AMMO Additive Manufacturing for Maintenance Operations

Meeting Name	AMMO Workshop – Day 2
Meeting Date	June 24, 2020

Plenary Introductions

Each breakout session provided an overview of the major takeaways from discussions held on June 23, 2020. For additional insights refer to the workshop materials posted on the All Partners Access Network (APAN).

AM Guidebook:

- Training as to how policy is implemented needs to be established. This will help develop guidebook language that communicates how policy relates to real world execution.
- Establishing a common data repository will help provide easier access to needed information to develop Additive Manufacturing (AM) policies.

AM Cyber

- Efforts exist within industry and across the DoD that are identifying cyber's impact to business efforts. With many businesses ranging in size the question becomes how a standard approach can be applied.
- There is a constant tradeoff between functionality and security with respect to part manufacturing. It is important security be prioritized to help ensure part produced using AM meet the required technical specifications.
- There is still an interest in blockchain, but it is recommended a separate working group be established to look into its applicability with respect to AM.

AM Data Management

- To improve wider data management adoption, it is recommended the DoD focus on producing additional workforce development efforts in data science.
- To improve data management practices across the DoD, it is recommended these practices be incorporated earlier into policy development efforts. The team is reviewing industry data management best practices to identify how this can be accomplished.

AM Workforce Development

- 70 roles are identified with the team actively mapping as many as they can to the AM body of knowledge. These roles will allow an individual's "reskill" and "upskill" time moving forward to be reduced.
- AM training is an area of focus moving forward. A number of options to support workforce training were discussed and will be considered in future discussions (e.g., leveraging routine training schools to "reskill" the workforce).

AM Metrics

- Cost and time are largely dependent on a part criticality.

AM Part Risk Categorization

- Risk categorization varies across the Military Departments (MILDEPs). A common theme across all MILDEP's is AM part approval and development are driven by urgency (e.g., warfighter readiness).
    - Aligning on common definitions across the services will help cross pollinate efforts and help standardize processes.

TDP Procurement in Sustainment Breakout Session:

The results from the TDP Procurement in Sustainment working group are below. Refer to the documents uploaded to APAN for greater detail (includes takeaways and survey questions/results). Contact Tony Delgado (Luis.Delgado@dla.mil) if support is needed to locate these documents.

NIST AM Standards:

- The two major standards related to AM:
    - American Society of Mechanical Engineers (ASME) y14.46
        - Addresses development of symbolism and semantics to communicate between designers, manufacturers, and inspection (e.g., focused on product definition with respect to Geometric Dimensioning and Tolerancing (GD&T)).
        - Draft of the standard is complete with the goal of transitioning to a full standard in 2020.
        - Complements International Organization for Standardization (ISO) Technical Committees (TC) 213 and ASME Y14 communities.
    - ASTM Preliminary Work Item (PWI) 52923
        - Addresses the packaging of information and data requirements to communicate between designers, manufacturers, and inspection (e.g., how do we package the information and communicate with vendors).
        - Tony Delgado is supporting use case development that will help identify additional information/data elements that need to be communicated.
        - Challenge: making the data elements in the data package agnostic, due to the number of materials part can be manufactured out of.
        - Next Step: begin to identify the data elements that fall into specific Technical Data Packages (TDPs).
    - Cyber and part security concerns are actively being worked into standards being developed but are not critical for TDP development at this point in time.
    - Configuration management processes need to be further defined to understand how the data elements with the TDP are viewed.
    - Due to the scale of the DoD's effort regarding AM, workshops and "boots on the ground" are the best methods to relay progress regarding standards development across the DoD.

Military Standard (MIL-STD) 31000

- Focuses on defining the requirements to develop a TDP and related management processes. The standard does not address anything related to AM parts being produced.
    - The Army sees AM information being supplemental data being "attached" to the TDP.
        - Section 3.1.35 Supplemental Data provides guidance on how supplemental information can be added to the TDP.
- The Army's TDP focuses on what the product will do once produced not the manufacturing information. This means manufacturing information is seen as additional information that can be added into the TDP.
    - Section 3.1.14 Detailed Specifications provides guidance around adding manufacturing components.
    - Industry recommendation: the manufacturing data should be in alignment with the criticality of the part being produced (e.g., high criticality means more specific manufacturing requirements should be included)
    - If AM specific manufacturing information is provided, its applicability will vary across the Military Departments (MILDEPs). This is a result of varying levels of AM capability compared to industry (e.g., number of AM machines to meet demand)
- With AM being integrated into the supply chain, it is important the TDP be "Dual Use" meaning a TDP would allow the part to be both traditionally and additively manufactured. Challenges to achieve this are below:
    - Clarity needs to be made as to what TDP components are required for traditional versus AM part development.
    - Clarity needs to be determined on how the DoD accepts or mitigates the level of risk associated with producing a part using AM with the current TDPs. (e.g., if a vendor does not have the machine specified to produce the part using AM, what are the approval processes to absorb the risk is if it is agreed the part can produced using another machine? If not having specified machine is a non-starter is that considered vendor exclusion?)
- Stereolithography (STL) files can be included in the TDP submitted. Manufactures prefer developing these files to allow for additional manipulation to fit their defined processes.
- Having a neutral Computer-aided Design (CAD) file is recommended, but with different CAD software being used will make this a challenge.
- Concern: the standard is ambiguous as to what information is provided in the TDP. If additional information is required to approve a part for AM, the level of effort (LoE) is anticipated to be high to gather it.
    - Potential Solution: develop a repository (such as the Joint Additive Manufacturing Model Exchange (JAMMEX)) where subject matter experts (SMEs) can gather the information required.
- A "request for variance" needs to be submitted if the AM part is slated for part time use.

Naval Air Systems Command (NAVAIR) TDP:

- TDPs produced focus on model based components. This means the TDPs are used for AM parts produced.

- TDPs developed do not include:
    - Manufacturing production instructions. TDPs produced follow the MIL-STD 31000 instructions. An exception to this rule is if the part's criticality is high enough this information can add in the technical data section of the TDP.
    - Supplemental documentation
- A Produce Definition Data Set (PDDS) is the primary document that supports TDPs produced. Information about the file is below:
    - An STL file is not included. This is captured during the manufacturing process.
    - Information is packaged into a Portable Document Format (PDF) since it is a standard file type accessible by all vendors.
    - Does not include supplemental information.
- Engineers own criticality determination for a part. Not owning all aspects of a part's development reduces risk and competition to produce parts using AM (e.g., reduction in competition = more vendors are able to produce the part)
- Future goals and next steps:
    - Goal: Develop a TDP development process that is CAD software and Product Lifecycle Management (PLM) system agnostic.
    - Finalize how the risk assessment process aligns to TDP development.
    - Develop training sessions to convert TDP into the various CAD software.

<u>DLA 2D3D Pilot</u>

- Goal: Provide an overview of Defense Logistics Agency (DLA's) partnership with external contractors and vendors (Deloitte and Siemens) to develop, pilot, and optimize a scalable, cost effective process to convert 2D design documents to 3D TDPs.
- 80 part files were part of the pilot. Parts were selected by applying business rules (e.g., 2D Drawing: contained Distribution A material only, was of low-criticality, and was hard-to-source) .
- To ensure file conversion consistency, the team allowed multiple vendors to convert a 2D drawing. The produced drawings were compared to ensure conversion accuracy.
- The converted files were packaged into the NAVAIR TDP template.
- Part approval after 3D TDP creation was not in the scope of the pilot effort. The focus of the project was accelerating the 2D to 3D conversion process.
- Applications and Impacts:
    - Increases vendor options (small businesses can more readily process 3D TDPs).
    - Improves mission readiness by reducing lead times for part production.
    - Lowers part cost through increased competition and reduction in processing time.
    - Improves part quality by reducing risks of design interpretation error.
    - Enables warfighters to print parts on demand.

<u>3Di Viewable CPI Effort</u>

- Engagement Goal: Analyze different viewing software and determine the best once to support MILSVC efforts.

- Software selection analysis consisted of an algorithm to identify how the software packages handle certain types of CAD files along with getting feedback on the data and end-use requirements (need to have and nice to haves).
- To ensure adoption moving forward, it is recommended policy be the lever to drive technical transformation.

3D Technical Data Package Development

- Based on MIL-STD-31000 (two different packages: 2D and 3D).
- It is easier to convert a file from 3D to 2D versus 2D to 3D.
- DLA's role in TDP development is to help manage downstream supply chain processes versus consuming and approving TDPs developed.
    - This will help bridge the information gap between the MILSVCs and manufacturing processes.
    - The future state vision to enable this includes leveraging the Digital Thread to enable a model based enterprise to securely share technical data throughout a part development lifecycle (refer to the 2018 Digital Engineering Strategy to learn more about achieving a model based enterprise).
    - High level steps the establish the Digital Thread:
        - Connect the Enterprise (e.g., data taxonomy and standards, IT Framework)
        - Build the Digital Thread
        - Create and Agile Supply Chain
        - Ensure a Robust Infrastructure
- The majority of 3D TDP files are in the PDF format (everyone has PDF format readers).

JAMMEX

- Mission: provide a secure web-based system to collaboratively share 3D models across DoD in support of AM.
- JAMMEX is built on system to system data connections with MILDEP data repositories. The Army is in the final stages of connection establishment.
- 175 total models are in the JAMMEX system to date since Go Live in January 2020.
    - The majority of the models currently in the system are Army.
- The MILDEPs have control of the access privileges for their repository within JAMMEX.
    - If a data file's risk level in a repository is green, the model can be accessed by all JAMMEX users by receiving a global access roll.
- There is flexibility as to what information is needed to post a design to JAMMEX due to TDPs not being standardized across the DoD.
    - Gap: This might result in incomplete data files prior to part manufacturing.
    - Gap: Incomplete data will affect the query language to pull specific model files.
- Recommended enhancements:
    - Setting up a configuration control board to vote a prioritize our development efforts. Some of the suggested decisions the committee will support are below:
        - Updates modifications to posted models
        - File version control

- Recent download tracking
- Dashboards to view JAMMEX activity at a glance

AM Guidebook Survey:

A series of survey questions were provided to the breakout session participants to identify topics to support AM Guidebook development. Refer to the survey results file posted on APAN for greater detail on the results.