

Air Force Sustainment Center

AM360: A MBSE DIGITAL THREAD APPROACH TO ADDITIVE MANUFACTURING AND AIRWORTHINESS



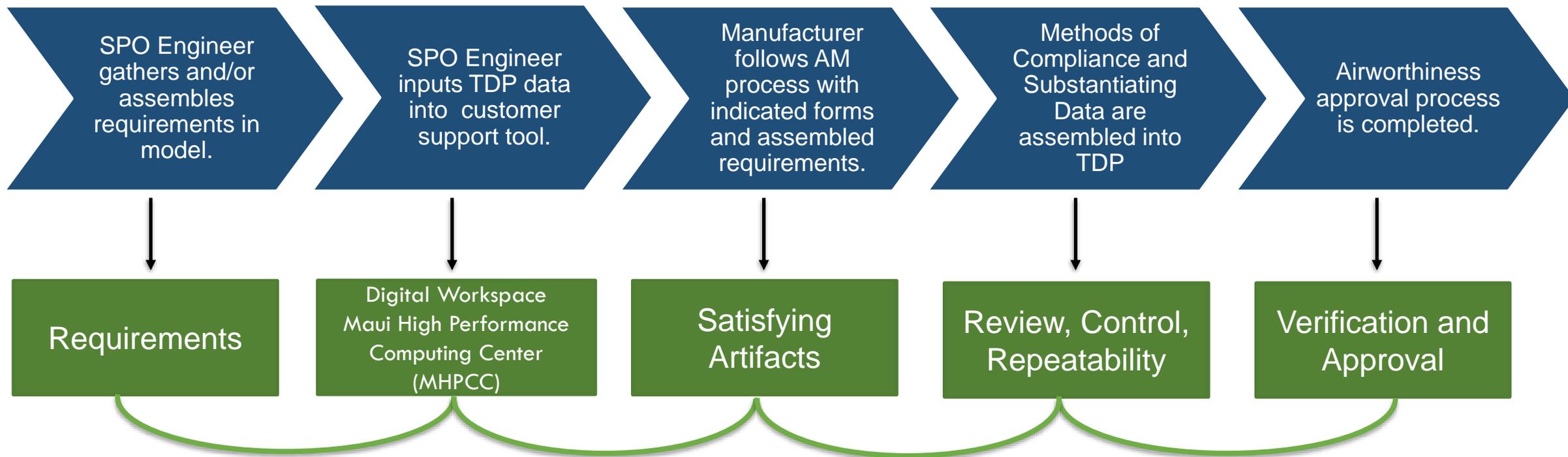
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Oct 19, 2023

Distribution Statement A.
Approved for public release.



AM360 Framework



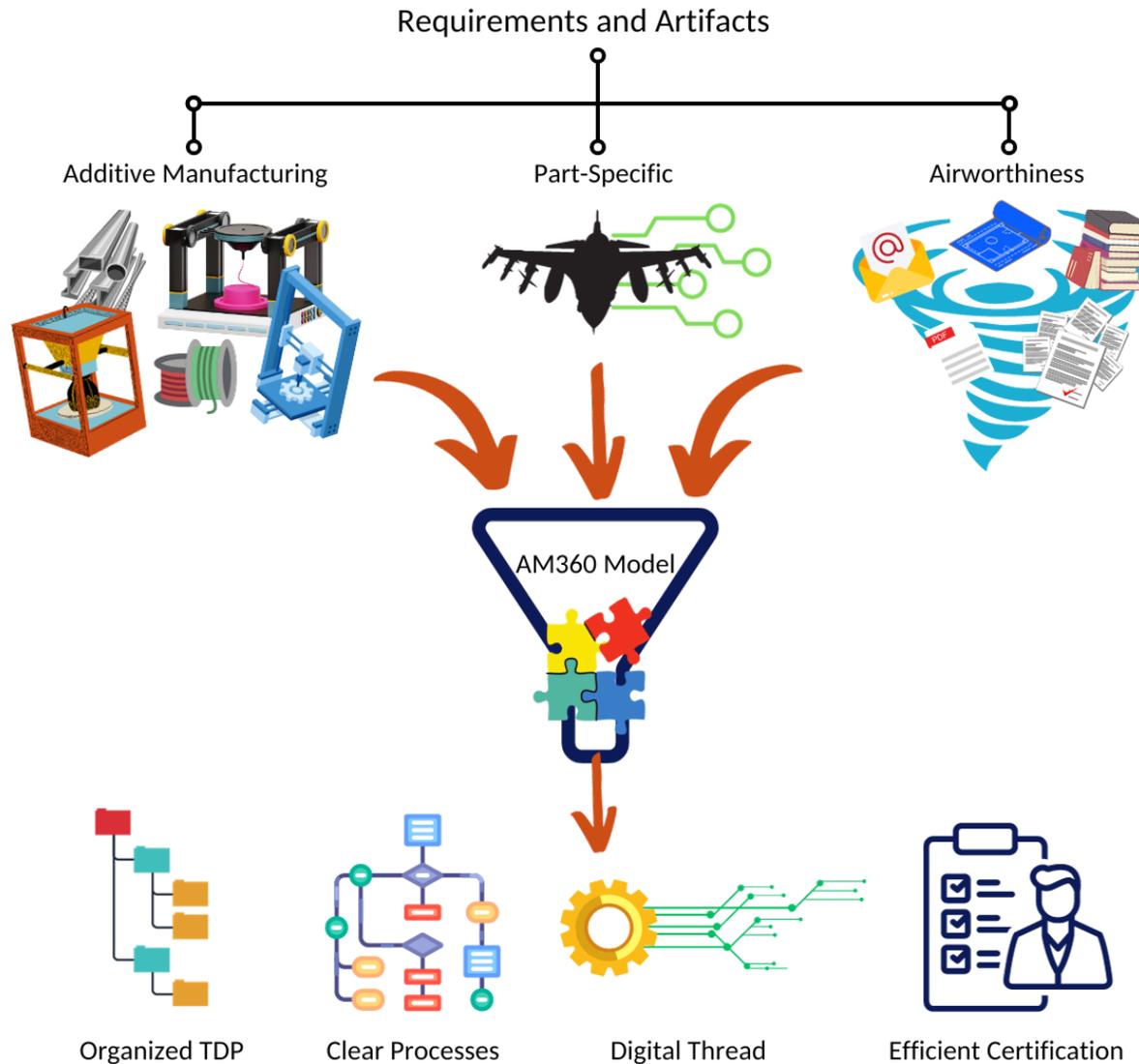
Digital Thread based AW Certification



Maui High Performance Computing Center



How Can AM360 Help Struggling Additive Manufactured Parts Get Certified for Flight?



“The Air Force has been doing additive manufacturing for over a decade, but very few metal critical parts have actually flown.” – Roger Jones, Technical Director AFSC



AM360 MBSE Solution Highlights

How can AM360 help struggling additive manufactured parts get certified for flight?

- 1) Act as the central **authoritative source of truth** by moving away from slow, confusing, and inefficient document-based approaches.
- 2) Apply systems engineering to **reduce complexity**: Efficiently organize which requirements and processes are applicable, where they are located, and what is required to satisfy them.
- 3) Provide a **digital thread** for an organized TDP: transparency and traceability in the process.
- 4) Give approving authorities methods to **tailor existing standards** to accommodate additive manufacturing without stifling innovation.



1) Act as the Authoritative Source of Truth (ASoT)

- Individuals often act as the SMEs, distributing their “tribal knowledge” in siloed, legacy documents.
- As a result, additive manufacturing is conducted by different program offices using ad-hoc and inconsistent processes.

AM360 Model Successes

- Utilizing a model-based approach, the **model acts as the SME** so that legacy knowledge is retained and refined into a best practice.
- The tests and procedures used to verify or validate a requirement can be **consistent and standardized**.

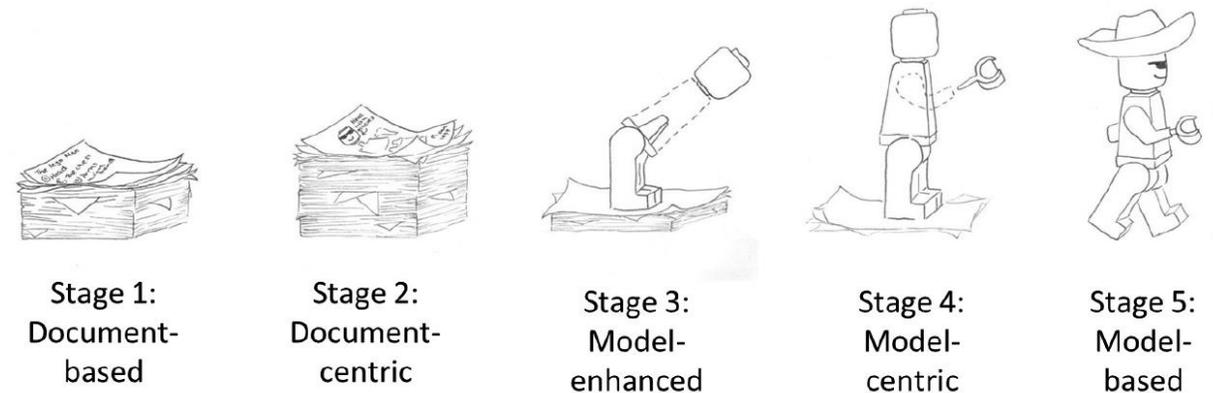


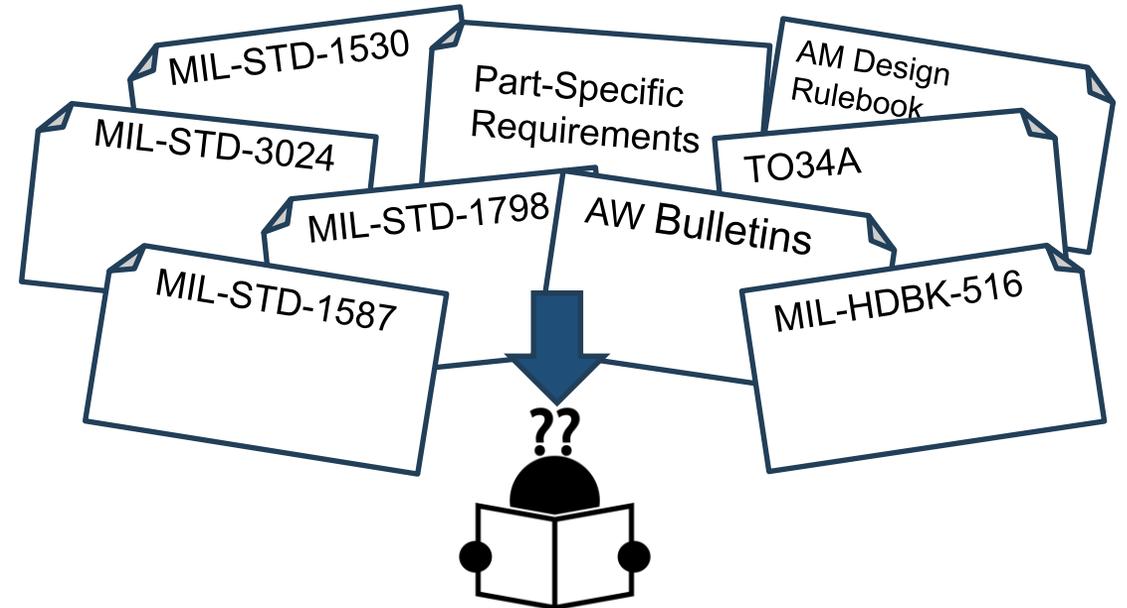
Figure 2.10 – The evolution of MBSE (Holt & Perry 2020)





2) Present Clear Processes and Requirements

- Relevant policies are distributed in TOs, handbooks, MIL-STDs, bulletins, and specifications which are owned by different divisions and groups.
- The airworthiness process is scattered throughout multiple documents and there are hundreds of airworthiness standards in MIL-HDBK-516.



AM360 Model Successes

- The model **organizes the chaos** by distilling processes, **preassembling** the requirements, and **pre-allocating** satisfying artifacts.

“The strength of this model for AM is that it can prepopulate the required artifacts for AM processes, which can then be used to help generate tailored methods of compliance, and lead to the use of AM parts without a non-compliance and risk.” – Jeff Calcaterra, Chief AFLCMC/EZF



3) Provide the Digital Thread for an Organized TDP

- Reviewing authorities often receive a structureless folder of files with little to no indication of why they are there, where they came from, or if they are complete.
- The transparency and traceability of the process are locked in emails or lost to sneaker-net approaches.

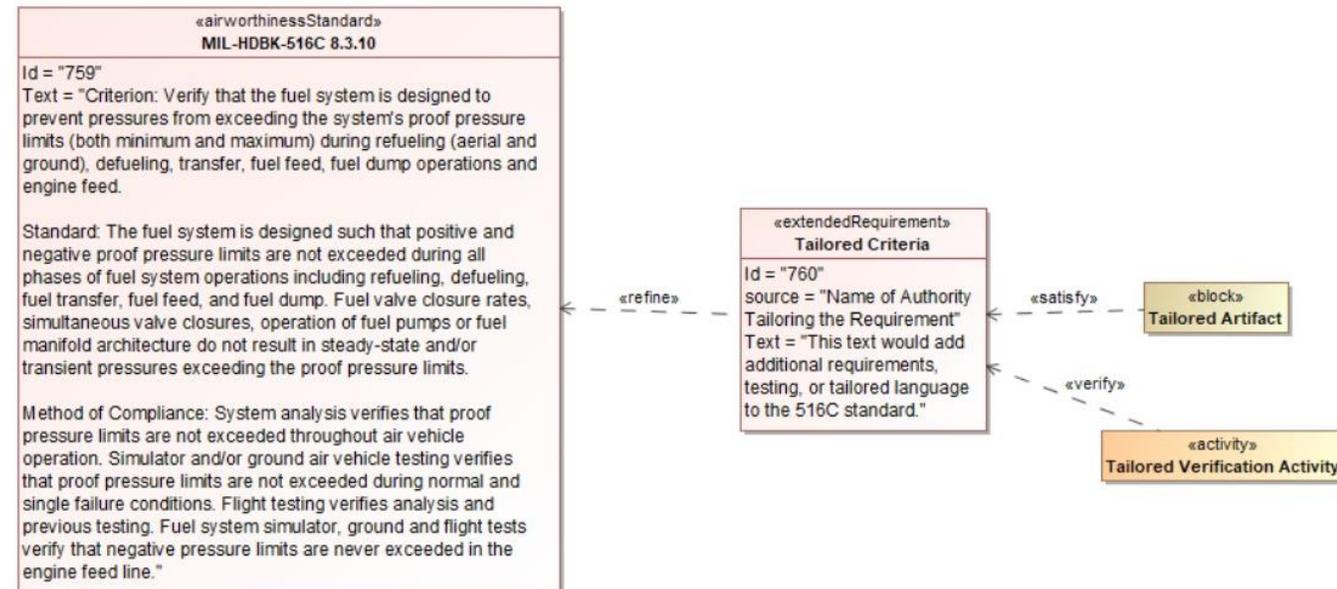
AM360 Model Successes

- The model **connects** the people, processes, requirements and artifacts.
- Artifacts are provided **in context**.
- Expected TDP artifacts are prepopulated and allocated to TDP requirements providing **guidance and consistency**.



4) Give Approving Authorities a Method to Tailor Existing Requirements

- Existing standards were not written with additive manufacturing in mind.
- Additive manufacturing is continuously being used in new and innovative ways. Constraining its scope would stifle innovation.
- Therefore, a means of tailoring existing standards to accommodate AM is desired.



AM360 Model Successes

- The MBSE approach provides a way to **tailor existing standards**, require additional testing, or indicate the need for additional satisfying artifacts.

“Most engineers don’t know enough about AM and airworthiness to do ... tailoring effectively and prepopulation of required artifacts gets us 90% of the way to a complete solution. It’s significantly better than the process we have right now.” – Jeff Calcaterra, Chief

AFLCMC/EZF



AM360 SysML Model Live Demonstration

