packaging and validation - Digital thread integration - Automated downstream consumption (e.g., manufacturing, quality) - Configuration and change management
L6	Product definition system data model communicates all product definition	Example: A system-level digital twin or digital thread environment where all product data is interconnected and managed. Artifacts: Unified data model (e.g., ontology or schema)

C1: Product Design Activities T1: Product Definition Authority F1: Authorized Product Definition		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
	artifacts along with their relationships.	- Linked product definition artifacts (models, documents, simulations) - Relationship maps (e.g., dependencies, traceability) Work Product Activities: - System modeling and architecture definition - Data integration across lifecycle tools - Semantic linking and metadata management - Real-time updates and analytics

C1: Product Design Activities T2: Product Requirements Association F1: Form		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Non-electronic document(s)	Example: Printed engineering drawings and handwritten specifications. Artifacts: - Paper-based two-dimensional drawings - Physical bills of materials - Handwritten notes or inspection checklists Work Product Activities: - Manual drafting and annotation - Physical distribution and storage - Manual change tracking and approvals
L1	Electronic document(s)	Example: Digital files such as scanned drawings or word processing documents. Artifacts: - Two-dimensional drawing files (e.g., PDF or image formats) - Text-based specifications and reports Work Product Activities: - Digital creation and editing - Email or shared drive distribution - Basic version control and electronic approvals
L2	Same, with itemized identifications	Example: Structured documents with clearly labeled components or parts. Artifacts: - Drawings with labeled features and part numbers - Itemized bills of materials - Structured inspection plans Work Product Activities: - Tagging and labeling of document elements - Cross-referencing items across documents

C1: Product Design Activities T2: Product Requirements Association F1: Form		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
		Semi-automated data extraction for downstream use
L3	Uniquely identifiable digital objects/records, manifested as electronic document(s)	Example: Digital models or files with unique identifiers for each component. Artifacts: - Three-dimensional models with embedded identifiers - Metadata-enriched documents - Configuration-controlled digital records Work Product Activities: - Assignment of persistent identifiers - Linking of digital objects to product lifecycle systems - Controlled access and traceability
L4	Same, with attribution linking items to generated electronic document(s)	Example: Documents that reference specific digital models or components. Artifacts: - Annotated drawings referencing model features - Linked specifications and analysis reports - Traceable inspection criteria tied to model geometry Work Product Activities: - Attribution mapping between documents and models - Validation of links and references - Integrated review and approval workflows
L5	Same, with generated electronic document's items traced back to digital object sources	Example: Fully traceable documentation where each item is linked to its source model or dataset. Artifacts: - Interactive viewables with traceable annotations - Audit trails showing the origin of each document item - Linked simulation and analysis results Work Product Activities: - Source-to-document traceability mapping - Automated updates based on model changes - Lifecycle tracking of product definition elements
L6	Discrete digital references to persistently identifiable digital objects/records.	Example: A digital thread or system model where all product data is interconnected and persistently referenced. Artifacts: - Unified product definition data model - Semantic links between models, documents, and lifecycle data - Persistent identifiers across systems and platforms Work Product Activities: - System-level data modeling - Real-time synchronization across enterprise tools - Full digital traceability and analytics

C1: Product Design Activities T2: Product Requirements Association F2: Associativity		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Disconnected	Example: Product characteristics are documented separately from design files, such as in spreadsheets or paper forms. Artifacts: - Printed inspection checklists - Standalone specification documents - Unlinked spreadsheets Work Product Activities: - Manual data entry - Independent verification processes - No traceability between design and inspection data
L1	Manually linked to a characteristic on a 2D drawing	Example: Product characteristics are manually referenced on a two-dimensional drawing using notes or callouts. Artifacts: - Annotated two-dimensional drawings - Manually created inspection plans - Reference tables linking drawing features to characteristics Work Product Activities: - Manual interpretation of drawing annotations - Manual creation of inspection criteria - Human-driven traceability
L2	Replicated the part object in the PDM system	Example: Requirements are manually entered into part records in a product data management system. Product requirements are copied into the product definition system, but not dynamically linked. Artifacts: - Part records with replicated requirement attributes - Separate requirement documents Work Product Activities: - Manual data entry and duplication - Risk of inconsistency between source and replicated data - Basic traceability without automation
L3	Linked to a part object in the PDM system	Example: Requirements are associated with specific part records in the system. Product requirements are digitally linked to product definition elements Artifacts: - Part records with linked requirement references - Integrated requirement and design documents Work Product Activities: - Digital linking and validation - Improved traceability and change management - Semi-automated updates and reporting

C1: Product Design Activities T2: Product Requirements Association F2: Associativity		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L4	Linked to product characteristics in the 3D model	Example: Requirements are tied to specific features or annotations in the three-dimensional model. Product requirements are embedded and linked directly to product characteristics in the model. Artifacts: - Annotated three-dimensional models - Embedded specifications and tolerances Work Product Activities: - Model-based definition creation - Automated extraction of requirement data - Enhanced visualization and validation
L5	Bi-directional link	Example: Changes to requirements automatically update the model, and vice versa. Product requirements and product definition update each other when changes occur. Artifacts: - Synchronized requirement and design records - Linked verification and validation plans Work Product Activities: - Real-time synchronization - Closed-loop feedback between design and requirements - Automated impact analysis
L6	Automated bi-directional link	Example: A digital thread environment where requirements and product definition are continuously aligned. Product requirements and product definition are fully integrated and automatically synchronized. Artifacts: - Unified data model with persistent identifiers - Automated compliance and traceability reports Work Product Activities: - Continuous integration across lifecycle systems - Automated validation and reporting - Scalable enterprise-wide governance

C1: Product Design Activities T3: Product Description F1: Shape Definition		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	2D drawing	
L1	3D models as solid geometry	
L2	Same via feature-based design and parametric capabilities	
L3	Same with mixed modes of modeling (e.g., parametric, direct) techniques	
L4	Same with multiple feature-based disciplines (e.g., design, manufacturing, metrology, deburring)	
L5	Same with precise & unambiguous bounded complex surfaces & volumes	
L6	Same with generative design	

C1: Product Design Activities T3: Product Description F2: Non-Shape Information		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Textual annotations and notes on a 2D drawing	
L1	Same with textual notes driven from the 3D model	
L2	Annotations and notes in a 3D model	
L3	Semantic annotations and notes in the MBD model	
L4	Same with common notes across Peer-Organization	
L5	Minimum standard PMI, including product characteristic tags with any criticality designators	
L6	Same, with augmentations to product characteristics (e.g., product requirement associations, quality requirements)	

C1: Product Design Activities T3: Product Description F3: Metadata		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	As text on drawing	
L1	Parameters within the 3D Model	
L2	Same	
L3	3D Model and PDM	
L4	Automatic syncing between Model and PDM	
L5	Model metadata stored with the model; product metadata stored with the part in the PDM system	
L6	Standardized metadata linked to external systems.	

C1: Product Design Activities T3: Product Description F4: Presentation Views		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	2D drawing views, sections, & detail	
L1	Standard 2D drawing views, sections, & detail	
L2	Same	
L3	3D model presented in a standard set of interactive views	
L4	Same with product characteristic views between Peer-Organization	
L5	Same throughout Enterprise	
L6	Same with user-defined and specific discipline views	

C1: Product Design Activities T3: Product Description F5: Tolerancing Scheme		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Tolerancing without geometrical tolerances controls.	
L1	Tolerancing with Geometrical Dimensioning and Tolerancing (GD&T)	
L2	Standards-based GD&T with functional datum features	
L3	Same with piece-part functional datum features from an assembly perspective	
L4	Same between Peer-Organizations	
L5	Infer tolerancing schemes from a piece-part perspective.	
L6	Infer tolerancing schemes from an assembly perspective.	

C1: Product Design Activities T4: Model Quality & Certification F1: Verification		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Business/Design practices	
L1	Same and geometry	
L2	Same	
L3	Same and semantic PMI	
L4	Same	
L5	Same and checks related to production processes	
L6	Same and advanced precision geometry checks	

C1: Product Design Activities T4: Model Quality & Certification F2: Automation		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Manual checks	
L1	Same	
L2	Ad hoc interactive check	
L3	On-demand checking	
L4	Same	
L5	Same and automatic checks through workflow or promotion state change	
L6	Same	

C1: Product Design Activities T4: Model Quality & Certification F3: Certification		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Signature on drawing	
L1	Signature on an electronic drawing	
L2	Separate the electronic certificate with traceability to the model.	
L3	Electronic certificate associated with the part object	
L4	Same	
L5	Digital certificate embedded in the model file	
L6	Same	

C1: Product Design Activities T5: Model Derivatives F1: Content		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	Basic delineation (e.g., shape for MCAD)	
L2	Same w/ metadata	
L3	Same w/ textual PMI	
L4	Same w/ semantic PMI	
L5	Same with precision for target production processes	
L6	Same with precision for multiple target production processes	

C1: Product Design Activities T5: Model Derivatives F2: Authoring Automation		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	Manual from the Client Desktop	
L2	On demand from the PDM interface	
L3	Same	
L4	Automatic via PDM promotion states and/or workflows	
L5	Same rules determining the type of derivative	
L6	Same	

C1: Product Design Activities T5: Model Derivatives F3: Validation to & Certificates		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	Manual sign-offs without a certificate	
L2	Manual sign-offs with a separate electronic certificate	
L3	Interactively with a certificate linked to a PDM object	
L4	Same with embedded digital certificate	
L5	Same and automatic via a promotion state change	
L6	Same	

C1: Product Design Activities T5: Model Derivatives F4: Traceability		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	None	
L2	Reference to the source model	
L3	Same	
L4	Same and reference to the basis model	
L5	Complete traceability to the original source model	
L6	Same	

C1: Product Design Activities T5: Model Derivatives F5: Managed		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	Electronic file directories and disconnected	
L2	Document-centric PDM systems, but disconnected	
L3	Part-centric PDM systems, and associated	
L4	Part-centric, connected PLM system with a common schema between Peer-Organization	
L5	Single, part-centric, PLM system with common schema throughout the Enterprise.	
L6	Same with Extended Enterprise	

C1: Product Design Activities T5: Model Derivatives F6: Viewables		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper 2D Drawing	
L1	Electronic 2D static drawing	
L2	Proprietary 3D viewer, geometric interaction	
L3	Geometric and annotation interaction in a standard format	
L4	Same with spatial interrogation	
L5	Same with managed mark-ups	
L6	Same with holographic	

C1: Product Design Activities T6: ECAD/MCAD Collaboration F1: Condition		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Ad hoc	
L1	Design reviews	
L2	Design changes	
L3	Same	
L4	Same	
L5	Concurrent design	
L6	Same	

C1: Product Design Activities T6: ECAD/MCAD Collaboration F2: Mode		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Email and verbal	
L1	Exchange of model files	
L2	Shared access to PDM systems	
L3	User-initiated workflow	
L4	Same	
L5	Application tool integration	
L6	Common application tools	

C1: Product Design Activities T6: ECAD/MCAD Collaboration F3: Commonality		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	None	
L1	Duplicate component library	
L2	Same with the 3D component library with time guarantees	
L3	Shared library via PDM system	
L4	Shared part-centric library via PLM system between Peer-Organizations	
L5	Same throughout the Enterprise	
L6	Common MCAD-ECAD application tool	

C1: Product Design Activities T7: Design Analysis & Simulation F1: Basis Model Source		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Independent	
L1	Unauthorized model	
L2	Same	
L3	Authorized model	
L4	Model authorized specifically for analysis	
L5	Analysis is integral to the design process	
L6	Same	

C1: Product Design Activities T7: Design Analysis & Simulation F2: Analysis Model Authoring Automation		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Manual	
L1	Manually modified	
L2	Same	
L3	Directed automated modification	
L4	Automatic modification	
L5	Automatic updates	
L6	Same	

C1: Product Design Activities T7: Design Analysis & Simulation F3: Managed		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper file cabinets	
L1	Disconnected, electronic file directories.	
L2	Disconnected, document-centric PDM systems.	
L3	Disconnected, part-centric PDM systems.	
L4	Harmonized PLM schema between Peer-Organizations.	
L5	Single, part-centric PLM throughout the Enterprise.	
L6	Same with Extended Enterprise.	

C1: Product Design Activities T7: Design Analysis & Simulation F4: Influence		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Independent of design.	
L1	Shared with product and production process design teams.	
L2	Same	
L3	Business practices include design simulation results in design review.	
L4	Same and shared as part of change management.	
L5	Change is automatically proposed.	
L6	Automatic update of design definition with digital twin.	

C1: Product Design Activities T7: Design Analysis & Simulation F5: Traceability		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Textual references	
L1	Electronic, textual references	
L2	System-level awareness of other disciplines.	
L3	Part-level navigation to objects in other disciplines.	
L4	Model digital element-level navigation to data/objects in other disciplines.	
L5	Same with bi-directional navigation.	
L6	Same with write-back access, as appropriate	

CATEGORY 2: PRODUCT DATA/LIFECYCLE MANAGEMENT ACTIVITIES

C2: Product Data/Lifecycle Management Activities T1: Product Definition Authority F1: Part-Centricity		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper file cabinets	
L1	Electronic file directories	
L2	Document-centric PDM system connected to models	
L3	A part-centric PDM system for product definition is an authoritative source for the organization.	
L4	Common part-centric PLM schema with a single authoritative source between Peer-Organization	
L5	Same throughout the Enterprise.	
L6	Same with Extended-Enterprise.	

C2: Product Data/Lifecycle Management Activities T1: Product Definition Authority F2: Associativity		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Textual references	
L1	Electronic, textual references	
L2	System-level awareness of other disciplines	
L3	Part/item-level navigation to objects in other discipline systems	
L4	Model digital element-level navigation to data/objects in other discipline systems	
L5	Same with bi-directional navigation	
L6	Same with comment or write back access	

C2: Product Data/Lifecycle Management Activities T2: Data Management Approach F1: Content Management Scope		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Individual, disconnected electronic documents and 2D drawings	
L1	Same, and digital models	
L2	Collected as Product Definition set	
L3	Same with supplementary definition data and associated links	
L4	Same with production process definition data	
L5	Same with product data supplied by other disciplines, authoritative sources	
L6	Same with Extended-Enterprise	

C2: Product Data/Lifecycle Management Activities T2: Data Management Approach F2: Change Management		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Change textually tied to product definition	
L1	The electronic CM system exists dAllowsected from PDM	
L2	CM integrated with PDM	
L3	Same and change request digitally tied to the product definition part	
L4	CM is integrated with the product lifecycle within PLM	
L5	Single inter-organization-wide workflows embedded within PLM	
L6	Same and change request digitally tied to a discrete item within the product or production process definition	

C2: Product Data/Lifecycle Management Activities T2: Data Management Approach F3: Product Structure Management		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	On drawing(s)	
L1	Same and structured data duplicated in PDM	
L2	Subassemblies partially defined in PDM	
L3	Same with product's characterized attributes in PDM	
L4	Substructures defined with characterized attributes in PDM	
L5	Full up product structure (i.e., systems), defined and characterized attributes with product variants in PDM.	
L6	Same and available to the Extended-Enterprise	

C2: Product Data/Lifecycle Management Activities T2: Data Management Approach F4: User Interface Applications		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	None	
L1	Default tool interface for each application	
L2	Same with limited linkage to other discipline sources	
L3	Role/task-based application for viewing of data items	
L4	Same and contributing to existing data items	
L5	Same and authoring content	
L6	Same with combining data from other sources.	

C2: Product Data/Lifecycle Management Activities T2: Data Management Approach F5: Data Governance		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	None	
L1	Informal guidelines	
L2	Formal governance applied within local PDM/PLM capability	
L3	Same across OUA	
L4	Same between Peer-Organization	
L5	Same throughout the Enterprise.	
L6	Same with Extended- Enterprise.	

C2: Product Data/Lifecycle Management Activities T2: Data Management Approach F6: Traceability of Data		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Unknown authority	
L1	Authorized and unauthorized sources	
L2	Multiple authorized sources for a given data item.	
L3	Single authorized source for a given data item.	
L4	Same with verifiable traceability to the source of truth.	
L5	Same with on-demand audits	
L6	Same with Extended-Enterprise.	

C2: Product Data/Lifecycle Management Activities T2: Data Management Approach F7: Change Control		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Ad-hoc with no documentation	
L1	Formal, textual documentation is required for authorization.	
L2	Same with change control documentation manually associated to design document-centric items as unincorporated or incorporated	
L3	Industry standard change management workflows (i.e., problem reports, change requests, change notices, change tasks, change authorization) connected to part-centric PDM; Integrated unincorporated change workflow	
L4	Same with optional change review boards for impact analysis; Change control objects serve as change control documentation and authorization; Change description includes annotations (e.g., red marks)	
L5	Same with common change control systems (e.g., ERP, MES) for data traceability throughout the Enterprise.	
L6	Same with predictive analytics for corrective actions; Standard change control with Extended-Enterprise	

C2: Product Data/Lifecycle Management Activities T3: Product Definition Management F1: Product Definition Set		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper document package, manually compiled	
L1	Electronic document list, manually compiled	
L2	Electronic product definition set with manifest, manually compiled	
L3	Same and managed in the PDM system. allows for additional 3D model types (e.g., natives, derivatives), manually compiled	
L4	Product definition datasets are managed as PDM baselines, standardized, and interactively compiled.	
L5	Same and automated compilation	
L6	Same, and digitally consumable, and available to the Extended-Enterprise	

C2: Product Data/Lifecycle Management Activities T3: Product Definition Management F2: Supplemental Data Reference		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Supplemental data called out	
L1	Same and available in OUA's repositories	
L2	Same	
L3	PDM links to OUA's authoritative sources.	
L4	PLM linked through part objects to authoritative sources between Peer-Organizations.	
L5	Same throughout the Enterprise.	
L6	Model digital elements linked to authoritative sources with Extended-Enterprise.	

C2: Product Data/Lifecycle Management Activities T3: Product Definition Management F3: Product Definition Authorization		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Manual	
L1	Electronic is separate from PDM..	
L2	Same	
L3	Same and PDM are informed	
L4	Same and digital	
L5	Automated release process within PDM/PLM	
L6	Same	

C2: Product Data/Lifecycle Management Activities T4: Production Process Data Management F1: Product Definition Association		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Manual reference to 2D paper definition via part number	
L1	Textual reference to a 2D electronic document via part number	
L2	Digital reference to the product definition drawing	
L3	Digital association to product definition model	
L4	Digital association to product definition set within PLM	
L5	Same, but association to items within the product definition set	
L6	Digital bi-directional association to items within the product definition set	

C2: Product Data/Lifecycle Management Activities T4: Production Process Data Management F2: Definition Set		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper document package, manually compiled	
L1	Electronic document list, manually compiled	
L2	Electronic production process definition set with manifest, manually compiled	
L3	Same and managed in the PDM system, manually compiled	
L4	Production process definition datasets are managed as PDM baselines, standardized, and interactively compiled.	
L5	Same and automated, compilation	
L6	Same and digitally available to the Extended-Enterprise.	

C2: Product Data/Lifecycle Management Activities T4: Production Process Data Management F3: Supplemental Data Reference		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Supplemental data called out	
L1	Same and available in OUA's repositories	
L2	Same	
L3	PDM links to OUA's authoritative sources.	
L4	PLM linked through part objects to authoritative sources between Peer-Organizations.	
L5	Same throughout the Enterprise.	
L6	Model digital elements linked to authoritative sources with Extended-Enterprise.	

C2: Product Data/Lifecycle Management Activities T5: Bill of Materials (BOM) Management F1: Authoring		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	No Digital BOMs	
L1	xBOMs are manually parsed from document data	
L2	xBOMs are interactively parsed from document data	
L3	Design is digitally represented as a hierarchical product structure in PDM	
L4	Same and eBOM automatically seeded from the digital product structure	
L5	Same and mBOM automatically seeded from eBOM.	
L6	Same and all xBOMs automatically seeded from other xBOMs	

C2: Product Data/Lifecycle Management Activities T5: Bill of Materials (BOM) Management F2: Managed		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper file cabinets	
L1	Disconnected electronic file directories	
L2	Disconnected, document-centric PDM systems	
L3	Part-centric PDM systems	
L4	Harmonized PLM schema between Peer-Organizations	
L5	Single, part-centric PLM throughout the Enterprise.	
L6	Same with Extended-Enterprise	

C2: Product Data/Lifecycle Management Activities T5: Bill of Materials (BOM) Management F3: Traceability		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Textual references	
L1	Electronic, textual references	
L2	Same	
L3	eBOM digitally traceable to 3D Model(s)	
L4	mBOM digitally traceable to product definition via eBOM	
L5	Each xBOM is digitally traceable to all other BOMs, and discrepancies are automatically identified.	
L6	Same and bi-directional xBOM notification & reconciliation	

C2: Product Data/Lifecycle Management Activities T6: Common Digital Libraries F1: Extent		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	No digital libraries	
L1	Some shared (i.e., copied) structured digital libraries.	
L2	Common structured digital libraries for selected product definition types	
L3	Same for most (i.e., more than half but not all) product definition types	
L4	Same for all product definition types and selected production process definition types	
L5	Same for all production process definition types	
L6	Structure digital libraries to support all product lifecycle activities	

C2: Product Data/Lifecycle Management Activities T6: Common Digital Libraries F2: Library Governance		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Manual by an individual librarian	
L1	Shared librarians, ad hoc	
L2	Assigned librarian(s)	
L3	OUA governance team	
L4	Peer-organization governance team	
L5	Enterprise governance team	
L6	Same with automated “smart” librarian governance.	

C2: Product Data/Lifecycle Management Activities T6: Common Digital Libraries F3: Managed		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper file cabinets	
L1	Disconnected electronic file directories	
L2	Disconnected, document-centric PDM systems	
L3	Part-centric PDM systems	
L4	Harmonized PLM schema between Peer-Organization	
L5	Single, part-centric PLM throughout the Enterprise.	
L6	Same with PLM portals with Extended-Organizations.	

C2: Product Data/Lifecycle Management Activities T6: Common Digital Libraries F4: Access		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Ad hoc	
L1	Separated by discipline	
L2	Same	
L3	PDM/PLM share common part-centric libraries for the product definition discipline	
L4	Same, and for the production process definition	
L5	Same for all common disciplines	
L6	Same and controlled access with Extended-Organizations	

C2: Product Data/Lifecycle Management Activities T7: Data Records F1: Long Term Archival & Retrieval (LOTAR)		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	2D paper drawing or other physical medium (e.g., film, microfiche, mylar)	
L1	2D drawing as an electronic file	
L2	2D drawing as PDF format, with equivalent derivative model in standard (e.g., STEP AP203) format	
L3	Drawing (2D or 3D) and documents as PDF/A format, with equivalent derivative model in NARA-compliant archival formats	
L4	Complete design definition—including 3D mechanical CAD, PMI, and product structure--compliant with NAS-9300.	
L5	Same with as-planned and as-built production data (per NAS-9300, if available)	
L6	Same with electrical, model-based system engineering (MBSE), and/or analysis & simulation data.	

C2: Product Data/Lifecycle Management Activities T7: Data Records F2: Data Package		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Manually prepare a paper package.	
L1	Manually prepare electronic documents collected and compressed.	
L2	Manually prepare electronic data packaged with a manifest.	
L3	Same, but packaged using the standard format	
L4	Same between Peer-Organizations	
L5	Same throughout the Enterprise and managed and generated from PLM.	
L6	Same and available to Extended-Organizations.	

CATEGORY 3: PRODUCT MANUFACTURING ACTIVITIES

C3: Product Manufacturing Activities T1: Manufacturing Process Definition F1: Product Definition Source		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Use or derive basis artifacts from authorized 2D drawings, obtained from the file directory.	
L1	Use or derive basis artifacts from both authorized 2D drawings and ad-hoc derivative models, obtained from the file directory.	
L2	Use or derive basis artifacts from authorized 2D drawings and support models, obtained via PDM.	
L3	Use or derive basis artifacts from authorized 3D drawings (e.g., 3DIV) and support models, obtained via part objects in PDM.	
L4	Use or derive basis artifacts from the authorized MBD model, obtained via part objects in PDM.	
L5	Use or derive basis artifacts from the authorized product definition dataset (PDD), obtained via part objects in PDM.	
L6	Use or derive basis artifacts from the authorized product definition system model, obtained via part objects in PDM.	

C3: Product Manufacturing Activities T1: Manufacturing Process Definition F2: Method		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	2D drawings and documents of cutting tools, fixtures, and other resources	
L1	Same with start-process and in-process models	
L2	Same, but in-process and fixture models made from the basis model and mBOMs documented.	
L3	In-process MBD made from basis MBD and previous final-process models, digital cutting tool library used; mBOMs linked with eBOMs	
L4	Same; MBD can auto-generate “arithmetic mean” derivative models; digital cutting tool and fixture model libraries are used.	
L5	All in-process models inherited from the basis MBD; cutting tool & fixture models linked with in-process models; cutting tools auto-selected	
L6	Auto-generated from the start-process model to the last final-process model equivalent to the basis MBD model, and	

C3: Product Manufacturing Activities T1: Manufacturing Process Definition F2: Method		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
	from manufacturing knowledge and process definition system models; mBOMs are auto-generated.	

C3: Product Manufacturing Activities T1: Manufacturing Process Definition F3: Managed		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper file cabinets	
L1	Disconnected electronic file directories	
L2	Grouped as a common file in document-centric PDM systems	
L3	Collected with support models in part-centric PDM systems	
L4	Managed as associated objects within part-centric PLM between Peer-Organizations.	
L5	Same as a part-centric item to connected mBOM and derivatives	
L6	Same and Extended-Organization's artifacts are managed within authorized PLM.	

C3: Product Manufacturing Activities T1: Manufacturing Process Definition F4: Response to Change		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	No notifications	
L1	Response to ad hoc notification of change	
L2	Response to procedural notification of change	
L3	Same with stated response time guarantee	
L4	Response to product change notification via PLM	
L5	Same with automated state change of related artifacts	
L6	Same with automated updates of related artifacts	

C3: Product Manufacturing Activities T2: Tooling Definition & Realization F1: Basis		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Visual analysis of product definition	
L1	Same	
L2	Created from the basis of the 3D model	
L3	Same	
L4	Created from the basis of 3D MBD	
L5	Created from the basis of the MBD dataset	
L6	Defined automatically from product definition	

C3: Product Manufacturing Activities T2: Tooling Definition & Realization F2: Managed		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper file cabinets	
L1	Disconnected electronic file directories	
L2	Disconnected, document-centric PDM systems	
L3	Disconnected, part-centric PDM systems	
L4	Harmonized PLM schema across Peer-Organization.	
L5	Single, part-centric PLM throughout the Enterprise.	
L6	Same with Extended-Enterprise.	

C3: Product Manufacturing Activities T2: Tooling Definition & Realization F3: Traceability		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Textual references	
L1	Electronic, textual references	
L2	System-level awareness of other discipline systems	
L3	Part-level navigation to objects in other discipline systems	
L4	Model digital element-level navigation to data/object in other discipline systems	
L5	Same with bi-directional navigation	
L6	Same with write-back access, as appropriate	

C3: Product Manufacturing Activities T3: Manufacturing Process Instructions F1: Method		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Authored manually using Text & photographs	
L1	Authored within the delivery system using text, photographs, and model images	
L2	Same with model-based animations	
L3	Same, but authored within an authorized source of models (PDM)	
L4	Same and with MBD models.	
L5	Same with augmented reality	
L6	Automatic instructions based on product type, facility, and applicable manufacturing processes	

C3: Product Manufacturing Activities T3: Manufacturing Process Instructions F2: Managed		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper file cabinets	
L1	Disconnected electronic file directories	
L2	Disconnected, managed in the delivery system (e.g., MES)	
L3	Same with supplemental data managed in other systems	
L4	Managed as objects within a part-centric PLM and published in the delivery system	
L5	Directionally connected from the part-centric PLM system to the delivery system.	
L6	Bi-directionally connected between the part-centric PLM system and the delivery system.	

C3: Product Manufacturing Activities T3: Manufacturing Process Instructions F3: Response to Change		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	No notifications	
L1	Response to ad hoc notification of change	
L2	Response to procedural notification of change	
L3	Same with stated response time guarantee	
L4	Response to product change notification via PLM	
L5	Same with automated state change of related artifacts	
L6	Same with automated instruction segment updates and updates to the delivery system	

C3: Product Manufacturing Activities T4: Manufacturing Numeric Control Code F1: Basis Model Source		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	2D drawings from the work package	
L1	MPDD contains 2D drawings and ad hoc derivative models (e.g., STEP) from the file directory	
L2	MPDD contains 2D drawings and derivative models from PDM	
L3	MPDD contains drawings (i.e. 3DIV, 2D) and validated models from PDM	
L4	MPDD contains basic MBD derivative models and 3DIVs via part object in PLM	
L5	Same and MPDD include the basis MBD native models.	
L6	Same with inheritance models from native models.	

C3: Product Manufacturing Activities T4: Manufacturing Numeric Control Code F2: Method		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Manual	
L1	Interactively generated and validated with a 3D model.	
L2	Same with the basis model and the separate narrative	
L3	Same with PMI incorporated in lieu of a narrative	
L4	Same with integrated validation	
L5	Same with inheritance models	
L6	Automatically generated from manufacturing feature-based rules.	

C3: Product Manufacturing Activities T4: Manufacturing Numeric Control Code F3: Managed		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper file cabinets	
L1	Disconnected electronic file directories	
L2	Grouped as a common file in document-centric PDM systems	
L3	Collected with support models in part-centric PDM systems	
L4	Managed as objects within part-centric PLM	
L5	Same and as a part-centric item to connect mBOM	
L6	Same and Extended-Organization's artifacts are managed within authorized PDM.	

C3: Product Manufacturing Activities T4: Manufacturing Numeric Control Code F4: Response to Change		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	No notifications	
L1	Response to ad hoc notification of change	
L2	Response to procedural notification of change	
L3	Same with stated response time guarantee	
L4	Response to product change notification via PLM	
L5	Same with automated state change of related artifacts	
L6	Same with automated code segment updates	

C3: Product Manufacturing Activities T5: Manufacturing Analysis & Simulation F1: Basis Model Source		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Independent	
L1	Unauthorized model	
L2	Same	
L3	Authorized model	
L4	The model is authorized specifically for analysis.	
L5	Analysis is integral to the design process.	
L6	Same	

C3: Product Manufacturing Activities T5: Manufacturing Analysis & Simulation F2: Analysis Model Authoring Automation		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Manual	
L1	Manually modified	
L2	Same	
L3	Directed automated modification	
L4	Automatic modification	
L5	Automatic updates	
L6	Same	

C3: Product Manufacturing Activities T5: Manufacturing Analysis & Simulation F3: Managed		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper file cabinets	
L1	Disconnected electronic file directories	
L2	Grouped as a common file, disconnected in document-centric PDM systems	
L3	Collected with support models in part-centric PDM systems	
L4	Managed as objects within part-centric PLM between Peer-Organizations.	
L5	Single, part-centric PLM throughout the Enterprise.	
L6	Same and Extended-Enterprise's artifacts are managed within authorized PLM.	

C3: Product Manufacturing Activities T5: Manufacturing Analysis & Simulation F4: Influence		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Independent of design	
L1	Shared with design and production teams	
L2	Same	
L3	Business practices include manufacturing simulation results in design and production reviews.	
L4	Same and shared with stakeholders via change management	
L5	Change is automatically proposed.	
L6	Automatic update of design & manufacturing process definition with digital twin	

C3: Product Manufacturing Activities T5: Manufacturing Analysis & Simulation F5: Traceability		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Textual references	
L1	Electronic, textual references	
L2	System-level awareness of other discipline systems	
L3	Part-level navigation to objects in other discipline systems	
L4	Model digital element-level navigation to data/objects in other discipline systems	
L5	Same with bi-directional navigation	
L6	Same with write-back access, as appropriate	

C3: Product Manufacturing Activities T6: Manufacturing Operations F1: Basis Model Reference		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper 2D drawing	
L1	Electronic 2D drawing	
L2	Same	
L3	3D interactive viewable (3DIV)	
L4	Same with support model derivatives	
L5	MBD dataset	
L6	Same with enhanced 3DIV	

C3: Product Manufacturing Activities T6: Manufacturing Operations F2: Presentation		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Textual instructions on paper	
L1	Electronic textual instructions	
L2	Same with graphics and photo images	
L3	Same with images from the model	
L4	Same with model-based interactions	
L5	Same with interactive model-based animations	
L6	Same with augmented or mixed reality	

C3: Product Manufacturing Activities T7: Product-Related Procurement F1: Content		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	2D drawings	
L1	2D drawings and derivative model	
L2	Same	
L3	3DIV and derivative models	
L4	3DIV and derivative models as a procurement data package	
L5	Auto-generated and conforms to business rules and data package practices	
L6	Same and includes quality planning and quality results	

C3: Product Manufacturing Activities T7: Product-Related Procurement F2: Managed		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper file cabinets	
L1	Disconnected electronic file directories	
L2	Disconnected, document-centric PDM systems	
L3	Disconnected, part-centric PDM systems	
L4	Harmonized PLM schema between Peer-Organization.	
L5	Single, part-centric PLM throughout the Enterprise.	
L6	Same with Extended-Enterprise.	

C3: Product Manufacturing Activities T7: Product-Related Procurement F3: Response to Change		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	No notifications	
L1	Response to ad hoc notification of change	
L2	Response to procedural notification of change	
L3	Same with stated response time guarantee	
L4	Response to product change notification via PLM	
L5	Same with automated state change by discipline	
L6	Same with automated updates from the discipline	

C3: Product Manufacturing Activities T7: Product-Related Procurement F4: Delivery		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Mail	
L1	Email	
L2	Same with authenticated file exchange	
L3	.Standalone authenticated file exchange	
L4	Authenticated PLM	
L5	Same with automatic notification via email	
L6	Auto sent to Extended-Organizations with confirmation.	

CATEGORY 4: PRODUCT QUALITY ACTIVITIES

C4: Product Quality Activities T1: Quality Process Definition F1: Product Definition Source		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Use or derive basis artifacts from authorized 2D drawings, obtained from the file directory.	
L1	Use or derive basis artifacts from both authorized 2D drawings and ad-hoc derivative models, obtained from the file directory.	
L2	Use or derive basis artifacts from authorized 2D drawings and support models, obtained via PDM.	
L3	Use or derive basis artifacts from authorized 3D drawings (e.g., 3DIV) and support models, obtained via part objects in PDM.	
L4	Use or derive basis artifacts from the authorized MBD model, obtained via part objects in PDM.	
L5	Use or derive basis artifacts from the authorized product definition dataset (PDD), obtained via part objects in PDM.	
L6	Use or derive basis artifacts from the authorized product definition system model, obtained via part objects in PDM.	

C4: Product Quality Activities T1: Quality Process Definition F2: Method		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Manual via 2D drawings and documents, fixtures, and gauge drawings	
L1	Same with quality visual aids; the Inspection plan was manually captured from BoCs.	
L2	Same and interactive fixture and gauge models made from a basic 3D model	
L3	Same and 3DIV quality visual aids from the basis MBD model; Inspection plan interactively captured from BoC	
L4	Same; on-demand augmentation of product characteristics on a native basis, MBD; BoC exported in electronic format	
L5	Same; on-demand augmentation of verification methods and/or sampling plans on model-based product characteristics in the model	
L6	Same; and auto-generated from rule-based inspection methods from model-based product characteristics;	

C4: Product Quality Activities T1: Quality Process Definition F2: Method		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
	Inspection plan exported in standard (e.g., QIF) digital format.	

C4: Product Quality Activities T1: Quality Process Definition F3: Managed		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper file cabinets	
L1	Disconnected electronic file directories	
L2	Grouped as a common file in document-centric PDM systems	
L3	Collected with support models in part-centric PDM systems	
L4	Managed as associated objects within part-centric PLM between Peer-Organizations.	
L5	Same, and as a part-centric item to connect BoC	
L6	Same and Extended-Organization's artifacts are managed within authorized PLM.	

C4: Product Quality Activities T1: Quality Process Definition F4: Response to Change		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	No notifications	
L1	Response to ad hoc notification of change	
L2	Response to procedural notification of change	
L3	Same with stated response time guarantee	
L4	Response to product change notification via PLM	
L5	Same with automated state change of related artifacts	
L6	Same with automated updates of related artifacts	

C4: Product Quality Activities T2: Product Characteristics & BoC F1: Method		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Manually labeling “ballooning” the drawing just before inspection.	
L1	Interactive labeling on electronic drawing just before inspection	
L2	Interactive labeling on electronic drawing during quality planning with BoC	
L3	On-demand tagging of product characteristics with criticality classification during quality planning from the derivative MBD model; BoC exported as a formatted document	
L4	Same via native MBD model, and published as BoC within product definition artifact (e.g., 3DIV)	
L5	Same and augmented with criticality classification, verification methods, and/or product requirement associations	
L6	Same and BoC exported via a digital standard format (e.g., QIF)	

C4: Product Quality Activities T2: Product Characteristics & BoC F2: Managed		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper file cabinets	
L1	Disconnected electronic file directories	
L2	Grouped as a common file in document-centric PDM systems	
L3	Collected with product definition in a part-centric PDM system	
L4	Managed as objects within part-centric PLM	
L5	Same and as part-centric item to connected xBoMs	
L6	Same and Extended-Organization’s BoC are managed within authorized PLM.	

C4: Product Quality Activities T2: Product Characteristics & BoC F3: Traceability		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Textual references on drawings	
L1	Electronic, tag references on drawing (e.g., balloons)	
L2	Electronic tag references entities in the model.	
L3	Digital tags are associated with PMI on the MBD model.	
L4	Same and tags augmented with criticality classifications	
L5	Same with tags having digitally persistent universally unique IDs (UUIDs)	
L6	Same with associations with product requirements	

C4: Product Quality Activities T3: Quality Process Instructions F1: Method		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Authored manually using Text & photographs	
L1	Authored within the delivery system using text, photographs, and model images	
L2	Same with model-based animations	
L3	Same, but authored within an authorized source of models (PDM)	
L4	Same and with MBD models.	
L5	Same with augmented reality	
L6	Automatic instructions based on product type, facility, and quality processes	

C4: Product Quality Activities T3: Quality Process Instructions F2: Managed		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper file cabinets	
L1	Disconnected electronic file directories	
L2	Disconnected, managed in the delivery system (e.g., MES)	
L3	Same with supplemental data managed in other systems	
L4	Managed as objects within a part-centric PLM and published in the delivery system	
L5	Directional connected from the part-centric PLM system to the delivery system	
L6	Bi-directionally connected between the part-centric PLM system and the delivery system.	

C4: Product Quality Activities T3: Quality Process Instructions F3: Response to Change		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	No notifications	
L1	Response to ad hoc notifications of change	
L2	Response to procedural notifications of the change	
L3	Same with stated response time guarantee	
L4	Response to product change notification via PLM	
L5	Same with the automated state change of related artifacts	
L6	Same with automated instruction segment updates and updates to the delivery system	

C4: Product Quality Activities T4: Inspection Numeric Control Code F1: Product Definition Source		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Use or derive basis artifacts from authorized 2D drawings, obtained from the file directory.	
L1	Use or derive basis artifacts from both authorized 2D drawings and ad-hoc derivative models, obtained from the file directory.	
L2	Use or derive basis artifacts from authorized 2D drawings and support models, obtained via PDM.	
L3	Use or derive basis artifacts from authorized 3D drawings (e.g., 3DIV) and support models, obtained via part objects in PDM.	
L4	Use or derive basis artifacts from the authorized MBD model, obtained via part objects in PDM.	
L5	Use or derive basis artifacts from the authorized product definition dataset, obtained via part objects in PDM.	
L6	Use or derive basis artifacts from the authorized product definition system model, obtained via part objects in PDM.	

C4: Product Quality Activities T4: Inspection Numeric Control Code F2: Method		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Manual	
L1	Interactively generated per work request and validated with a 3D model.	
L2	Same with the authorized model	
L3	Same with PMI incorporated	
L4	Same with the validated inspection plan requirements	
L5	Semi-automatically generated based on a minimum metrology feature set with PMI.	
L6	Automatically generated from metrology feature-based rules.	

C4: Product Quality Activities T4: Inspection Numeric Control Code F3: Managed		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper file cabinets	
L1	Disconnected electronic file directories	
L2	Packaged as a common file in document-centric PDM systems	
L3	Collected with support models in part-centric PDM systems	
L4	Managed as objects within part-centric PLM	
L5	Same and connected to the inspection plan with BoC	
L6	Same and extended enterprise's artifacts are managed within authorized PLM.	

C4: Product Quality Activities T4: Inspection Numeric Control Code F4: Response to change		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	No notifications	
L1	Response to ad hoc notification of change	
L2	Response to procedural notifications of change	
L3	Same with stated response time guarantee	
L4	Response to product change notification via PLM	
L5	Same with automated state change of related artifacts	
L6	Same with automated code segment updates	

C4: Product Quality Activities T5: Quality Results Management & Analysis F1: Managed		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper file cabinets	
L1	Disconnected electronic file directories	
L2	Grouped as a common file in document-centric PDM systems	
L3	Collected in part-centric PDM systems	
L4	Managed as objects identified within part-centric PLM with linkages to the quality results management tool	
L5	Same with part-centric serialized items	
L6	Same and Extended-Organization's artifacts are managed within authorized PLM.	

C4: Product Quality Activities T5: Quality Results Management & Analysis F2: Traceability (Serialization)		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Textual reference to part and serialized parts	
L1	Electronic reference to part and serialized parts	
L2	Same with references to inspection tags (e.g., Key Ids)	
L3	Same with references to product characteristic identifiers	
L4	Same with references to persistent universally unique identifiers	
L5	Digitally associated with model-based product characteristics on the serialized part.	
L6	Same with associations from Extended-Organizations.	

C4: Product Quality Activities T5: Quality Results Management & Analysis F3: Reporting		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Individual ad hoc textual part summary report	
L1	Disconnected, results recaps with statistical analysis.	
L2	Automatic results recaps and statistical analysis.	
L3	Same and import results for display on the derivative model	
L4	Results via digital interoperability standards (e.g., QIF) format.	
L5	Same with statistical analysis and quality plans.	
L6	Same and shown via product characteristics on the MBD digital as-measured derivative model	

C4: Product Quality Activities T6: Test Equipment Definition & Realization F1: Basis		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Visual analysis of product definition	
L1	Same	
L2	Created from the basis 3D model	
L3	Same	
L4	Created from the basis of 3D MBD	
L5	Created from the basis of the MBD dataset	
L6	Defined automatically from product definition	

C4: Product Quality Activities T6: Test Equipment Definition & Realization F2: Managed		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper file cabinets	
L1	Disconnected electronic file directories	
L2	Disconnected, document-centric PDM systems	
L3	Disconnected, part-centric PDM systems	
L4	Harmonized PLM schema between Peer-Organizations.	
L5	Single, part-centric PLM throughout the Enterprise.	
L6	Same with Extended-Enterprise	

C4: Product Quality Activities T6: Test Equipment Definition & Realization F3: Traceability		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Textual references	
L1	Electronic, textual references	
L2	System-level awareness of other discipline systems	
L3	Part-level navigation to objects in other discipline systems	
L4	Model digital element-level navigation to data/objects in other discipline systems	
L5	Same with bi-directional navigation	
L6	Same with write-back access, as appropriate	

C4: Product Quality Activities T7: Inspection Operations F1: Product Definition Reference		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper 2D drawing	
L1	Electronic 2D drawing	
L2	Same	
L3	3D interactive viewable (3DIV)	
L4	Same with support model derivatives	
L5	MBD dataset	
L6	Same with model-based product characteristics	

C4: Product Quality Activities T7: Inspection Operations F2: Presentation		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Textual instructions on paper	
L1	Electronic textual instructions	
L2	Same with graphics and photo images	
L3	Same with images from the model	
L4	Same with model-based interactions	
L5	Same with interactive model-based animations	
L6	Same with augmented or mixed reality	

CATEGORY 5: ENTERPRISE ENABLING ACTIVITES

C5: Enterprise Enabling Activities T1: Product Work Collaboration F1: Actors		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Ad hoc	
L1	Core group	
L2	Cross-functional team	
L3	OUA	
L4	Peer-Organization	
L5	Enterprise	
L6	Extended-Enterprise	

C5: Enterprise Enabling Activities T1: Product Work Collaboration F2:Methods		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Phone and in-person meetings	
L1	Same and asynchronous messaging (email, voice mail, instant messaging)	
L2	Same and synchronous sharing (voice & video conferencing)	
L3	Same and multi-user screen sharing	
L4	Same with common collaborative virtual meetings, access to calendars, schedules, and web-based tools	
L5	Same and common, concurrent, multi-user authoring tools	
L6	Same and augmented or virtual reality collaboration	

C5: Enterprise Enabling Activities T2: MBE Governance F1: Leadership		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	None	
L1	Informal, part-time MBE champion	
L2	Formal part-time MBE Champion	
L3	Formal, full-time MBE champion	
L4	Same and Peer-Organization management leadership	
L5	MBE leadership at the Supra-Organization management level.	
L6	MBE leadership extends to Extended-Organizations.	

C5: Enterprise Enabling Activities T2: MBE Governance F2: Structure		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	None	
L1	Ad hoc	
L2	Non-authoritative or informal group	
L3	Team led by the core team	
L4	Centralized MBE program amongst Peer-Organizations.	
L5	Same with embedded liaisons throughout the Enterprise.	
L6	Same, including Extended-Organizations.	

C5: Enterprise Enabling Activities T2: MBE Governance F3: Commitment to Change		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Absent, project teams are unaware of their need to manage the people-side of change.	
L1	Ad-hoc, no formal practices or plans. OCM is reactive to people's resistance and becomes an add-on to the project	
L2	In isolated Projects, some elements of OCM begin to emerge in isolated parts of the organization. Efforts to manage the people side of change are infrequent and not centralized.	
L3	Multiple Projects, groups begin using a structured OCM process, and OCM is localized to particular teams or areas in the organization.	
L4	Organizational standards: The organization has selected a common approach and implemented standards for using OCM on every new project or technical change.	
L5	Enterprise Competency, OCM competency is part of the skill set of the organization.	
L6	Same and OCM steps are completely integrated into project management, OCM activities begin before project kick-off, and are viewed as standard practice..	

C5: Enterprise Enabling Activities T3: MBE People F1: Training		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	Locally managed, inconsistently delivered.	
L2	Centrally managed, classroom based.	
L3	Same and electronic delivery.	
L4	Digital, on demand, consistent across all media.	
L5	Role-based, in the context of Enterprise systems and business processes.	
L6	Independently audited, aligns with industry best practices.	

C5: Enterprise Enabling Activities T3: MBE People F2: Support		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	Info wiki; quick reference guides	
L2	Same with FAQ and on-demand instructions	
L3	Same with the help request mechanism	
L4	Same with interactive scripts (e.g., tutorials)	
L5	Same with content incorporated in Enterprise's multi-tiered help desk	
L6	Same as Enterprise, organizations have access to Enterprise's help content.	

C5: Enterprise Enabling Activities T3: MBE People F3: Certified Roles		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	Not standardized, no formal certification	
L2	Standardized certification for key roles	
L3	Standardized in business processes; certification for formally recognized roles.	
L4	Roles granted when formal certification is achieved, digital approvals	
L5	Roles and permissions align with training records.ds	
L6	Accredited and recognized by external professional bodies	

C5: Enterprise Enabling Activities T3: MBE People F4: Awareness		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	Ad hoc	
L2	Broadcasts to interested parties	
L3	MBE communications portal	
L4	Interactive MBE communications portal (e.g., internal wiki/webpage)	
L5	Automated feeds from core MBE business functions and capabilities	
L6	Metrics from the integrated business intelligence capability	

C5: Enterprise Enabling Activities T4: MBE Process F1: Business Practices		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	2D drawing-based	
L1	Same	
L2	Accommodate 3D models	
L3	Mix MBD-specific practices with legacy practices.	
L4	Locally operated exclusive end-to-end practices for MBD between Peer-Organizations.	
L5	End-to-end practices for MBD throughout the Enterprise.	
L6	Same with Extended-Enterprise.	

C5: Enterprise Enabling Activities T4: MBE Process F2: Repeatable (Documented)		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	Inconsistent, reliant on subject matter expert knowledge	
L2	Documented, OUA managed	
L3	Same	
L4	Digital in a designated repository between Peer-Organizations.	
L5	Fully integrated business process framework throughout the Enterprise.	
L6	Closed-loop business process with Extended-Enterprise	

C5: Enterprise Enabling Activities T4: MBE Process F3: Governance		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	No governance	
L2	OUA management	
L3	Same	
L4	Centrally governed, standardized between Peer-Organizations.	
L5	Actively managed by Supra-Organization through a team of business process specialists to support the Enterprise.	
L6	Same with Extended-Organizations.	

C5: Enterprise Enabling Activities T4: MBE Process F4: Optimize		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	Not well understood	
L2	Efficiency not measured	
L3	Key Performance Indicators are measured, but are inefficient.	
L4	Maintained alignment	
L5	Assessed and optimized, tailorable	
L6	Continuous improvement	

C5: Enterprise Enabling Activities T4: MBE Process F5: Industry Standard		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	Locally conceived	
L2	No alignment	
L3	Benchmark key business processes	
L4	COTS systems aligned to industry standards	
L5	Regularly benchmark all related business processes	
L6	Standards organizations' engagement, influence standard definitions; regular audits.	

C5: Enterprise Enabling Activities T5: MBE Technology F1: Standardized		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	Non-scalable, customized, non-standard, disconnected	
L2	Same but connected	
L3	Standardized for discrete workflows with OUA customizations	
L4	Standardized for discrete workflows with Peer-Organization customizations	
L5	Enterprise platform	
L6	Same with interoperability to Extended-Organizations.	

C5: Enterprise Enabling Activities T5: MBE Technology F2: Integrated		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	Disjointed technologies	
L2	Technologies enable distinct, coherent workflows.	
L3	Technology enables integrated workflows.	
L4	All MBE technologies are either integrated or interoperable between Peer-Organizations.	
L5	Technology enables a digital thread across inter-organization and lifecycle phases throughout the Enterprise.	
L6	Technology enables a digital thread with an extended enterprise.	

C5: Enterprise Enabling Activities T5: MBE Technology F3: Verification & Validation		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	No reliable regime	
L1	Functional verification checks on installations and upgrades	
L2	Same with verification of no side effects	
L3	Same, plus exercise software against canonical standards	
L4	Same and exercised on a routine schedule	
L5	Same with continuous verification	
L6	Independent verification & validation (V&V)	

C5: Enterprise Enabling Activities T5: MBE Technology F4: Maintained		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	No reliable configuration checking regime	
L1	Configuration check of individual technologies	
L2	Same	
L3	Ad hoc configuration check of dependencies	
L4	Routine configuration check of dependencies	
L5	Continuous configuration check of dependencies	
L6	Same with self-aware and self-organizing technologies	

C5: Enterprise Enabling Activities T5: MBE Technology F5: Tool Availability		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	None	
L1	None	
L2	Pilot projects only	
L3	Limited environments	
L4	Between Peer-Organizations.	
L5	Throughout Enterprise.	
L6	Extended-Enterprise access.	

C5: Enterprise Enabling Activities T6: MBE Information Assurance F1: Authenticity		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Markings on a 2D drawing	
L1	Release records	
L2	Electronic certificate of authenticity for 2D drawing with associated 3D model	
L3	Authoritative sources. Linked electronic certificate of authenticity	
L4	Same, with intrinsic, digital certificates for applicable content between Peer-Organizations	
L5	On-demand digital trust framework to verify authenticity, authorization, and certification per user-provided agreements throughout the Enterprise.	
L6	The same trust framework extends to Extended-Organizations.	

C5: Enterprise Enabling Activities T6: MBE Information Assurance F2: Accessibility		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Paper documents are accessible to librarians.	
L1	Electronic documents are in disorganized stores and are accessible only by OUA / local organization.	
L2	Same, but stored in organized collections.	
L3	Searchable distinct sources.	
L4	Searchable across sources and accessible between Peer-Organizations	
L5	Searchable across sources throughout the Enterprise.	
L6	Selected sources accessible and searchable by Extended-Organizations	

C5: Enterprise Enabling Activities T6: MBE Information Assurance F3: Confidentiality		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	Physical control	
L1	Control of individual electronic files	
L2	Control of sets of electronic files	
L3	Encryption and trust policies across all authoritative sources within QUA.	
L4	Same with digital rights management and digital redaction between Peer-Organizations.	
L5	Same, with object/feature-level access controls throughout the Enterprise.	
L6	Extended-Organizations participate in a digital rights management system and/or automated redaction.	

C5: Enterprise Enabling Activities T6: MBE Information Assurance F4: Governance of Access Control		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	Ad hoc access granted by an individual in possession.	
L2	Granted by the individual per OUA policy	
L3	Granted by the program per OUA policy	
L4	Granted by the program per the Peer-Organizations agreement.	

C5: Enterprise Enabling Activities T6: MBE Information Assurance F4: Governance of Access Control		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L5	Granted by policy across all programs throughout the Enterprise.	
L6	Access controls extend to Enterprise-Organizations; Automatic, adaptive management of access controls.	

C5: Enterprise Enabling Activities T7: MBE Financials F1: Mechanism		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	Ad hoc	
L2	Projects for technology capability maturation	
L3	Same and pilot applications for the maturation of MBE practices	
L4	Program of MBE-related projects	
L5	Same and coordinated across multiple funding venues	
L6	Portfolio of MBE programs	

C5: Enterprise Enabling Activities T7: MBE Financials F2: Continuity		
Maturity Level	Maturity Level Description	Transition: As maturity increases, the organization's . . . Examples
L0	N/A	
L1	Ad hoc	
L2	Funding is requested annually.	
L3	Multiyear funding.	
L4	Sustained amongst Peer-Organizations.	
L5	Sustained throughout the Enterprise.	
L6	Sustained throughout the Extended-Enterprise.	



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