NAVSEA Additive Manufacturing Program Overview

NRC Public Workshop on Advanced Manufacturing

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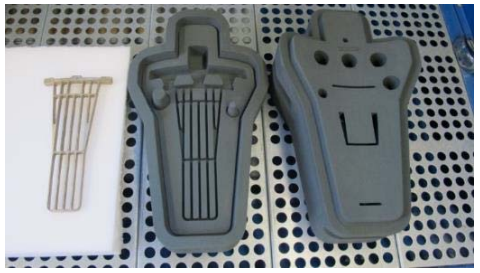
Additive Manufacturing

Why AM?

- **Increase readiness** through production of obsolete or long-lead items
- **Enhance capabilities** through mission-tailorable solutions and employment of designs not otherwise possible
- **Maintain operational availability** through “good enough” production at the point-of need



Key Initiatives

- Develop specifications and standards necessary to incorporate AM components for surface and subsurface applications
- Engage fleet and leverage logistics databases to ID priority components
- Prototype the digital infrastructure to securely store and share files
- Published policy for installing equipment onboard submarines
- Working closely with industry on identification and approval of components for AM.

NAVSEA AM Lines of Effort

- **Tech Authority**
  - Technical publications for multiple AM processes
  - Guidance enabling equipment deployed surface and subsurface
  - AM approval processes
  - Materials database

DSO valve installed on CVN-75

- **Digital**
  - File securing/transiting/storage strategy, including parts repository
  - 'Apollo Lab': Surface fleet able to reach back electronically to CONUS engineering support
  - Explore topology optimization and generative design
  - Development of digital manufacturing enclave
- **Afloat/Undersea Deployment**
  - Explore how to deploy and integrate advanced/additive manufacturing equipment surface and subsurface
  - Install AM equipment on 8 platforms in 2019
  - Provide in-service engineering support
- **Logistics integration**
  - Incorporate components into logistics databases to enable part provisioning, tracking and 'buy or print' decisions
- **Innovation challenges**
  - Scale propulsor production; rapidly deployable manufacturing capability

Tech Authority Products

- NAVSEA AM Guidance released August 2018
  - Guidelines for use of polymeric materials aboard ship (fire, smoke, and toxicity requirements)
- Powder Bed Fusion Technical Publication published – 21 Jan 2020
- Directed Energy Deposition Technical Publication – Q2 FY21
- Establishing framework for qualifying critical polymer machines and components
- Develop Technical Data Package for AM components
- Performing machine assessment for new metal AM systems going to NSYs and NSWCs
- Engage Standard Development Organizations with industry for AM processes
- Establishing methodology to qualify vendors for metal AM production

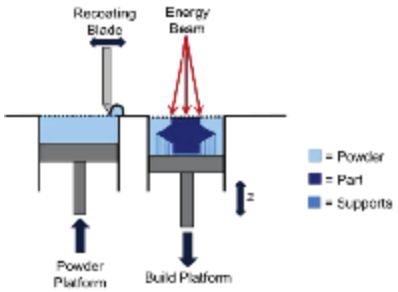
Part Risk Assessment 'Boxes'

Yellow: Part received by NAVSEA, in process of risk assessment

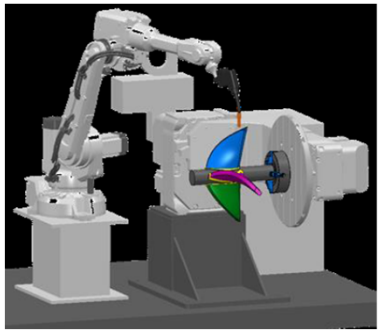
Green: Low criticality, can be approved waterfront or shipboard and installed

Blue: Part requires NAVSEA HQ review and approval

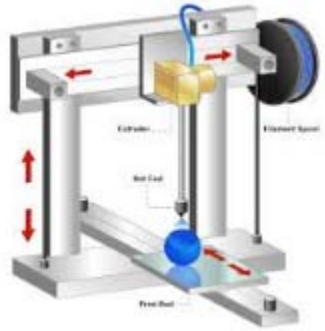
Red: Part cannot or should not be produced via additive manufacturing; will inform S&T strategy



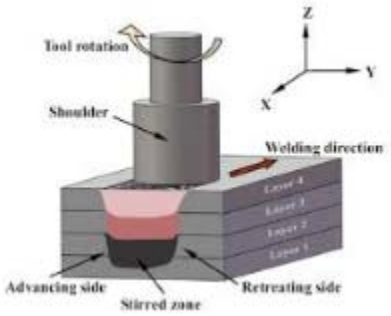
Powder Bed Fusion Process



Directed Energy Deposition Process



Material Extrusion



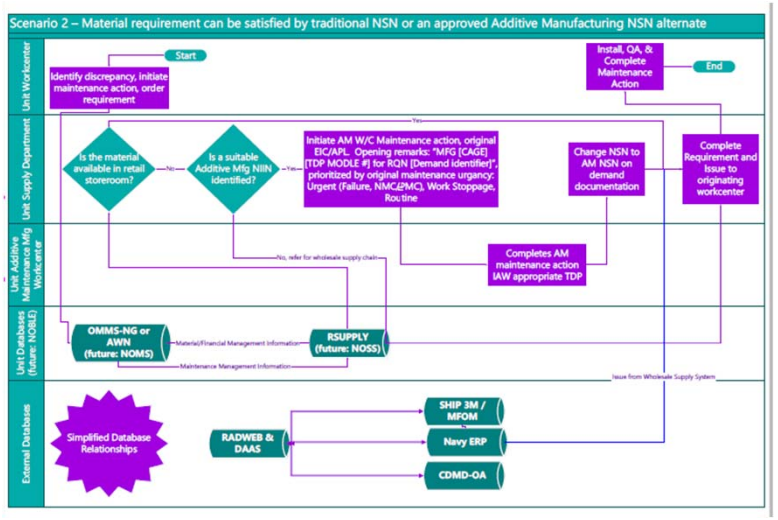
Additive Friction Stir

Ensuring repeatable, reliable production of AM components organically and from industry

Logistics Integration

- Motivation: Growing application space for AM across the Naval Enterprise requires supply chain Integration

- Goal: Data-driven AM part identification using automated logistics, supply and maintenance data



- Approach: Leverage existing databases and policies to integrate AM into the supply chain to promote improved agility, lower response times minimize brittleness

- Current Roadmap:
  - Establish cataloging and provisioning guidelines for AM parts
  - Logistics database and search for evaluating AM mission impact and readiness
  - Establish procedures for traceability of shipboard AM components at all levels; risk assessment and management

Logistics Integration

- Provisioning for AM Components
  - Temporary AM Part Allowance Parts List (APL) set up for AM TDPs as NSNs get assigned
  - 4 AM parts routed for provisioning review
- NSN Assignment of AM Components
  - Federal Cataloging Committee (FCC) Interim plan for identifying AM part at the reference level of NSN
  - Interim policy requires DLA to provide a list of AM NSNs to the services at a minimum monthly cadence
- Mission Impact Analysis
  - Integrating NAVSUP N25 Price Fighter's AM cost/part tool into the TDP development process to provide a more accurate projected AM part cost

Integrating AM components into the Navy supply system

NAMPIE Events

- Naval Additive Manufacturing Part Identification Exercises (NAMPIE)
  - Organized and supported by greater NAVSEA community

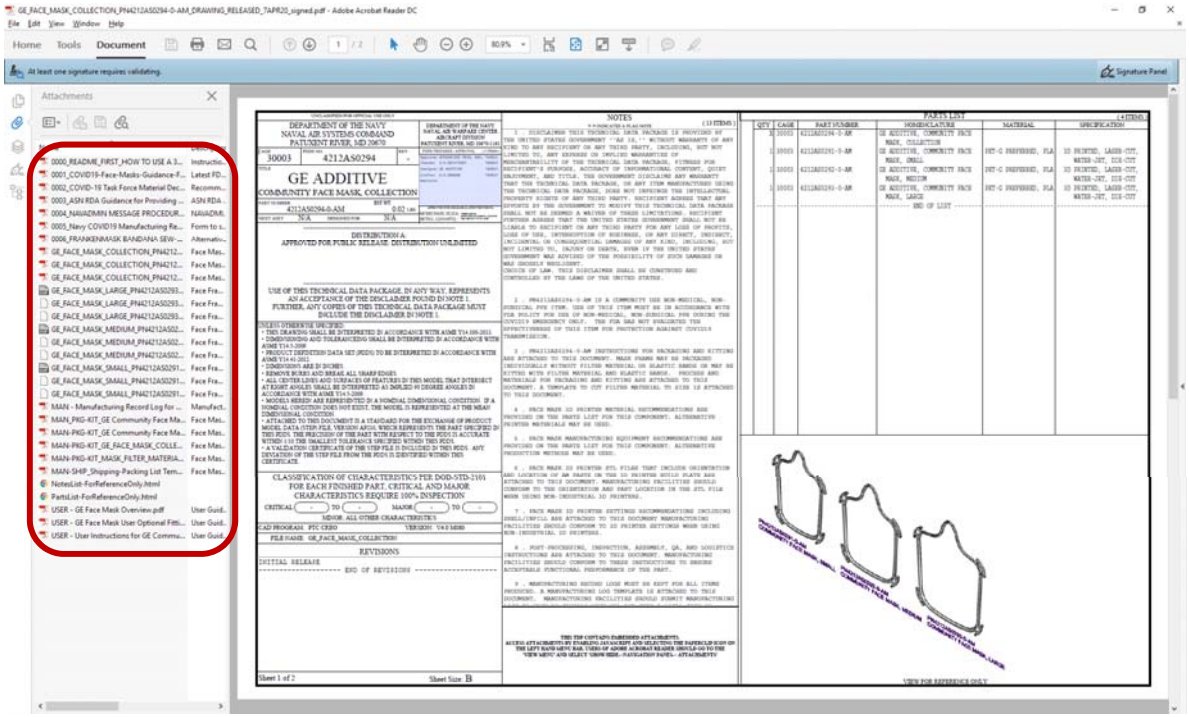
- Objective: Identify candidate AM parts onboard ships and influence creation of associated technical data packages (TDPs) for fleet utilization
  - Increase exposure to AM
  - Build database of AM parts

- Began as small data gathering sprint/AM showcase
- Grew into large scale multifaceted event

Photo Courtesy: navy.mil

Integrating AM components into the Navy supply system

Technical Data Packages/Approval



DON COVID-19 non-surgical facemask AM TDP

- Engage fleet and leverage logistics databases to ID priority components
- Interim process established for digitally sharing files
- NAVSEA AM TDP format established
  - DON COVID-19 facemask AM TDP (top left)
  - Supporting attachments within TDP promote repeatable AM parts
- Risk categorization box approach for AM TDPs
  - Yellow = Triage
  - Green = Low risk
  - Blue = Moderate-high risk
  - Red = Not AM capable at this time

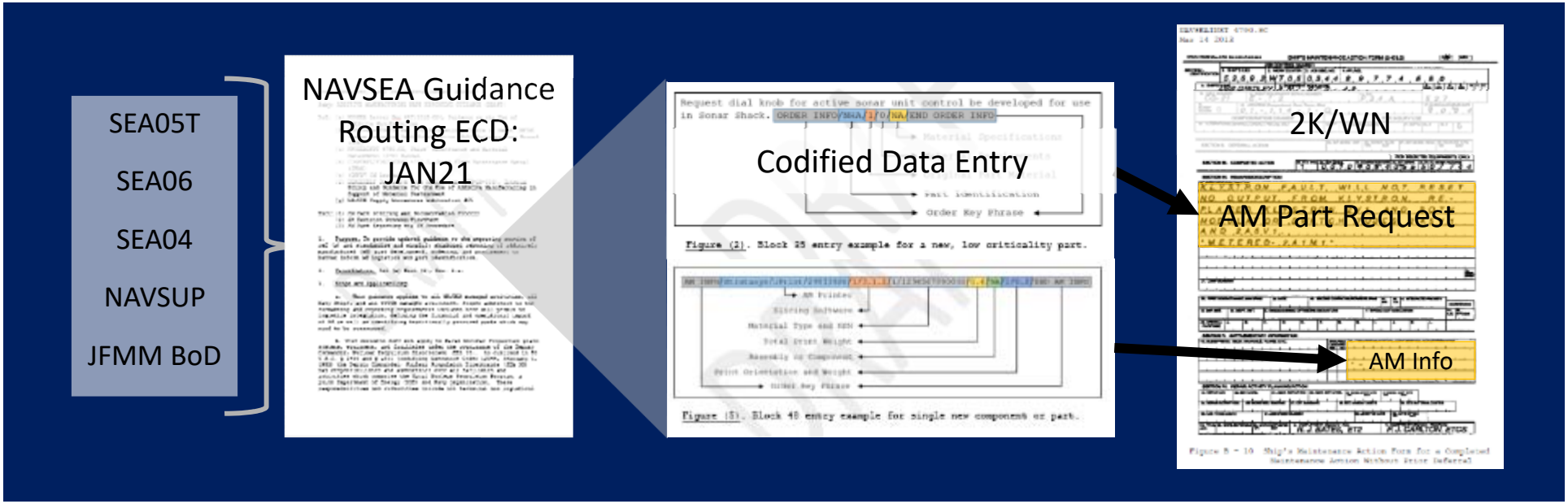
Submitted For Approval
Applications have been submitted for assessment.

Approved Low Risk Applications
Delegated to local technical authority (Chief Engineers - Waterfront or Ship).

Received Tech Authority Approval
Approved TDP which specifies materials and printers

Additive Manufacturing Part Reporting Guidance

- Current tracking of AM part demand, AM parts produced is manual (reported via Excel spreadsheet and email/hand-carry hard drive)
- New approach takes advantage of established processes and systems with sailor and shipyard experience – OMMS-NG and Automated Work Notification (AWN)
- Reporting as maintenance provides traceability and time metrics to support logistics tracking without further burdening sailors
- Proposed process is being piloted with USS MAKIN ISLAND. Additional pilot will initiate with an AWN ship after MKI pilot completes. Results will be used to update reporting process outlined in guidance update



Automated data collection

Afloat Advanced Manufacturing Overview

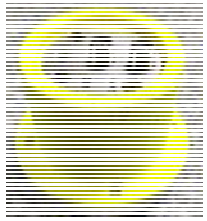
Afloat Advanced Manufacturing Strategy

AM Process Investigation → Shipboard Installations → R&D and Process Refinement → Afloat AM Program of Record

- Surface Ship Polymer AM
- Sub Polymer AM
- Surface Metal AM

Results to Date

- 8 Surface Ship Installations (FY19/20)
- 3 Sub Kits Delivered and one requested (FY20)
- 1 FDRMC Rota Installation (IOC FY19, FOC FY20)
- 50+ Sailors Trained
- 3 Underways Supported
- AIRPAC Requested SOW to fund additional CVN Installations



CAT2 CASREP for Satellite IP Antenna

Night Ops Porthole Covers

Light Bracket Bridge

Afloat Advanced Manufacturing

Metal AM

- Test candidate hybrid metal wire directed energy deposition (DED) and CNC systems
- Develop a requirements document and installation plan for shipboard installation
- Identify appropriate platform for FY21 install
- Preliminary R&D on melt pool effects from motion and vibration
- Development of preliminary SOPs and operator training/familiarization

Polymer AM

- Development of four AM packages for installation aboard CVNs
- Model development for vibration and motion effects on machines and materials
  - Influence of ship motion on printer components
  - Influence of shipboard vibration on printer components and parts and development of mitigation strategies
- Off-gas testing at NASA White Sands Test Facility
  - Determining emission products, amounts, and rates from processing thermoplastic with AM equipment

Apollo Lab

- Provide continued reach-back support for deployed equipment

Afloat Advanced Manufacturing Capabilities
Updated Polymer Equipment

Tier 1 – Desktop Polymer

- Non-critical shipboard repair applications and some NAVSEA-approved critical applications with corresponding technical data package
- Polymer desktop printer, laptop with design and AM processing software, reverse engineering kit and maintenance/feedstock sustainment for 1 year

Tier 2 – Industrial Polymer

- Suitable for non-critical and critical shipboard repair applications
- Expands to high temperature and engineering-grade plastics and composites
- Polymer desktop printer, engineering-grade (PEEK, PEKK, ULTEM, etc.) polymer printer, composite polymer printer, design and software suite (desktop / laptop computers)

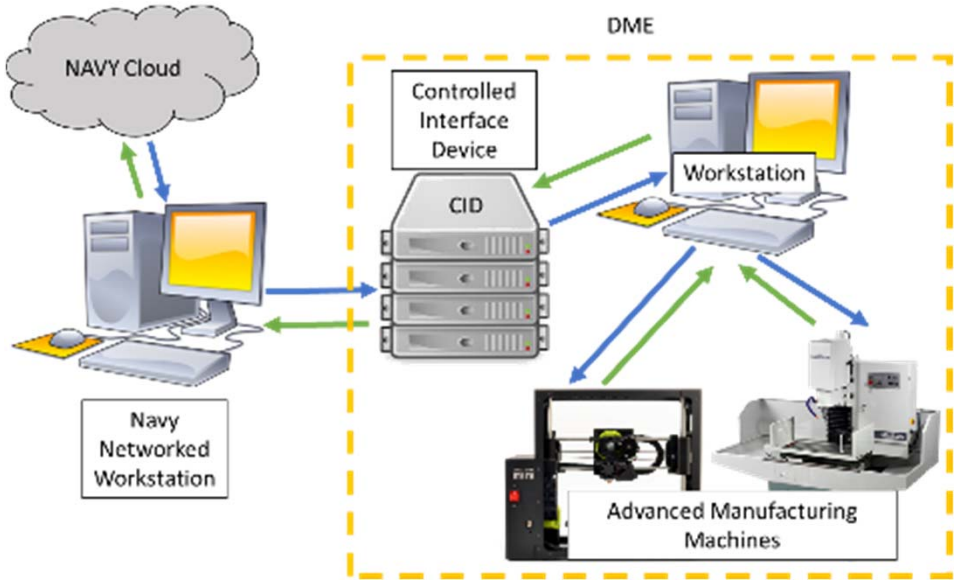
- Leverages lessons learned from over 2 years of shipboard installation support while also continuing R&D to expand critical polymer applications
- Expands shipboard printable materials to higher strength engineering plastics and polymer composites
- All equipment must be "hatchable", either whole or disassembled, to enable installation

Cybersecure Digital Manufacturing Enclave

- BLUF: Advanced Manufacturing capabilities on operational platforms is isolated and sub-optimal, due to inability to network AM computers or equipment. The development of a dedicated network enclave with a controlled interface to DoN networks will facilitate an appropriate security posture, enabling efficient utilization of AM capabilities.

- Notional Schedule:

• Domain Specific Tailoring Guide Routing	18 Aug
• Prototype enclave (shore)	Q3 FY21
• Evaluate enclave during HacktheMachine-Atlanta	21-23 March
• Enclave installation (afloat)	CY FY21



The DME will enable the secure transfer of Advanced Manufacturing Data between Ship and Shore to facilitate distributed manufacturing