PATH TO 450 PARTS QUALIFIED FOR ADVANCED MANUFACTURING

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ABSTRACT

The United States Army is leveraging Advanced Manufacturing (AdvM) methods to solve both operational and tactical readiness gaps. AdvM includes not only Additive Manufacturing (AM), but also traditional manufacturing capabilities in the field and at Army production facilities. The Tank-Armaments and automotive Command (TACOM) and the Ground Vehicles Systems Center (GVSC) Materials-AdvM Branch have developed a strategy of five critical path key words oriented on three Lines of Effort (LOE) that enables a disciplined process to deliver final use qualified parts manufactured by the Organic Industrial Base (OIB) as an alternate source of supply that will improve readiness of TACOM's combat and tactical wheeled fleets. Additionally, an alternate critical path has been developed to provide limited use parts for Battle Damage and Repair (BDAR).

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1. INTRODUCTION

The United States Army is utilizing advanced technologies to increase Operational and Tactical Readiness. It will result in an Army that is more lethal, versatile, agile, survivable, maneuverable, and more sustainable. To provide the required sustainment and operational readiness for a versatile Army, it is necessary to leverage Advanced Manufacturing (AdvM), with emphasis on Additive Manufacturing (AM) capabilities within AdvM [1]. As shown in Figure 1, TACOM and the GVSC Materials-AdvM Branch developed a disciplined approach called the 'Critical Path' that consists of five stages; Identify, Certify, Make, Qualify and Deliver that will enable execution to (1) Augment supply chain responsiveness in the Strategic Support Area *TODAY* to produce OIB (Final Use) parts, and (2) Empower forward Advance Manufacturing (AdvM) capability of the *FUTURE* Army to produce Field (Limited Use) parts at the tactical point of need in the Operational and Tactical Support Area as technology develops reducing the sustainment tail while increasing

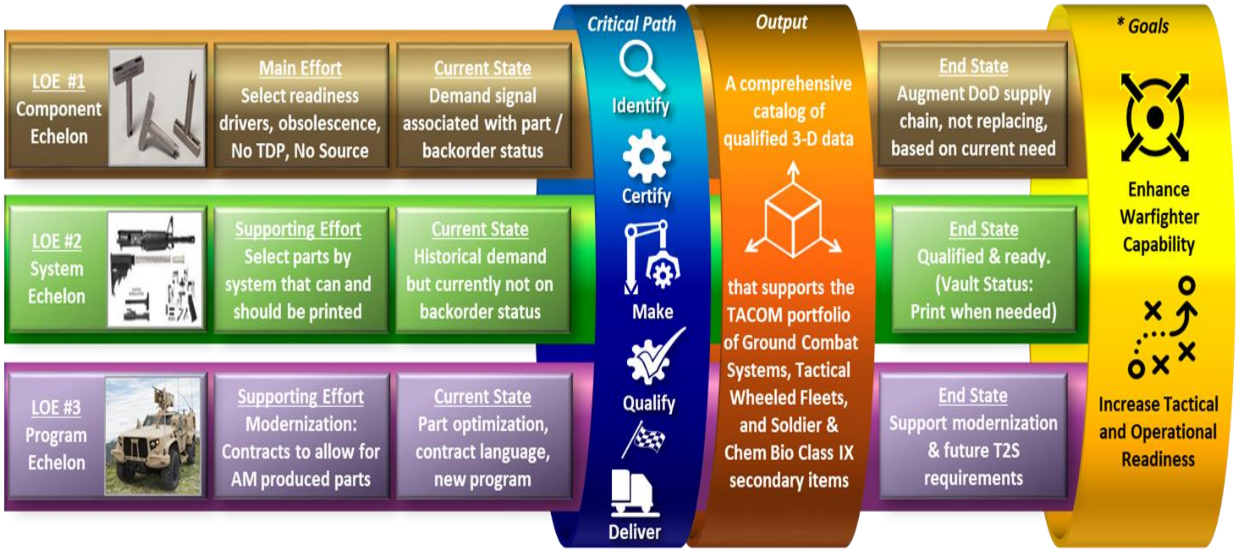

Figure 1: TACOM AdvM FY21-24 Execution Plan;
Echelons Concurrent and Complementary.
* Goals correlate to Campaign Plan end states [2]

readiness. These goals are tied directly to AM Campaign Plan objectives [2].

The first aim of this effort is to leverage Rock Island Arsenal-Joint Manufacturing Technology Center (RIA-JMTC) as a secondary source of supply capable of producing equivalent OEM permanent replacement parts. The second aim of this effort is to leverage forward AdvM capabilities to make BDAR temporary replacement parts.

An emphasis of this effort will be to utilize AM capabilities at Rock Island Arsenal, GVSC, and at the tactical point of need. The Army is making significant capital investment (equipment and infrastructure) in RIA-JMTC's Advanced Manufacturing Center of Excellence (AM CoE) where AM is to become a core competency [1].

This effort is a continuation of the 60 Day Challenge, which was issued on 25 October 2019 to the GVSC Materials-AdvM Sustainment team to utilize the RIA-JMTC to manufacture parts that were deemed readiness drivers for TACOM using AM. The Sustainment team at GVSC committed to a goal where RIA-JMTC would manufacture a minimum of ten (10) parts ready for qualification testing with an objective of thirty (30) parts [3]. Based on their success in identifying twenty-one (21) parts in the 60 Day Challenge, the Sustainment team is now tasked with identifying 450 parts and fully qualifying as many as possible in FY21.

2. QUALIFICATION FOR ORGANIC INDUSTRIAL BASE

The key activities to deliver a qualified replacement part via AdvM are outlined in the critical path as shown in Figure 2. The GVSC-AdvM Sustainment team receives parts from a variety of sources at the DLA, ILSC, PM and PEO levels, as well as from field requests. Additionally, many parts have been identified internally within the Sustainment team. Once it is confirmed that a Technical Data Package (TDP) is available, the next step is to determine if the parts are readiness drivers. Parts are then assessed for suitability and fit within the working equipment envelope for available additive and subtractive capabilities [3]. The Sustainment team then coordinates with the Configuration Manager (CM) and the legal team to determine if the Intellectual Property (IP) is

Identify	Certify	Make	Qualify	Deliver
▪ Original TDP available ▪ What is the size of the part ▪ Who manages the part ▪ Configuration manager (CM) / Sustainment Engineer agreement (SE) ▪ DLA agreement ▪ IP determination	▪ Determine method of mfg: additive or subtractive, or both ▪ Determine material that achieves original design intent ▪ Create 3-D data/STL file/G-Code ▪ Part prove-out ▪ Create test plan ICW CM	▪ Prepare for method of Mfg; additive or subtractive ▪ Make Part ▪ Post mfg operations ▪ Secondary post mfg operations	▪ QA – meets engineering specifications ▪ Execute Test Plan ▪ Receive CM approval ▪ Complete TDP ▪ Provision, if needed	▪ Qualified and Ready

Figure 2: Advanced Manufacturing OIB Critical Path.

government-owned. Additional work is completed with the CM to develop a qualification test plan.

Figure 3: M249 Spanner Wrench.

Next is to 'Make' the part using equipment at RIA-JMTC or GVSC, followed by appropriate quality controls and testing to ensure the part meets specifications called out on the original TDP. The 1st Army Additive Qualified Part to successfully complete the critical path is the M249 Spanner Wrench, shown in Figure 3. The TDP package approving the part for additive manufacturing was released on 15 July 2020.

3. QUALIFICATION FOR BATTLE DAMAGE AND REPAIR

The process to make parts in the field is a condensed version of the critical path. This process guides knowledgeable Allied Trades Warrant Officers to fabricate BDAR parts at the point of need using field capabilities, such as the Metal Working and Machining Shop Set (MWMSS) and other additive capabilities available in theater, until an OEM replacement part is received. BDAR parts do not need to meet all specifications annotated on the original TDP. Therefore, field manufacturing for BDAR purposes can bypass certain steps such as CM approval. To be entered into this process, a part must come from a field request or submission into the Repository for Additive Manufacturing Parts for Tactical and Operational Readiness (RAPTOR).

The part is then assessed for suitability for field manufacturing with the MWMSS capabilities. If a 2D drawing is available, then a 3D model can be created using software within the Sustainment team or the Technical Data Management (TDM) team. If a 2D drawing is not available, a physical part must be scanned to obtain the 3D model. Once a model is created or obtained, GVSC provides a recommendation including materials, equipment, and manufacturing instructions. Depending on criticality level, the part may also need to be proved out and additional testing may take place. The 3D model and recommendation are then submitted to RAPTOR so users in the field can download and manufacture parts as needed.

Figure 4: VMMD MKIII Reservoir and Cap.

The Husky Vehicle Mounted Mine Detector (VMMD) MKIII Reservoir and Cap, shown in

Figure 4, has successfully progressed through the steps for field manufacturing. The lead time from RAPTOR submission to approval was 7 days, with the approval date 01 March 2021.

4. LINES OF EFFORT

Three LOEs are identified in the TACOM AdvM FY21-24 Execution Plan, each with a defined end state that culminates in a Campaign Plan end state, shown in Figure 1 [1]. These LOEs have informed the execution of the critical path by TACOM and GVSC Materials-AdvM Sustainment. The corresponding three echelons (Component, System, and Program) are in concurrent execution and are complementary in their objectives to enhance capabilities of the Warfighter and to increase readiness.

4.1. Component Echelon

LOE 1 is defined as the Component Echelon, where component parts that drive readiness are qualified to augment the DoD supply chain. Qualifying individual parts based on current need is the main effort of the campaign. Candidate parts are selected from a variety of sources, including Obsolescence Reports which identify parts that exhibit low or zero availability due to new designs or supply chain process changes. Candidate parts can also be selected from Sustainment 339/335 Reports, which identify parts that are TACOM- or DLA-managed and currently have no source of supply. GVSC supports the Sustainment Engineering Division in qualifying the Army's OIB to produce all parts from these reports that are assessed as suitable for the Army's AdvM capabilities.

As part of this LOE, many parts have been pushed through the critical path that have been identified internally within GVSC. As opposed to assessing part suitability after parts have been selected as current readiness drivers, the reverse process is followed. More specifically, team members have scrubbed the Army's available technical data index, known as Windchill, for parts suited for AdvM based on the vehicle platforms they have been assigned. Subsequently, these parts have been run through a Defense Logistics Agency (DLA) tool that outputs Supportability Analysis-Stock Out Reports (SA-SOR). These reports provide more information about the inventory status of a specific component or assembly tied to an NSN including quantity of stock-on-hand, monthly usage, lead time, and contracts that are supplying a part. Candidate parts are then selected as readiness drivers based on these factors (zero stock-on-hand, high monthly usage and low stock-on-hand, no parts on contract, etc.).

Figure 5: Bradley Fighting Vehicle (BFV) Upper Squad Leader's Display Arm.

As this LOE is the primary effort and helping to close current demand gaps, a majority of the parts that have either been added to the critical path or fully qualified for OIB production fall within the Component Echelon. Among these is the M249 Spanner Wrench shown in Figure 1, as well as the Upper Squad Leader's Display Arm from the Bradley platform shown in Figure 5. Furthermore, the Bradley Display Arm is the 1st Army Additive Qualified Combat Vehicle Part.

4.2. System Echelon

LOE 2 outlines the System Echelon, a supporting effort where parts are qualified based on historical demand but are not currently on backorder status.

In examining past losses in availability and present lack of supply method, this LOE ensures that the OIB is positioned to deliver parts when a future demand signal arises. The System Echelon is especially valuable in the situation where extensive lead times exist. Essentially, the OIB is prepared and ready to produce an OEM-equivalent part when a part is requested.

Figure 6: Joint Light Tactical Vehicle (JLTV) Slotted Bushing.

The Joint Light Tactical Vehicle (JLTV) is a newly designed platform that has been in full-rate production since 2019. JPO JLTV is collaborating with GVSC to identify AdvM candidate parts. An example part in this echelon is the JLTV Slotted Bushing, shown in Figure 6. The bushing was fully qualified on 21 April 2021, a timespan of 4 months since the part was identified as a candidate. This effort will ensure that the selected candidate parts from the JLTV platform a source of supply before the vehicles are in theater where a demand signal for a component could occur.

4.3. Program Echelon

LOE 3 corresponds to the Program Echelon, an additional supporting effort with a focus on modernization rather than sustainment. To support this LOE, new contract language is in development to allow for AM-produced parts on new programs. Additionally, parts are selected based on opportunities for optimization, such as data from a reliability report showing part failures. From this input, parts can be redesigned with alternate materials or alternate production methods to reduce future failures. This echelon is well-positioned to support new vehicle programs, which may not have any current demand for parts or relevant data from SA-SOR reports.

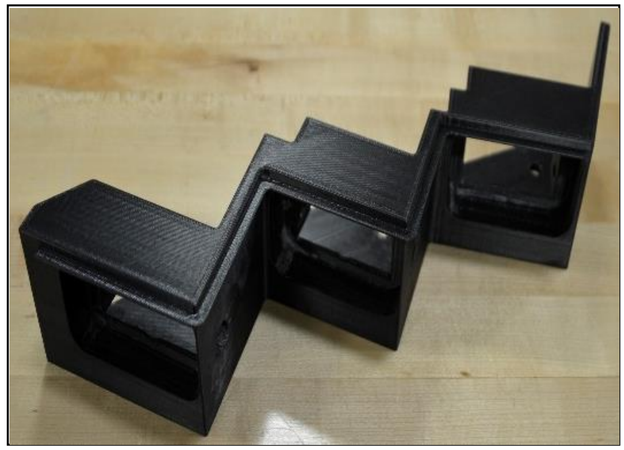

Figure 7: Infantry Squad Vehicle (ISV) Headlight Mount proof of concept.

The Infantry Squad Vehicle (ISV) platform is an example of LOE 3 in action. The ISV is a new platform manufactured by GM Defense, which started production in 2020. Supply contracts are in place for a majority of the platform's components. For the component parts with no supplier currently on contract, GM Defense contacted the Army to provide proof of concepts. One such component is the Headlamp Mount, shown in Figure 7.

5. CONCLUSION

The effort to deliver parts as permanent replacement parts has involved collaboration across the entire TACOM enterprise and GVSC; namely, TACOM AdvM Program Office, GVSC (TDM, Sustainment Engineering, Product Assurance and Test (PA&T), Materials – Characterization & Failure Analysis (CFA), and Analytics), PEO Ground Combat Systems, PEO Combat Support & Combat Service Support, Program Managers, DLA, ILSC, and industry CRADAs. Delivering parts as temporary replacement parts has involved coordination between GVSC, CASCOM, Allied Trades, Armaments Center, and PEO CS&CSS. At the time of writing, there are 630 active candidates and 102 parts that have been delivered for either OIB or field fabrication.

The execution critical path developed by TACOM and GVSC-AdvM Sustainment is laying the foundation for leveraging AdvM efforts that are at the cusp of initiating long term benefits for logistics support and sustainment to mitigate readiness gaps for Warfighters. AdvM will fundamentally change the way the Army designs, delivers, produces, and sustains materiel capabilities [4]. TACOM and GVSC leadership are leaning forward and are committed to achieving the Army Materiel Command's FY21 goal to deliver 5000 parts by AdvM methods.

6. REFERENCES

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