

RAPID SUSTAINMENT OFFICE

Annual Report 2023

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2023

2023 was a year of firsts for the Air Force Rapid Sustainment Office (RSO). From our Condition Based Maintenance Plus (CBM⁺) Program Office's Predictive Analytics and Decision Assistant (PANDA) toolkit becoming our first technology to achieve status as an official Air Force System of Record to our Advanced Manufacturing Program Office's (AMPO) Part Assessment and Cost Tool (PACT) leading the way as the Air Force's first advanced manufacturing application in Cloud One, the RSO broke new ground during 2023 in its Air Force sustainment modernization mission.

Additionally, with new leadership taking the helm in April 2023, the RSO hosted numerous distinguished Air Force senior leaders and introduced a "Maintenance Kill Chain" demonstration, integrating RSO's six technology focus areas into a single-part scenario, progressing from an initial predictive maintenance alert, to virtual/ augmented reality maintainer training, and finally to AM reverse engineering, part production, and delivery.

This RSO Annual Report looks back on a busy and successful 2023.

OVERVIEW

The RSO was established with a sustainment-centric focus to leverage mature, new, emerging, and disruptive technologies to dramatically improve Air Force readiness. Organized with a non-traditional Air Force construct based on agile principles and a short chain of command, we pioneer the acquisition and development of innovative and cost-effective sustainment technologies and tools for the betterment of the sustainment enterprise. The RSO is located near Wright-Patterson AFB, with a robust presence in the Air Force Life Cycle Management Center's (AFLCMC) Advanced Technology & Training Centers (Dayton, OH and Warner Robins, GA).

PURPOSE

ACCELERATE DELIVERY OF CRITICAL OPERATIONAL SOLUTIONS TO THE DEPARTMENT OF THE AIR FORCE SUSTAINMENT ENTERPRISE

MISSION

OPTIMIZE WARFIGHTER READINESS BY EXPLOITING TECHNOLOGIES TO REVOLUTIONIZE SUSTAINMENT OPERATIONS

VISION

TO BE THE PREEMINENT DEPARTMENT OF DEFENSE SOLUTIONISTS THAT CHALLENGE CONVENTIONAL MINDSETS, PUSH THE BOUNDARIES OF INNOVATION, AND GENERATE CONCEPTS THAT SOLVE PROBLEMS AT THE SPEED OF USER NEED

RSO RETURN ON INVESTMENT (ROI)

The Rapid Sustainment Office's projected ROI is exceeding expectations from the original RSO organizational stand-up and permanence document dated in 2020.

Additive Manufacturing (AM) and Cold Spray (CS) is projected to enhance USAF mission capabilities and re-imagine USAF supply chain, improving USAF readiness and providing a strategic advantage to the sustainment community.

ASSUMPTIONS/METHODOLOGY:

- AM completed 35 parts in FY23 that resulted in the net ROI.
- AM completed Cold Spray repairs on 4 repair areas on the F-15 Airframe Mounted Accessory Drive (AMAD), 6 repair areas on the GAU-8 Differential Gearbox Housing (DGH), and 7 repair areas on the GAU-8 Speed Reduction Gearbox Housing (SRGH).
- AM ROI is lower due to program office's inability to catalog additively manufactured parts as "qualified for production" within the organic industrial base. The lack of published qualification standards limits the ability to qualify commercial sources of supply.
- ROI is calculated comparing purchase cost of the part via FEDLOG/DLA vs. cost to produce part via AM at AF depot locations.
- The justification to produce such parts using AM is that it creates an additional source of supply and can diminish or eliminate future supply chain gaps.
- Automation & Robotics (A&R) numbers only include investments and ROI on the Robotic Laser Coating Removal system.
- A&R ROI is lower due to the low utilization rates. If used to full capacity, ROI would increase.



The RSO works with partners across the private and public sectors to bring the most advanced technology to the Air Force's sustainment enterprise. Some of our partners include: Headquarters Air Force, Air Force Sustainment Center, Air Force Research Laboratory, Major Commands, Federal Aviation Administration, Defense Innovation Unit, and the Defense Logistics Agency.

OUR PROCESS

Our approach is a three-step process with distinct but overlapping phases to ensure potential solutions are prototyped and tested quickly and optimized for success at scale. The RSO is focused on a set of six core technology areas where emerging and commercial technology solutions have outsized impact on increasing readiness and decreasing costs.





RSO PATHWAYS TO SCALE - LIGHTHOUSE UPDATE





In 2023, the third year of the Lighthouse project, the team progressed toward the attainment of an Authority to Operate (ATO) for the Lighthouse

Integration Technology Engine (LITE). This certification will enable the evolution of currently extant technology capabilities while paving the way for the transition of Lighthouse capabilities from test to production environments for operational user testing. The Lighthouse Team also entered a partnership with the Logistics IT Portfolio to create a proof of concept for a Classified Maintenance Information System capability, leveraging the powerful integration features in

LITE to connect the Integrated Maintenance Data System (IMDS) and Field Maintenance Command and Control (FMxC2) systems to new,

Lighthouse = Site Optimization Continued refining the approach of optimizing a location to gain maximum benefits from multiple new and emerging technologies

innovative technologies that enable enhanced data processing and management. The RSO executed a contract to stand up the next Lighthouse location in December 2023 to continue refining the value proposition while propagating technology modernization enterprise wide.



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TECHNOLOGY Focus areas

Artificial Intelligence & Machine Learning Advanced Manufacturing Automation & Robotics Data & Digital Environments Augmented & Virtual Reality Rapid & Austere Maintenance Environments



ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

We apply Artificial Intelligence and Machine Learning (AI/ML) to optimize fleet maintenance, increase aircraft availability, and minimize aircraft downtime.

Our most prominent use of AI is our CBM⁺ program. Employing AI has enabled us to improve maintenance data quality and evaluate large sets of aircraft sensor data and maintenance history to predict component failures. These applications enable our CBM⁺ program to save thousands of maintenance hours every year.



CBM⁺

Accomplishments

- PANDA designated as the Air Force's System of Record for CBM⁺ and Predictive Maintenance
- Iteratively delivered five major PANDA software releases, deploying new applications, capabilities, and features to over 800 Air Force users
- Deployed Sensor Based Algorithm (SBA) capability in PANDA for the C-5 and expanded nine additional failure modes for the B-1B
- Delivered CBM⁺ forecasts and alerts to over 3200 aircraft across 16 weapon system platforms
- Enabled 300+ predictive maintenance actions with RSO-deployed forecasts and alerts
- Hosted two CBM⁺ Stakeholders Summits, totaling over 600 attendees from DoD, industry, and academia

- Expand application of SBAs to new weapon system platforms and depot use cases
- Institutionalize and codify CBM⁺ enterprise strategies and solutions
- Drive innovative solutions to data challenges and gaps
- Explore novel applications of AI/ML technology to address sustainment challenges





ADVANCED MANUFACTURING



Overview

The Department of the Air Force AMPO scales organic capability and serves as the Air Force's focal point for the application of AM in matters related to acquisition and sustainment. The AMPO executes four major functions:

- Technology Assessment
- Airworthiness Certification Support
- Product Support Management
- Deployment Across the Enterprise

Vision

Empowering supply Chain Management and scaling AM across the Department of the Air Force to ensure continuous Warfighter advantage and readiness anytime, anywhere in the world

Accomplishments

 Transitioned 20 Stratasys F900 printers to mission essential units across nine Major Commands (MAJCOMs) and the National Guard Bureau. Coordinated efforts with Headquarters Air Force A4 staff offices, 72 organizational units and partnerships with industry to equip the future state of Air Force Polymer Additive Manufacturing (P-AM) and enterprise readiness

- Delivered a Stratasys F900 industrial P-AM printer to "Big Safari" for innovating and prototyping high-priority and dynamic requirements for programs that require rapid response to changes in operational environments
- The AMPO, in coordination with the C-5 System
 Program Office (SPO) and Air Mobility Command, rapidly repaired an unserviceable C-5 at Travis AFB with P-AM.
 This repair is a complete modification of an aerodynamic fairing for a C-5M Super Galaxy, incorporating printed 3D parts. The integration of P-AM printing technology into the maintenance and repair of the C-5M had a significant impact for the Air Force, offering faster repair times and the potential for cost savings, while making aircraft more operationally ready
 - Garnered approval from HAF/A4 to proceed with a deployment plan to scale AM technology across the Air Force. This execution includes the standardization of P-AM and Additive Repair (AR) processes within MAJCOMs to deliver an Air Force field level capability. The stand up of two Centralized Air Force Manufacturing Centers (CAFMCs) and fielding of 32 large format polymer printers across MAJCOMs and establishing advanced manufacturing capabilities in support of Air Force Materiel Command's (AFMC) vision for "One AFMC." AMPO's mission is to be a trusted advisor and collaborator to keep the Air Force ahead of industry trends, emerging technologies, and operational challenges
- Deployed the Part Assessment and Cost Tool (PACT) into Cloud One, the first in a series of applications to be deployed into Cloud One. PACT is a milestone in the Air Force's digital enabler effort to improve operational readiness and lay the groundwork for rapidly deploying new capabilities and technologies.
- The AMPO Cyber Team successfully established an Operational Technology Cyber Risk Tolerance Baseline creating the standard for development of secure manufacturing technological advancements and safeguards in future system networks in pursuit of ATOs for additive equipment
- Partnered with the AFLCMC Bomber and Mobility Directorates to host AM Roadshows, reaching over 250 logistics, program managers and engineers.
 Significantly increased the AMPO Data Exchange membership to over 600 technicians worldwide





- Updated DoDI5000.93_DAFI63-149 with an interim change to add requirements for AR implementation and strategy. This provides AR process execution procedures and supports the accountability of equipment such as CS and Directed Energy Deposition (DED) for RSO AMPO management and implementation
- The Defense Logistics Agency (DLA) cataloged and screened the first polymer part (B-2 Radio Knob) for organic production at the Reverse Engineering and Critical Tooling (REACT-II) laboratory at the Oklahoma City Air Logistics Complex (OC-ALC). Initial procurement for the knob equaled nine parts but significantly changed to 39 parts that will be produced organically for the Air Force
- Cataloged and screened the first metal part for organic production at the REACT lab at OC-ALC. The C-5 service door support assembly is a reengineered part, replacing the original aluminum support. The lab currently has a requirement for six parts under procurement from the DLA. The material advancements developed by printing Titanium Ti64 is expected to reduce the frequency of maintenance actions performed on the C-5Ms' upper service door and decrease life cycle sustainment costs slightly through this material solution for a fragile component, due to reduced lead times and a decreased frequency of part replacements
- Received the first request from DLA to manufacture a "no-bid" part. The part was an Intercontinental Ballistic Missile light housing that was designated for AM and passed over twice for procurement from DLA, who ultimately requested the Air Force reengineer and provision the item for procurement from either organic or industrial sources
- Provisioned the first 19 AM materials for Air Force procurement. Prior acquisition required the use of government purchase card or contract to purchase materials used in additive manufacturing. The team catalogued eight polymers and one expendable supply asset for Stratasys printers and 10 polymers from Essentium
- Executed 41 training courses and trained 105 members via online and on-site delivery. Certified 54 field level operators to advance AM capabilities across the CONUS/OCONUS
- Awarded Woodward FST machine a contract to advance Metal AM (M-AM) machine equivalencies, optimizing the cost, improving the efficiency of AM processes, and establishing an innovative methodology demonstrating equivalencies between assets and published data, agnostic of a designated printer by model
- Delivered 31 AM and 14 CS Test Reports to Defense Technical Information Center repository. This data will support the technical and engineering community implementation of M-AM and AR processes that lead to part acceptance, inspection and utilization of advanced manufacturing techniques for sustainment and repair
- Published the first edition of the CS Guidebook, a resource for maintainers and SPO engineers interested in CS and its application to repair parts with no suitable alternative repair solutions. The CS Guidebook not only serves as an introductory and educational tool to attract more CS customers, but it also contains best practices and lessons learned during enterprise expansion of advanced manufacturing applications



- Conditionally qualified REACT EOS M290 printer for Ti64 alloy printing, setting the path forward for further M-AM printing capability in the Air Force
- Delivered 15 M-AM Detail Specifications (Heat Treat, Powder, and Materials), defining requirements for processes and material performance for implementation of M-AM and support Technology Assessment Process (TAP) submittals for materials. These process and procedures support SPO Airworthiness determination to approve parts/components produced via M-AM
- Received Safe Use Determination circulars from the AFLCMC Engineering Directorate via the TAP for Antero 800NA fused filament deposition polymer and additively manufactured AISi10Mg aluminum alloy. These circulars provide cognizant engineers with sufficient data to make informed decisions and recommend consideration of these materials in non-structural, non-critical applications across the Air Force enterprise
- Updated Technical Orders (TO) 34A-1-1, 34A-2-1, 34A-3-1: TO 34A-1-1 will now include the addition of CS and Essentium printer facility requirements; TO 34A-3-1 will be updated with process information for Essentium's printing technology for organic use; and TO 34A-2-1 will be updated with new build plate data as well as heat treatment table additions for alloys being submitted to TAP
- Published three test reports on materials characterization for CS: DARC-AL6061 on AL 2024-T3 - High Pressure Nitrogen-VRC-Predictability and DARC-AL6061-G1H1 on Al 2024-T351- High Pressure Nitrogen-VRC- Property Characterization. These characterizations establish parameters for material combinations of CS bounded recipes involving the powder and substrate
 Performed successful CS demo on an unserviceable C-130 at Robins AFB to showcase possible Aircraft Battle Damage Repair capabilities in a deployed environment. Efforts capitalized on real-world applications and opened dialogue among all MAJCOMs and sister services

- Certify 21 Stratasys printers for aircraft maintenance and initially certify up to 84 technicians in 10 MAJCOMs, creating a network of industrial polymer printing capabilities to support the Warfighter from numerous organizational-level bases across the globe
- Grow the organic industrial base by transitioning five laser powder bed fusion metal printers to REACT OC-ALC, providing an increased capacity and expertise across the Air Force
- Field 17 Essentium 180 and 11 Essentium 280 printers for O-Level maintenance support and utilization. These printers provide support for the development of tool, fixtures and jigs up to the printing of parts with airworthiness considerations (Essentium 280). The Essentium 280 will have a complete sustainment plan completed to include the development of technical orders and addition to the AMPO qualified printer list
- Publish TO 34A-4-1 CS Process to standardize Warfighter employment of additive repair systems. This TO
 will aid in the development and approval of CS repairs that can be transitioned to the organic industrial base to
 support mission generation. Additionally, it provides critical information including training requirements,
 facility guidance, safety, and system upkeep and maintenance required to perform AR on parts/components
 with airworthiness considerations and impacts
- Continue deployment of the CAFMC at Travis AFB to increase O-Level advance repair employment supporting weapon system readiness. Integrate the CAFMCs into Air Force Sustainment Center Repair Network Management process to increase the SPOs' abilities to identify field level repairables and decrease Not Mission Capable Maintenance rates
- Advance M-AM by growing the approved printer list to include the GE Concept laser systems. Develop an Air Force TO to detail specification for material and inspection processes to support Depot level maintenance across the Air Logistics Complex
- Procure funding for necessary equipment for the Air Force Metrology and Calibration Program Office Laser Lab to calibrate the Laser Power Monitor for the EOS M290 in the US
- Continue Woodward FST contract to advance AM machine equivalencies progresses with additive trial builds and test plans. Complete mechanical, metallurgical, and physical testing
- Continue existing M-AM F-357 Aluminum materials characterization projects to validate machine and material processes to deliver the first functional prototype of a complex hydraulic component
- Establish procedures for receiving and reviewing an Integrally Bladed Rotor Repair Capability within the ALC, including scanning data and developing an adaptive blend solution for use in Robotic and/or Machining Cells to remove damaged areas. Additionally, develop a DED repair process that relies on process modeling to define material requirements and reduce the time required for initial process parameter development, providing an accelerated path to meet material requirements and a validated repair





AUTOMATION & ROBOTICS



Overview

The RSO applies automation and robotics to eliminate maintenance tasks that are repetitive, labor-intensive, or hazardous, making it possible to accomplish these tasks safely and efficiently with a high degree of accuracy.

Accomplishments

- Replaced/upgraded robotic F-16 radome de-paint and paint capabilities at Ogden Air Logistics Center for improved workload throughput. The system is capable of meeting current workload requirements using 25% of its operation capacity and will save 3.5 labor hours per radome and could save up to 67 labor hours per part. The system's design allows for near future scale activities to additional aircraft
- Expanded robotic match drilling efforts for the replacement of aircraft skins to additional part types, including internal structures such as fighter bulkheads
- Developed a minimum viable product electronic inspection tool to provide verification of accuracy related to the removal of fasteners via the previously developed Electro Discharge Machining tool, which is up to 20x faster than the traditional manual twist drill method. The tool also reduces the chance of accidental damage due to "drill walking"

- Scale activities related to the previously developed Electro Discharge Machining tool and Electronic Inspection tool to further aid the removal of aircraft fasteners
- Scale activities related to a previously developed robotic metal sheet forming cell that can be used for low quantity/high mix part production
- Scale activities for a fighter-sized robotic intake painting system that can be both mobile and adaptable to multiple aircraft models
- Automation of the repetitive, time-consuming Software Integration Laboratory human testing requirements associated with Line Replaceable Units that have been repaired





DATA & DIGITAL ENVIRONMENTS



Overview

We standardize maintenance and sustainment data collection to serve as a connector of data sources across the Air Force. Our process is to collect the data, identify what's useful, turn it into a functional format, and then leverage it to inform smart and proactive decisions.

Accomplishments

- Used the FiberTRAX system to install fiber optic cable on the surface of the apron at two Nellis AFB aircraft maintenance units (AMUs)
 - Enabled hardline NIPRNet access at the Lightning AMU, providing connectivity to the F-35 automated logistics information system
 - Provided the future capability to connect wirelessly to NIPRNet at the Strike AMU
- Successfully enabled Beacon Interactive to transfer the Aircraft Infrastructure Readiness System (AIRS) into their Cloud One integration environment. The files are confirmed to be within the environment, with the vendor team working to configure the environment for use
- Accomplished the final technical demonstration of a local mesh data network at Luke AFB, showcasing the technology's capability to enhance tactical decision making and Unit Commander awareness of the physical location and health of critical aerospace ground equipment. This technology supports Secretary of the Air Force's Operational Imperatives 5 and 7 by extracting and aggregating system diagnostic data via a low probability of intercept mesh network, assuring logistics and support assets are available for airpower generation
- Built FMxC2 Maintenance Information System (MIS) Search Functionality for program office partner. This project advances the on-going work toward the SIngle MIS Initiative in the Lighthouse program creating synergy and maximizing stewardship of tax-payer funds
- Hosted a Tech Order Summit for the AFLCMC Bombers Directorate
- Monopolized the use of the AIRS in the creation of a new classified logistics system, creating product synergies and ensuring stewardship of tax-payer funds
- Forged relationship with Air Force Special Operations Command to create a new logistics tool to streamline and shorten their deployment processing time of cargo and personnel

- Deliver mature AI solutions for rapidly accessing accurate data to improve maintenance data documentation
- Identify and implement new digital tools to improve flight line
 maintenance operations processes
- Streamline Small Business Innovation Research (SBIR) processes and projects to holistically align with the warfighter mission







AGILE COMBAT TECHNOLOGIES (ACT)

Augmented & Virtual Reality Rapid & Austere Maintenance Environments

Overview

The ACT Team provides Airmen with effective tools, leveraging modern, cross-cutting technologies to reduce the Air Force's logistical footprint and expand its extended reality capabilities to enable multi-capable Airmen. The ACT Team is working toward becoming the Air Force's leading office for Extended Reality (XR) implementation and solution-oriented technologies in home and austere environments.

Accomplishments

- Transitioned the \$51M MOTAR STRATFI project from the Air Education and Training Command and executed the first contract in cooperation with AFLCMC Bombers Directorate and Air Force Global Strike Command (AFGSC), enabling a key capability for extended reality content hosting and distribution
- Executed multiple contract awards that resulted in the acquisition of \$1.2M in rapidly deployable structures and SBIR Phase 1 and 2 awards for a small form factor cargo mover in support of AFSOC and US Indo-Pacific Command. These technologies will be utilized in support of AFSOC's Mission Sustainment Teams at operational exercises in FY24 and FY25
- Executed the delivery of two Solar Power Integrated Structures (SPIS) to the 437th MXG for Mobility Guardian 2023, in less than 45 days. The SPIS significantly reduced fuel to only 15 gallons over the 18-day exercise
- Hosted the RSO's Extended Reality Working Group with nearly 100 attendees, resulting in the largest Air Force working group designated for XR efforts. Event featured briefings and collaborative discussions
- Assisted 51st MXS in Osan, South Korea with preparations to acquire an Advanced Deployable Aircraft Maintenance System for use as a transition room after a crucial Corrosion Control Facility was shut down. Coordinated across RSO and Osan teams to procure the structure. The effort will greatly increase the working conditions of our Airmen and drastically reduce daily set up time spent on temporary "tent and vent" maintenance solutions, while enabling continued corrosion control activities and preventing mission degradation
- Completed user testing of the Maintenance Augmented Reality System (MARS) across 4 locations, encompassing over 100 test iterations. Results indicated that users were able to accomplish maintenance tasks with significantly less errors or required Subject Matter Expert interventions while using MARS compared to current maintenance completion methods

- Collaborate with AFSOC to support the Office of the Secretary of Defense's Rapid Defense Experimentation Reserve with capabilities in risk reduction and operational exercises
- Support Air Force XR Strategy for execution and fielding of XR capabilities
- Develop enhanced tele-maintenance capabilities to support multi-capable Airmen and Agile Combat Employment initiatives



OUR Accomplishments

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KEY ACCOMPLISHMENTS

The RSO identifies emerging technologies, applies and validates through rapid prototyping, then deploys and scales the technologies over time. Moving technology from one phase to another is an impressive feat that showcases the RSO's ability to rapidly deploy emerging technologies.



- PROJECTS IN FIRST APPLY (14)
- **PROJECTS IN TRANSITION (3)**
- PROJECTS ON WAY TO MVP (11)
- O PROJECTS SHELVED (3)
- MVPS ON PATHWAY TO SCALE (14)

2023 SIGNIFICANT EVENTS AND ADVANCEMENTS





LOOKING AHEAD: 2024 SIGNIFICANT EVENTS

04



2024 SIGNIFICANT EVENTS

Advanced Manufacturing Program Office (AMPO) Technical Interchange Meeting

February 2024 | Dayton, OH

This technical interchange meeting brings together the Air Force Advanced Manufacturing community to share advancements, exchange ideas and foster cooperation and collaboration among program offices and learn more from experts in Advanced Manufacturing and Cold Spray technologies.

Department of the Air Force (DAF) Advanced Manufacturing (AdvM) Strategy Workshop

March 2024 | Dayton, OH

As part of the planning for developing the DAF AdvM Strategy, in partnership with the University of Dayton Research Institute and Dayton Aerospace, the AMPO will host organizations from across the enterprise to identify AdvM capabilities and gaps for increasing warfighter readiness.

Logistics Officer Association Symposium

March 2024 | St. Louis, MO

A yearly premier event dedicated to enabling interactive exchanges among logistics, acquisition, and technology professionals from across the Department of Defense, defense industry and academia.

Augmented & Virtual Reality (AR/VR) Enterprise Working Group

April 2024 | RSO Hangar-01

The RSO is hosting the next HAF/A4L working group for AR/VR. This working group will focus on solidifying roles, responsibilities, and strategy for AR/VR technologies and sustainment across the MAJCOMs.

CBM⁺ Stakeholder Summit

May 2024 | TBD

The CBM⁺ Stakeholder Summit invites CBM⁺ stakeholders across DoD, industry, and academia to participate in valuable presentations, training sessions, and discussions to share successes, best practices and techniques, and lessons learned, promoting unity and collaboration across the DoD CBM⁺ community.

DoD Maintenance Symposium

December 2024 | Salt Lake City, UT

A yearly premier event dedicated to enabling interactive exchanges amongst the maintenance community. The RSO will attend to develop key partnerships and expand its customer base.

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