Qualification and Certification of Metallic Components for NAVSEA

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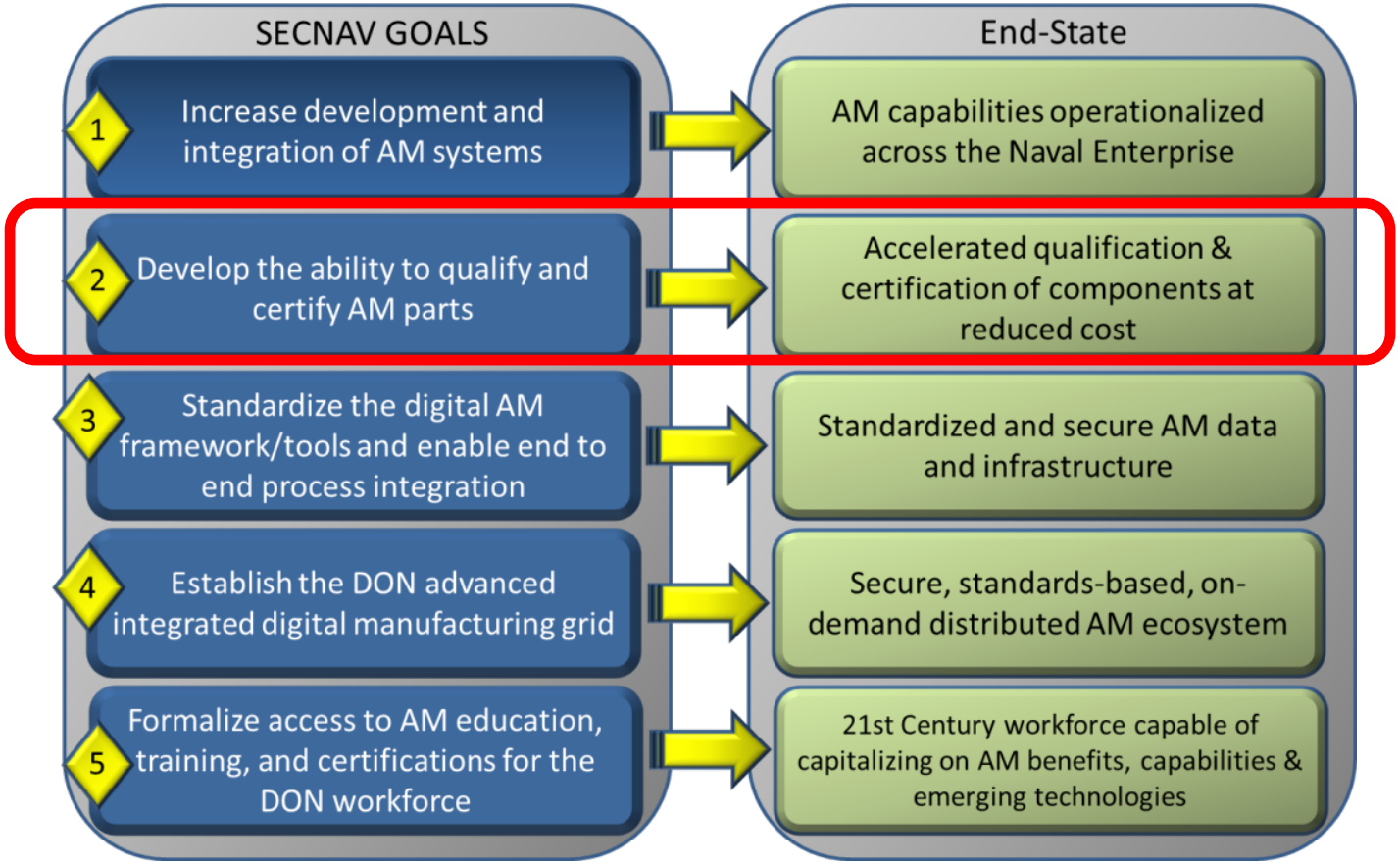
Department of the Navy Additive Manufacturing Implementation

- Maintain momentum and broaden our efforts across the NR&DE
- Assist, accelerate, and enable AM implementation to all naval communities (Operational, Logistics, technical, etc)



NAVSEA AM Strategy

- Develop & align engineering and acquisition competency and expertise to:
  - Ensure AM ship and weapon system components are safe, reliable and effective
  - Leverage AM as another manufacturing technique 'in the tool box'
    - Grow AM knowledge base through investments and collaboration
    - Push AM capabilities and authorities to waterfront (depots and shipyards), afloat, etc.
  - Employ AM in maintenance & repair
  - Expand the current use of AM for rapid design development, prototyping & tooling
  - Identify necessary S&T/R&D investment to enable AM capabilities for the NAVSEA enterprise
  - Connect AM digital backbone application with cybersecurity strategy
- Work with Directorates and PEOs to identify areas for application that improve capability and/or reduce cost
- Establish the processes, specifications and standards for use of AM for ship acquisition, design, maintenance, and operational support.
- Coordinate & collaborate with NAVAIR and other SYSCOMs for DoN AM objectives and investment

Operationalize AM in support of the Fleet where it makes sense.

Enabling AM Utilization Shipboard

- Current Fleet Memo (Jan 2015) specifies that no AM printed component can be installed shipboard w/o Departure from Specification (DFS)
- Design, Practice and Criteria Manual for AM – FY18 release
- Establish a "Green Box" Category for AM components
  - "Category" of components that are low-risk/low criticality
  - Approval Authority delegated down to CHENG (Waterfront or Ship).
  - Materials:
    - Polymer (substitute w/ like materials or better)
    - Metal
  - Criticality (as defined by NAVSEA S9800-AB-MAN-010, section E.3, NAVSEA-Tailored System Safety Risk Matrix):
    - Level 7: Could result in injury/illness resulting in no lost work days; or damage exceeding $10,000 but less than $100,000; or minimal environmental damage, requiring no restoration.
    - N/A: Could results in injury/illness requiring only first aid or less; or damage less than$10,000; and no environmental damage.
  - Fire/Smoke/Toxicity Consideration
    - AEL items
    - COSAL items
    - Volume Limitation
    - Storage requirements

Frequency and Probability	Severity: CVN Loss [2] (1)	Ship Loss [2] (2)	Catastrophic (3)	Critical (4)	Significant (5)	Marginal (6)	Negligible (7)	N/A
Frequent (A)	High	High	High	High	High	Serious	Medium	
Probable (B)	High	High	High	High	Serious	Serious	Medium	
Occasional (C)	High	High	High	Serious	Serious	Medium	Medium	
Feasible (D)	High	High	Serious	Serious	Medium	Medium	Low	
Rare (E)	High	Serious	Serious	Medium	Medium	Low	Low	
Remote (F)	Serious	Serious	Medium	Medium	Low	Low	Low	
Improbable (G)	Serious [3]	Serious [4]	Medium	Low	Low	Low	Low	
Eliminated [8] (H)								

NAVSEA Laser Powder Bed Fusion Process Specification

NAVSEA Laser Powder Bed Fusion Requirement *Draft Specification* requirements include:

- Identification of essential elements
- Process qualification through standard test array(s) and first article fabrication
- Process control plans to include: 1) digital file handling procedures, 2) build fabrication and feedstock handling procedures, 3) AM equipment maintenance control plan
- Performance qualification

Informed by:

- Platform specific requirements (such as for Friction Stir Welding)
- Leveraging industry and outside the DOD specifications where possible
  - Current specs/standards are immature
  - Some NAVSEA requirements may not be applicable outside of the Navy (SUBSAFE; Fire, Smoke, Toxicity (FST), etc.)
- Leveraging existing NAVSEA specs (NAVSEA Tech Pub 300 -Casting, NAVSEA Tech Pub 248 - Welding and Brazing)

Emphasis on leveraging ongoing work while ensuring requirements are suited to NAVSEA operating environments : 'Getting to yes' with qualification and certification

Naval Sea Systems Command Qualification Efforts

Part Demonstrations

- NAVSEA is currently working through 2 part demonstrations for parts produced utilizing the powder bed fusion process
  - 316L stainless steel and 17-4 PH stainless steel
- Part demonstrations are being used as an opportunity to test/exercise the requirements in the draft PBF process specification
- It is anticipated that the number of PBF/DMLS parts that are proposed as engineering changes to the fleet will continue to increase; current part demos provide the opportunity to explore the unique path to qualification and certification of AM parts from the standpoint of the NAVSEA Tech Authority process

Development of Industry Standards

- NAVSEA has representation on Standard Development Organization committees to aid in the incorporation of Naval specific requirements into industry standards
  - AWS D20 PBF specification

- Participation in the America Makes and ANSI Additive Manufacturing Standardization Collaborative (AMSC)
  - Co-chair for Process Control working group
  - Participation in Qualification/Certification working group

Long Term Goal: Rapid Qualification of Metallic AM parts

Long term goal for qualification of AM parts:

Utilization of a tiered qualification approach to achieve **rapid**, **reduced cost qualification** of AM parts by leveraging in-situ monitoring and process modeling.

What does NAVSEA need to accomplish this goal?

Technical:

- Validated in-situ monitoring
  - Specs for how to validate and limitations of use
- Validated process models
  - Specs for how to validate and limitations of use
- Acceptable material properties for a given material and process
- Material and Process specifications for all AM Materials and Processes
- Tiers of criticality for invoking different qual requirements

Cultural:

- Use of model based qualification
- Use of in situ monitoring in place of traditional NDE
- Drive for agility and adaptability within a traditionally rigid system/framework

Contracting/Approval Mechanism:

- What is the approval process for different criticality tiers?
  - Identify gaps
  - Identify areas that can be accelerated
  - Remove any roadblocks

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Questions?