

MAINTENANCE INNOVATION CHALLENGE

DECEMBER 18–21, 2023
SAN DIEGO, CALIFORNIA





SUSTAINMENT

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
3500 DEFENSE PENTAGON
WASHINGTON, DC 20301-3500

MEMORANDUM FOR 2023 DOD MAINTENANCE SYMPOSIUM PARTICIPANTS

The Maintenance Innovation Challenge (MIC) aligns with this year's 2023 DoD Maintenance Symposium theme, "Cultivating Global Integrated Sustainment in a Contested Environment," by highlighting and rewarding innovative solutions designed to improve and integrate sustainment operations in challenging operating conditions. The MIC provides an outstanding opportunity to identify, emphasize, and optimize promising innovations and technology within the sustainment community.

The MIC's objective is to elevate and expand sustainment innovation beyond new technology, to include value-added partnerships, resourcing strategies, business practices, processes, or any other transformative capabilities that make maintenance more agile, effective, and affordable. This annual competition raises awareness across our community to a myriad of new and promising technologies and innovative processes that present the best opportunities to positively impact DoD sustainment.

With assistance from the DoD Joint Technology Exchange Group, we thoroughly evaluated the submissions and selected six finalists. Senior maintenance and sustainment leaders, including the Military Services' Sustainment Technology Executives, selected this year's winner.

Additionally, the six finalists will be presenting their maintenance innovations during the MIC breakout on Monday, December 18, 2023, at the 2023 DoD Maintenance Symposium in San Diego, CA. Continuing with tradition, attendees at the MIC breakout session will select the MIC People's Choice Award winner from the six finalists based on their live presentations. Winners will be announced and formally recognized during the Symposium's plenary on Tuesday, December 19, 2023. I encourage your participation in this breakout session to engage with some of the most forward-thinking individuals in our community.

The six finalists will also showcase their maintenance innovations on storyboards in the co-located Defense Maintenance and Logistics Exhibition. Lastly, all qualifying abstracts and quad-chart submissions are published in this annual MIC publication.

Please join me in congratulating this year's MIC finalists, both winners, and everyone who contributed their efforts to share the innovative ideas highlighted in this Maintenance Innovation Challenge publication. Well done!

Sincerely,

A handwritten signature in black ink, appearing to read "Vic S. Ramdass", with a long horizontal line extending to the right.

Vic S. Ramdass, Ph.D.
Deputy Assistant Secretary of Defense
for Materiel Readiness

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THE MAINTENANCE INNOVATION CHALLENGE (MIC)

Background

The importance of sustainment innovation development and adoption is increasingly relevant as DoD strives to accelerate materiel availability by improving the effectiveness and viability of the Defense industrial base, including our organic capabilities. The COVID-19 pandemic has again illuminated the gaps we have in our domestic resources, industrial capabilities, and supply chain approaches and has highlighted the innovative spirit and world-class capabilities resident in our sustainment community during our response. Novel innovations can provide significant advances in capabilities to our sustainment enterprise and benefit other military and domestic challenges. The Military Services, Defense agencies, industry, and academia, are all actively pursuing innovative technologies and processes to improve maintenance capability, effectiveness, and efficiency.

Purpose

The objective of the Maintenance Innovation Challenge (MIC) is to elicit and share unique, enhanced maintenance capabilities, to potentially elevate and expand sustainment innovation beyond new technology, to include value-added partnerships, resourcing strategies, business practices, processes, and other transformative capabilities.

MIC SUBMISSION EVALUATION

Evaluation Process

MIC submissions are reviewed and evaluated by the Joint Technology Exchange Group (JTEG) Principals, composed of DoD logisticians representing each Military Service, and the Defense Logistics Agency (DLA). The JTEG selected six finalists from the group of 89 submissions. In the second phase, the six finalists were evaluated by senior DOD logisticians who ultimately selected an overall winner.

The Evaluation Criteria used to judge the submissions are:

- Innovation's impact on maintenance
- Impact on Maintenance
- Technical Maturity
- Cross-Service Application
- Potential to Benefit Maintenance
- Assessment of how viable the innovation is to transition to DoD maintenance

Finalists Presentations

At the 2023 DoD Maintenance Symposium, the six MIC finalists, selected by the Joint Technology Exchange Group (JTEG), will present their new technologies, processes, or business practices to the symposium audience during a breakout session. Attendees at this breakout session will have the opportunity to select the MIC People's Choice Award based on the six presentations. Additionally, all who submit a qualifying abstract and quad-chart are published in this MIC book.



MIC Winners

The MIC winner as selected by a panel of senior DoD logisticians, and the "People's Choice Winner" will both be announced and receive high profile DoD-wide recognition during a DoD Maintenance Symposium plenary session where they will receive striking trophies. Additionally, the National Center for Manufacturing Sciences has offered to provide each winner \$50,000 of in-kind support.

This MIC book contains the abstracts, quad charts, and contact information for all 89 innovations submitted, and is a great tool to utilize for information exchange as well as keep as a reference source.

JOINT TECHNOLOGY EXCHANGE GROUP (JTEG)

The purpose of the Joint Technology Exchange Group (JTEG) is to improve coordination in the introduction of new or improved technology, new processes, or new equipment into Department of Defense depot maintenance activities. The JTEG will seek ways to better leverage technology improvements in depot maintenance through collaboration to support the higher DoD goals of improving effectiveness and efficiency.

JTEG Mission:

- Provide a forum for the exchange of information on new technology, processes, and equipment developments within the DoD maintenance community
- Collect, analyze, and disseminate DoD maintenance requirements for new technology, processes, and equipment.
- Serve as an advocate for new technology or equipment with cross-service potential to increase efficiency

JTEG Community:

The JTEG community includes anyone in DoD, industry, or academia interested in exchanging information associated with DoD maintenance. The JTEG is overseen by a panel of representatives, or Principals, from each of the military services, the Defense Logistics Agency, the Joint Chiefs of Staff, the Office of the Deputy Assistant Secretary of Defense for Materiel Readiness – (ODASD-MR), and an industry representative.

JTEG Monthly Technology Forums:

The JTEG conducts virtual monthly technology forums that provide opportunities for the DoD maintenance community to exchange information and share ideas. The forums feature a different maintenance topic each month and are open to the public. The topics generally fall into one of three areas:

1. Technology focus areas which feature a specific maintenance capability such as digital maintenance, additive manufacturing and repair, or advanced wiring inspection capabilities.
2. Maintenance and sustainment processes such as better ways to adopt new capabilities, workforce development, or safety
3. Organizational perspectives which describe maintenance capabilities and initiatives at specific DoD maintenance activities such as maintenance depots or research centers.

JTEG Website:

Industry, DoD, and academic personnel can use the JTEG website, <https://jteg.ncms.org>, to view and share information on new technology, processes, and equipment developments that have proven benefits or potential applications involving depot maintenance. Visitors are welcome to review new and exciting technology posted on the website or reach out and contact the JTEG Principals listed on the website. In addition, all past and future JTEG technology forums are posted on the website.

THE JTEG PRINCIPALS AND KEY REPRESENTATIVES



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Technology Implementation

THE NEED FOR SPEED

CTMA: 25 Years of Driving Collaborative Maintenance & Sustainment Innovation

What Is CTMA?

For 25 years, the CTMA Program, operated by NCMS, has provided a streamlined and agile non-FAR-based contracting vehicle.

CTMA enables DOD partners to collaborate with industry and academia, aimed at solving specific maintenance and sustainment (M&S) challenges. Through CTMA projects, technology developed by industry and academic partners can be demonstrated, evaluated, and validated, thereby helping to implement innovative technologies that support the DOD's most critical M&S needs.

Through CTMA, the DOD can leverage our trusted network of technology experts to apply state-of-the-art solutions, including advanced data analytics and digital enterprise, to maximize our warfighters' readiness.

The CTMA Value

The CTMA process offers great benefits for all participants.

DOD Benefits	Partners Benefits
Advanced technologies that improve military capabilities	Access to DOD facilities and equipment
Testing and evaluation of technologies prior to acquisition	IP protection guaranteed by cooperative agreement
Reduced cost of R&D through leveraging and cost-sharing	Reduced time between innovation and commercial production
Streamlined contracting and cost accounting	Opportunities to commercialize inventions
Access to industry and academic expertise and knowledge	Opportunities to enhance DOD preparedness & corporate objectives

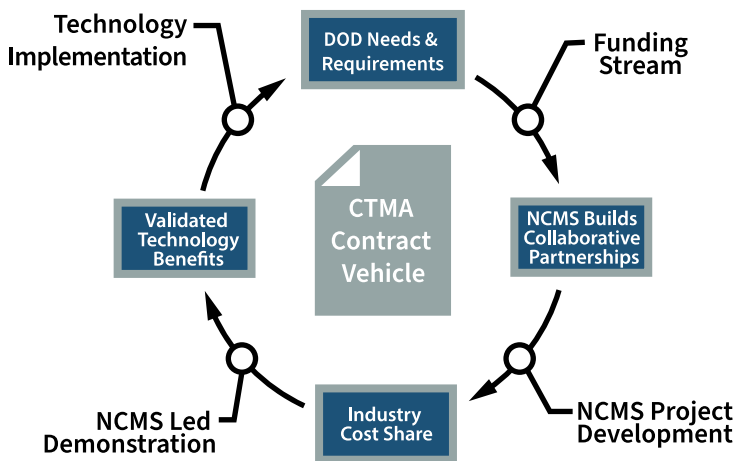
Technology Focus Areas

CTMA initiatives can target any of the following nine M&S areas:

- Advanced/Additive Manufacturing
- Business IT and Analytics
- CBM+/Predictive Maintenance
- Coating and Corrosion Prevention
- Energy, Environmental, Health, and Safety
- Enhanced Inspection
- Facilities and Industrial Process Modernization
- Reliability Improvement (Hardware)
- Workforce Development/Visualization

Since the CTMA program's goals are fully aligned with the goals of the DOD's Maintenance Innovation Challenge, NCMS is a proud partner of this event.

How CTMA Works



Every CTMA project begins with DOD needs and requirements and utilizes the above framework to achieve an implementation-ready technology solution.

Maintenance Innovation Challenge (MIC)

NCMS is pleased to support the MIC by providing \$50,000 to both the Overall MIC Award winner and the People's Choice Award winner.

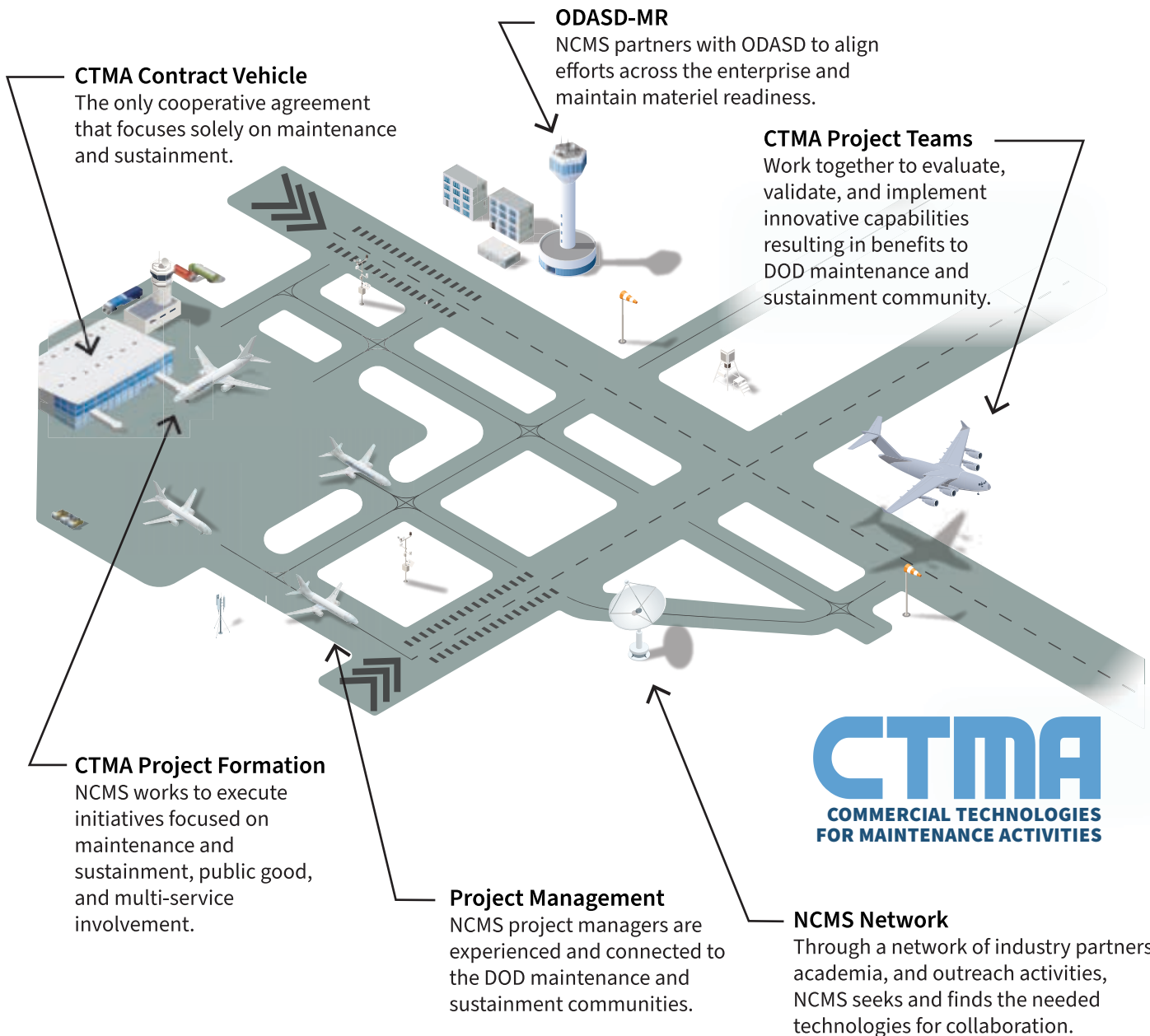
NCMS has a long-standing interest in the MIC, as it provides a wellspring of innovative capabilities that can be implemented throughout the DOD.



COME SEE US IN
BOOTH #747



The CTMA Airfield



Contact: Debbie Lilu, Vice President, Mx and Sustainment, Business Development, NCMS
Debbie.Lilu@ncms.org or (734) 262-0758

CONGRATULATIONS TO OUR 2022 MAINTENANCE INNOVATION CHALLENGE WINNER!

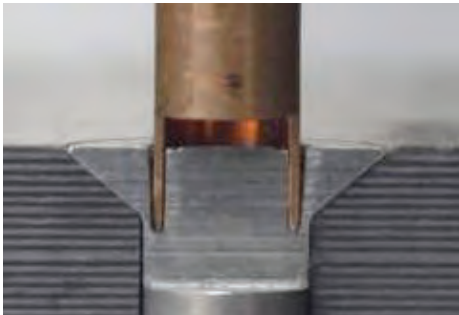
Overall Winner of the 2022 Maintenance Innovation Challenge:

E-DRILL: A NEW WAY TO REMOVE AIRCRAFT FASTENERS

Jared Wright from Naval Air Systems Command and Jim Becker from Perfect Point EDM

Perfect Point EDM, has invented a new way to remove aircraft fasteners: the E-Drill. E-Drill uses a semi-automated, plunge cut Electrical Discharge Machining or “EDM” tool to remove a fastener in seconds. Artisans use provided tooling to properly align E-Drill’s copper electrode, pull the trigger, and E-Drill completes the drilling process. The removed fastener is in two pieces: head and pin. No shavings.

E-Drill uses vacuum assisted alignment jigs which enable E-drill to access more than 95% of aircraft fasteners, including upside down, curved, or vertical sections. Studies show at least a 75% reduction in aircraft damage, and a 20 times reduction in time to remove a fastener. On August 18, 2022, NAVAIR issued an official Authorization Letter, clearing E-drill for use on an initial set of general use cases.



Peoples' Choice Winner:

FIBER OPTIC FUSION SPlice REPAIR

Brett Jordan from Air Force Research Laboratory and Technical Sergeant William Kesler from the Aircraft Battle Damage Repair Technical Support Office, Air Force Sustainment Center

Unlike copper wiring, there is no approved procedure for repairing fiber optic cables onboard aircraft. The current practice is complete, end-to-end replacement of damaged fiber optic cables on aircraft. The procedure is intrusive, time consuming, and negatively affects aircraft readiness.

The Air Force Research Laboratory’s Electrical and Electronic Materials Evaluation Team and Aircraft Battle Damage Repair Office worked together with Aurora Optics, Inc. to adapt a commercial, fiber fusion-type of repair technique to work with military-type fiber cables. The starting point was a Boeing approved kit for use in commercial Boeing aircraft. Fiber Optic Fusion Splice Repair tooling allows permanent repairs to broken fiber cables with a minimum increase in tooling for maintainers. A total of eight fusion splice repairs were made, all meeting the minimal signal loss requirements. Two splices were made on an F-35A Lightning II, and one on an F-22 Raptor. The field test demonstrated that a trained maintainer with the proper equipment can perform an acceptable fusion splice repair on an aircraft in roughly 20 minutes, while the current practice of replacing a damaged fiber optic cable can take hours or days.



2023 MAINTENANCE INNOVATION CHALLENGE

Overview:

The annual DoD Maintenance Innovation Challenge (MIC) provides an opportunity to highlight the innovative spirit and world-class capabilities resident in our sustainment community. This year the MIC received 89 submissions from which the Joint Technology Exchange Group principals selected six finalists based on criteria including technical maturity, feasibility, and cross-Service applications.

Moderator:

John Shultz, Director, Enterprise Maintenance Technologies, Office of the Deputy Assistant Secretary of Defense for Materiel Readiness

Finalists:

3-in-1 Portable Surface Preparation System

Author: Jeff Piascik, Atmospheric Plasma Solutions, Inc.

Presenters: Jeff Piascik and Scott Meller, Atmospheric Plasma Solutions, Inc.

Blue Light Scanner

Author: Leonel Narvaez, Corpus Christi Army Depot

Presenters: Leonel Narvaez and Thomas Sandoval, Corpus Christi Army Depot

Identifying Aircraft Pressurization Leaks Using Acoustic Imaging

Author: Edward H. Marchbanks, 439 Maintenance Squadron, Westover ARB

Presenters: CMSgt Edward Marchbanks and SRA Tristan Mckee, 439 Maintenance Squadron, Westover ARB

Marine Corps Platform Integration Center (MCPIC) Electronic Quality Management System (eQMS)-USMC LOGCOM/CGI Federal Partnership

Author: Scott Prouse, USMC LOGCOM

Presenters: Scott Prouse and Lucien Millette, USMC LOGCOM

Navy Cold Spray Technologies

Author: Mathew S. VanRavenhorst, NAVSEA 05T - NESAR

Presenters: Dr. Tim Eden (Penn State) and Mr. Jeff Campbell (SEA05T)

Spray-able Bushing for Aircraft Wheels

Author: Stoney Middleton, NAVAIR FRCSW

Presenters: Stoney Middleton, NAVAIR FRCSW

FINALISTS

3-IN-1 PORTABLE SURFACE PREPARATION SYSTEM

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Maintenance and sustainment of DoD combat systems is an annual multi-billion-dollar expense and reduces the readiness rates of critical military combat systems. Removing combat systems for extended periods limits the readiness of all DoD services and compromises the readiness of the warfighter. Combat systems that require precision coating removal around compromised structures require a precision tool that does not impact the structure leading to failure. Removal of any metal or damage to surfaces must be avoided in these scenarios, which disqualifies highly abrasive removal methods such as blast cleaning, needle-gunning, or other mechanical techniques.

In large-scale construction and manufacturing industries, such as marine and aerospace, coating removal is an essential but time-consuming process required for constructing and maintaining combat systems and other structures. Today's techniques (wire-brushes, needle-guns, wet chemicals, lasers) are often used for surface preparation, and each comes with their own drawbacks such as hazards to operator health, slow removal

rate, specialized containment requirements, and damage to substrates. For all DoD services, there is a significant need for an easy to use, mobile tool that will accelerate small scale coating removal operations without negatively impacting the health of the operator or the underlying substrate.

The PlasmaBlast technology requires no media, generates no waste streams beyond the removed coating, allows for debris capture, presents no undue occupational or environmental hazards to the operators, and can remove partial or whole coating layers across a wide variety of platforms. The complete elimination of media to remove coatings reduces the de-painting waste stream by more than 95% which provides environmental benefits, increases efficiency, and lowers costs. The PlasmaBlast system sets up quickly, with only electricity and compressed air as inputs (no media or chemicals) and is quickly deployed to forward operating locations. Localized repair, which can require hours of surface preparation just to perform inspections on critical areas, can be reduced to minutes using the PlasmaBlast system. For example,

PlasmaBlast has been field-demonstrated to significantly reduce NDI/NDT of critical welded systems from hours to minutes. Due to the mobility of the technology, the system can be brought to the work piece for field repairs, eliminating the need for lengthy downtimes.

The PlasmaBlast system significantly reduces the maintenance man-hours, improve equipment readiness, and prevent corrosion. Combat operations benefit with cost savings, reduction in resources (manhours), and quick turnaround enabling combat systems to return to field operation faster. It has been deployed and utilized across the depth and breadth of the DOD including Public and Private Naval Yards, Army Depots and Arsenals, National Guard Camps, and forward operating maintenance facilities.

PROBLEM STATEMENT

Maintenance and sustainment of DoD combat systems is an annual multi-billion-dollar expense and reduces the readiness rates of critical military combat systems. Today's techniques (wire-brushes, needle-guns, wet chemicals, lasers) are often used for surface preparation, and each comes with their own drawbacks such as hazards to operator health, slow removal rate, and damage to substrates. For all DoD services, there is a significant need for an easy to use, mobile tool that will accelerate surface preparation operations without negatively impacting the health of the operator or the underlying substrate.

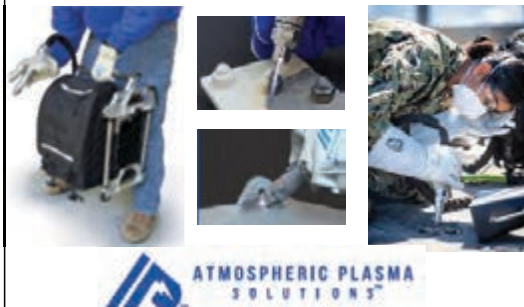
BENEFITS

- ✓ Removes coatings, cleans surfaces, promotes adhesion
- ✓ Profile is maintained, no damage to the substrate
- ✓ Requires only compressed air and electricity to operate
- ✓ Media and chemical free
- ✓ Safer for the operator, environmentally friendly, requires minimal containment and clean-up
- ✓ Significant job cost reductions
- ✓ Fast to train, simple to operate, low maintenance requirements
- ✓ Lightweight, 5-minute set-up
- ✓ All in one system

PORTABLE PRECISE POWERFUL

TECHNOLOGY SOLUTION

The PlasmaBlast technology requires no media, generates no waste streams beyond the removed coating, presents no undue occupational or environmental hazards to the operators, and can remove partial or whole coating layers across a wide variety of platforms. The complete elimination of media to remove coatings reduces the waste stream by more than 95% which provides environmental benefits, increases efficiency, and lowers costs. PlasmaBlast is easy to operate, < 5 minute set-up, portable single person carry, and provides precise coating removal and cleaning without damaging the substrate.



BLUE LIGHT SCANNER

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Problem Statement: Inspection of aircraft components can range from a simple visual inspection to calculating a percentage of surface damage over a complex area. Conventional hand tool inspection measurements can be questionable, especially when damage tolerance can be as low as 0.002". Any lack of confidence in the condition of a Flight Safety Part results is the discarding of the part.

Description: Blue Light Scanning (BLS) provides mechanics with an alternative automated inspection tool for performing component overhaul inspection procedures. This technology helps with reducing inspection times, complex surface comparison, component handling and executes sequence of events for performing examination. Reports are tailored to meet technical requirements in an electronic format. Data captured during scanning is saved by part number and serial number and is stored for future analysis.


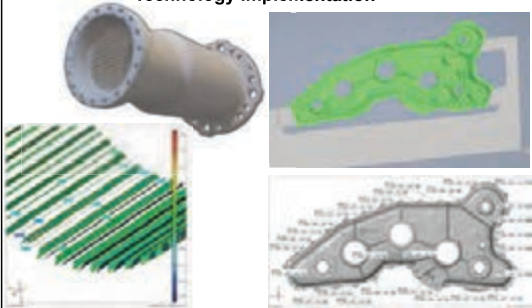
Current Development Status: Modernize overhaul inspection procedures for aircraft components by introducing automated inspection systems which enable

repeatable detailed inspections. CCAD is currently deploying BLS technology for the inspection of aircraft transmission components. Holding fixtures were developed to ensure repeatability and part alignment between samples. Robotic programs along with fixtures guarantee all surfaces of interest to be inspected per applicable technical requirements.

Test/Simulation Data (Supporting Claims of Benefits): CCAD's legacy inspection methods for transmission components range from half an hour to four hours and require constant manipulation of the inspection specimen. Time studies comparing legacy inspection methods and BLS demonstrate reduction of inspection times by a 30% with minimal handling of the part. By combining an automated system with the appropriate fixture, the inspection sequence and steps is guaranteed. The implementation of this technology translates to cycle time reduction and increases mechanic efficiency.

Next Steps/Potential Benefits: Maximize automated scanner capacity by utilizing all three scanning bays of existing equipment with appropriate fixtures and programs. Then

deploy additional BLS scanners to other component inspection activities to both decrease inspection times and decrease component fallouts.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> Inspection of aircraft components can range from a simple visual inspection to calculating a percentage of surface damage over a complex area. Conventional hand tool inspection measurements can be questionable, especially when damage tolerance can be as low as 0.002". Any lack of confidence in the condition of a Flight Safety Part results is the discarding of the part. 	<p>BENEFITS</p> <ul style="list-style-type: none"> Reduced component fallouts due to low confidence in inspection measurements – UH-60 Shafts 60-70% Reduced inspection times for transmissions overhaul of 30% - AH-64 Main Xmsn 3D data is saved for historical analysis Derived Benefits: 3D pdf for NDT instructions, reverse engineering of samples & CAD models for CMM inspections CAD created can be used to derive repairs using advanced manufacturing methods
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> Modernize overhaul inspection procedures for aircraft components by introducing automated inspection systems which enable repeatable detailed inspections. The introduction of Blue Light Scanning (BLS) in an automated environment has proven to increase mechanics inspection confidence. 	<p>Technology Implementation</p> 

IDENTIFYING AIRCRAFT PRESSURIZATION LEAKS USING ACOUSTIC IMAGING

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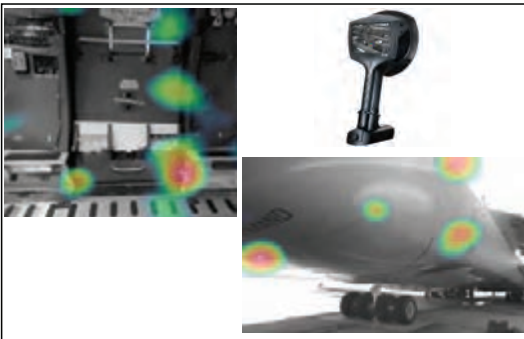
Achieving acceptable pressurization levels on aging airframes is an increasing challenge, requiring more manhours and increased fuel costs. The traditional methods of feeling for leaks with hands and using bags to identify leaks are no longer adequate. These methods may help technicians discover some leaks but are increasingly insufficient at identifying enough of the leaking areas to achieve required pressurization levels, especially with our aging fleets. These methods are time consuming, cannot be used in confined areas, and are overall less than effective. Relying on these inefficient methods increases maintenance downtime, reduces aircraft availability, increases manhours, and significantly increases fuel costs. For example, C-5M aircraft use 40,000 pounds of fuel per pressurization run, costing approximately \$23,000.

We can overcome these problems with innovative off-the-shelf technology. Acoustic imaging cameras very accurately pinpoint pressure leaks and overlay this information on a camera image. Utilizing an array of microphones tuned to the ultrasonic frequency of pressure leaks these cameras

can triangulate the location of leaks from up to 20 feet away. On-aircraft testing demonstrated their operational effectiveness in the loud flightline environment, easily distinguishing the sound of leaks from the background noise. These cameras also provide technicians with the ability to peer into confined spaces typically inaccessible during pressurization runs due to personnel safety concerns. The technology quickly verified leaks found using traditional methods and easily identified many more leaks that traditional methods could not find. The ability to save the camera images for reference reduced repair times and the need for rework. In addition, the cameras have applications both on-and-off aircraft and can be used to identify leaks in any compressed gas system. We recommend purchase of three cameras per maintenance unit to ensure active use capability of two cameras at any one time. Average cost of this technology ranges from \$15-20K per unit.

Use of this innovative technology will increase overall aircraft availability across the majority of MDSs by reducing maintenance downtime. The ability to identify pressurization leaks quickly and more

accurately will eliminate rework, reducing both manhours and fuel costs. These cameras are adaptable across all airframes and can be easily implemented for use in the field, ISO/Phase docks, and Depot locations. For Regional ISO docks which are kept to a tight schedule, such as the C-5 Minor RISO at Westover ARB, the time and cost savings would enhance ISO flow reliability, prevent excess downtime and late returns of aircraft to home station. In summary, this technology is a cost-effective tool that can be implemented today for returns on investment that will last long into the future.

<p>PROBLEM STATEMENT</p> <p>Passing aircraft pressurization checks during Isochronal Inspections has become increasingly difficult</p> <ul style="list-style-type: none"> Traditional methods used to find leaks are time consuming and less than effective <ul style="list-style-type: none"> Rely on feeling for leaks with hands or using paper towels & trash bags to detect leaks Access restrictions & safety concerns make it difficult/impossible to find leaks in confined areas on aircraft during pressurization checks Aging airframes leak significantly more and from previous unknown locations <p>Negative Impacts</p> <ul style="list-style-type: none"> Increased inspection flow, negatively affecting aircraft availability (typically 2-3 days per C-5M aircraft) Increased fuel costs associated with need for additional pressurization engine runs (40,000 lbs. per run for C-5M) Increased manhours required to achieve passing pressure <ul style="list-style-type: none"> Rework required to identify and repair previous missed leaks Manhours required to re-accomplish pressurization runs Ties up limited personnel needed for other maintenance tasks 	<p>BENEFITS</p> <p>Increased Aircraft Availability & Reduced Inspection Time</p> <ul style="list-style-type: none"> Improved leak detection eliminates the need for multiple pressurization runs Reduces rework and disruption to RISO inspection flow Pressurization rework within RISO adds 2-3 days of NMC time <p>Reduced Manhours & Labor Cost</p> <ul style="list-style-type: none"> 12 hours per pressurization run (4 personnel for 3 hours) \$40.66 per hour for WG-10 (\$488 per pressurization run) <p>Fuel Savings</p> <ul style="list-style-type: none"> C-5M burns 40,000 lbs. of fuel per pressurization run on average Reduced fuel cost = \$23,165 per pressurization run (C-5M) <p>Adaptable Across DOD</p> <ul style="list-style-type: none"> Can be used in the field, ISO/Phase Docks, and PDM Technology can be used on all MDS that experience pressurization leaks Camera can also be used to identify leaks in any compressed gas system (on or off aircraft)
<p>TECHNOLOGY SOLUTION</p> <p>FLIR Si124-LD Acoustic Imaging Camera</p> <ul style="list-style-type: none"> Off the shelf technology 124 microphones listens for "ultrasonic" sound of pressure leaks Pinpoints leaks and displays location on screen Can store images of leaks for reference when making repairs Works at distance & can look into confined areas personnel cannot safely go Can be used on all MDS to identify pressurization leaks Can also be used to identify leaks compressed gas systems (GOX, LOX, LN2, bleed air systems, Industrial shop air) <p>UNIT COST \$17,502</p>	

MARINE CORPS PLATFORM INTEGRATION CENTER (MCPIC) ELECTRONIC QUALITY MANAGEMENT SYSTEM (EQMS)-USMC LOGCOM/CGI FEDERAL PARTNERSHIP

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Problem: Commanders/Supervisors lack real-time digital visibility of maintenance operations and data in all types of operating environments to monitor quality standards conformance and to allow correction of non-conformance to maximize and expedite force and materiel readiness. Relevance: “the complexity of the tasks involved in supporting a high technology force also increases as the sophistication of its weapons and equipment increases...quite simply, the more advanced the equipment, the harder it is to fix.” Outdated maintenance quality and readiness reporting methods leave Commanders with sub-optimal visibility of data critical to operational planning and decision making. A modernized standardized system to monitor and capture inspections using real-time, trustworthy quality data capable of pinpointing effectiveness- and efficiency-diminishing actions in any environment was needed to mature maintenance management and operations to maximize readiness.

eQMS' immutable event-driven, sensor-based IoT architecture provides performance measurement, automated work instructions and notifications, forensics-enabling

history, and real-time event chronology in a scalable enterprise solution. eQMS promotes stakeholder data sharing, mitigates inefficient processes by bridging non-integrated systems, interoperates with USMC and DoD property accountability systems, and provides a modern commercial grade end-to-end maintenance management data capability to inform decision-making for operational advantage. Cloud Hosting– optimizes cost; affordably/agilely scales; native tools unleash data potential. System Sustainment–Agile, user-experience-based SecDevOps governance delivered 5 major enhancements in 2 years. System Modernization – architected to ease technology integration seeking efficient effectiveness. Auditability–delivers auditable solutions to satisfy ISO and other industry quality standards. Cybersecurity–authority to operate/connect via DoD Risk Management Framework and DISA compliancy. Automated Information Technology–A network of global RFID, bar codes, cameras, handheld tablets, fixed-readers, and mobile antennae with disconnected operations data-synching. Training–web-based, help desk (Tier 0 pending (affordability)) and

onsite. Field Support Representative–cross-trained mobile training teams ensure affordable effectiveness.

eQMS is currently operational at 2 USMC bases and depots globally and has been rigorously proven in numerous joint DoD operations/exercises. To date, unit maintenance activities have performed 7,000+ materiel inspections resulting in over 500 documented and corrected non-conformances.

The government-owned eQMS functionality and data can viably and affordably scale across the DoD and within all operating environments to analyze maintenance operations effectiveness, and eQMS outputs afford actionable digital insights to expedite, validate and increase materiel readiness to benefit Commanders at all levels.

<p align="center">PROBLEM STATEMENT</p> <p><i>Commanders lack real-time digital visibility of maintenance operations and data in all types of operating environments to monitor quality standards conformance and to allow correction of non-conformance to maximize and expedite force and materiel readiness.</i></p> <ul style="list-style-type: none"> Maintenance task complexity increases as the sophistication of weapons and equipment increases...quite simply, the more advanced the equipment, the harder it is to fix Outdated maintenance quality and readiness reporting methods leave Commanders with sub-optimal visibility of data critical to operational planning and decision making A modernized, standardized system to monitor and capture inspections using real-time data to pinpoint effectiveness- and efficiency-diminishing actions and operate in any environment was needed to mature maintenance operations & maximize readiness 	<p align="center">BENEFITS</p> <ul style="list-style-type: none"> Improved materiel readiness via standardized, real-time digital maintenance and quality inspection process visibility and data Ability to operate in <i>disconnected, denied, intermittent and/or with limited bandwidth (DDL)</i> (e.g., contested) environments Technology resides in the GOCO (government owned, contractor operated) MCPIC suite of applications = enhanced affordability Expandable to nearly all applications requiring standardized inspection performance and data collection Collected, processed, analyzed and visualized raw data generates digital operational intelligence/insights to improve readiness Mature solution in use at 2 USMC Commands supporting operations and exercises worldwide
<p align="center">TECHNOLOGY SOLUTION</p> <p>Immutable event-driven, sensor-based IoT architecture, provides delivery measurement, automated work instructions and notifications, forensics-enabling history, and real-time event chronology in a scalable enterprise solution</p> <ul style="list-style-type: none"> Communicates securely with host servers via military or commercial internet connection Simplified, intuitive user interfaces Ruggedized secure hardware & sensors ideal for in-field use Secure CAC-enabled access Data synchronization algorithm ensures data integrity and desired data outcomes including in <i>disconnected operations</i> 	<p>The diagram illustrates the MCPIC eQMS architecture. It shows data being ingested into USMC Maintenance via GOCO Maintenance Module using eQMS. This data is then processed through a workflow that reflects status against Work Order and Quality Standard for each step, with Condition Code captured and reflected in GOCO MAC upon completion. The architecture is supported by GOCO MAC and F2W Catalyst. The resulting MCPIC eQMS Application provides real-time visibility and readiness data to Commanders, enabling them to improve operational planning and execution, inventory speed, and accuracy audit results, and readiness reporting (e.g., Defense Readiness Reporting System (DRRS)).</p> <p>Key features and outputs include:</p> <ul style="list-style-type: none"> Top 10 Defect Codes (represented by a bar chart) Assets with Overlooked Quality Actions Real-time or last known asset location (eQMS made dependent) Capability of reporting quantity of the unit (asset level) Level 8 (system) and configuration (e.g., method items data) Condition code when captured Automated rendering of maintenance data into digitized Repair/Maintenance (R/M) Form

FINALISTS

NAVY COLD SPRAY TECHNOLOGIES

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Cold Spray is an additive repair technology that facilitates supersonic deposition of metallic powder on a base metal to re-establish or improve base metal conditions. Cold spray technology is an alternative repair method to reestablish surface dimensions on mechanical components. Traditional repair methods such as welding often add requirements (such as heat treatment) and introduce risks (such as warpage). Repair methods such as high velocity flame spray, epoxy, and chrome plating present adhesion and performance limitations. In many cases, cold spray is shown to reduce cost and schedule. Since 2020, NAVSEA has established numerous organic and pop-up cell repair capabilities and is actively repairing ships components with cold spray. In addition, cold spray has proven effective in mobile, expeditionary, and shipboard environments.

In November of 2022, the NAVSEA cold spray team received an opportunity to complete a challenging cold spray in an enclosed space on a submarine. The shipboard cold spray repair was performed by Norfolk Naval

Shipyards at the General Dynamics Electric Boat shipyard in Groton, CT. This repair was the first shipboard cold spray repair conducted by a Navy activity. NAVSEA's cold spray team had to use robotic arms and cameras for each evolution. In addition, this repair was accomplished on a SUBSAFE component in proximity of a non-metallic seal; therefore, component temperatures had to be monitored during the entire evolution to ensure integrity of the seal. The available repair options were electroplating, cold spray, or component replacement via an unscheduled dry docking of the waterborne asset. Cold spray was selected as the repair option after an evaluation by NAVSEA, the Supervisor of Shipbuilding, Conversion, and Repair Groton and GDEB of all the repair options. Cold spray repair was completed within eight days of the NNSY/Penn State ARL cold spray team's arrival ultimately allowing the avoidance of an unscheduled 5-month dry docking. This repair established cold spray as a viable time and cost saving alternative to traditional repair methods, provide lessons learned for future expeditionary repair opportunities.

In January of 2023, the NAVSEA cold spray team was approached by Southwest Regional Maintenance Center regarding cold spray as a potential repair. The USS ESSEX was in dry dock in San Diego, and both rudders had been removed with extensive rudder stock damage identified. Traditional weld repairs carried risks both in schedule growth as well as execution. Ultimately a team consisting of Penn State ARL, VRC Metal Systems, MARMC, SWRMC, BAE and NAVSEA 05T1 supported the development and execution of two cold spray repairs which resulted in 24 days of dry dock avoidance for the ship.

Recognizing the value of cold spray from a depot level and expeditionary manner, NAVSEA continues to grow its cold spray capability and work with other DOD/Industry/Academic partners in those efforts.

PROBLEM STATEMENT

A repair method is needed to address components that are sensitive to heat distortion from welding/thermal spray processes, and also more durable than traditional epoxy/electroplating repairs.

The repair method needs to be capable of being executed on components located at a traditional repair depot as well as in expeditionary/shipboard environments.

The repair method needs to be executed faster than traditional repair methods

BENEFITS

Virginia class submarine shipboard repair: Mobile cold spray was utilized to repair a component shipboard in lieu of a direct component replacement which would have required dry docking the submarine, saving five months of unscheduled maintenance. The repair was completed over the course of eight days.

USS Essex rudder stock: Mobile cold spray was utilized to repair two rudders' stocks in lieu of traditional weld repair, saving 24 days of dry dock schedule. The repairs were completed over the course of eight days.

Cold spray was utilized to repair and return to service more than 65 components. These repairs were conducted at pop up cells and organic US Navy cold spray facilities capability supporting current CNO availabilities.

TECHNOLOGY SOLUTION

Cold Spray provides a low heat input repair, reducing distortion, to support dimensional restoration of components while providing more durability than a traditional epoxy/electroplating repair.

Supporting technologies and capabilities (scaled cold spray components, mobile facilities, robotics, gas generation) were developed to allow cold spray to be utilized in mobile/shipboard applications.



SPRAY-ABLE BUSHING FOR AIRCRAFT WHEELS

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This submission summarizes development of the F/A-18E/F Super Hornet and EA-18G Growler Main Landing Gear (MLG) wheel bore repair using Low Pressure Cold Spray (LPCS) technology. The equipment used for this repair development is Inovati's Kinetic Metallization™ system, also known as LPCS. A majority of the testing conducted was made possible through NAVAIR SBIR Topic N07-122, Contract Number N68335-16-C-0376. The Aircraft Equipment Reliability and Maintainability Improvement Program (AERMIP) funded FRC-SW Materials Engineering at North Island for support of this SBIR topic.

A qualification test plan was made based on the Original Equipment Manufacturer (OEM) requirements for a new Super Hornet wheel. F/A-18 Fleet Support Team (FST) Landing Gear cognizant engineering approved the test requirements. The qualification test plan included both static and dynamic load testing of fully assembled wheels. Repaired wheels had both the inner and outer bores machined to a minimum thickness then cold sprayed to restore original dimensions. The LPCS coating is a metal matrix composite consisting of an aluminum alloy and nickel.

The qualification requirements were initially designed for a newly manufactured wheel to complete, not a repaired wheel.

After review of the SBIR testing results the risk from a Materials Engineering standpoint appears to be low in the worst case. Additionally, the LPCS process reduces parent material removal (i.e., strength conserved). The LPCS bore repair is now beginning to be implemented at FRC-SW and other platforms such as F-16 and F-35 are considering this repair process.

<p>PROBLEM STATEMENT</p> <p>Aircraft wheel bore damage causes an unacceptable premature scrap rate. Aircraft carrier deck landings and operational tempo demands are factors particular for naval aircraft, although other aircraft platforms also suffer bore damage. In 2015, NAVAIR Fleet Readiness Center Southwest investigated scrap rates of F/A-18E/F wheels. Over \$1 million dollars worth of wheels were scrapped for bore tolerance issues. Aircraft wheels are Critical Safety Items (CSI) which can be challenging to procure for ageing aircraft platforms. The current cost to procure the same amount of wheels scrapped in 2015 is now over \$7 million dollars. A bushing repair is standard practice for reestablishing bore tolerance. However, standard bushings are a challenging, time intensive, and one-time repair that remove the maximum amount of parent material from the wheel.</p>	<p>BENEFITS</p> <ul style="list-style-type: none"> ✓ Wheel strength conserved: The only wheel material removed is the damaged area and within structural repair limitations. Low Pressure Cold Spray can be applied as thin as 0.005 inch thickness. ✓ Increased repair opportunity: Wheels that have been Cold Sprayed and are further damaged in-service can be restored multiple times, if within structural limits. This is not possible with standard bushings. ✓ Low cost: Low pressure Cold Spray is uniquely efficient in its use of consumable materials. Repair cost is less than standard bushing repair. ✓ Fast turn around time: Low Pressure Cold Spray takes less than half the time than a standard bushing.
<p>TECHNOLOGY SOLUTION</p> <p>Low Pressure Cold Spray technology, a proven metal spray process, was used to demonstrate a bore repair with properties equivalent to a one-time bushing repair. In 2018 an SBIR Phase II.5 was leveraged to conduct full scale testing of F/A-18E/F Main Landing Gear Wheels according to the OEM qualification requirements. The Air Force Landing Gear Test Facility conducted static and dynamic loads according to Boeing wheel procurement specifications. As of 2023, the spray-able bushing repair is being implemented for F/A-18E/F wheels and being considered for F-35 and F-16 wheels.</p>	

PATRIOT RADAR ELEMENT PAINT MASK

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Letterkenny Army Depot provides sustainment support for the PATRIOT missile system, including but not limited to the recapitalization of the radar and secondary work on the radar elements. This sustainment support accounts for the overhaul of approximately 13,000 PATRIOT radar elements annually. Part of the overhaul process is painting the face of the element. Before the paint can be applied, the majority of the element must be masked off to keep paint from being applied to undesirable portions of the element. The current masking process requires the paint artisan to manually wrap the element with masking tape, which accounts for approximately 7.6% (\$30.42) of the cost of overhauling the elements.

In an effort to reduce the amount of time involved with masking the elements, other methods were explored. Due to the element areas that must be painted and angles the paint must be sprayed to meet the drawing requirements, the solution needed to be tight fitting and mask only a single element at a time. Of the solutions considered, 3D printing provided a customizable solution at

an economical cost. The design settled on is a two-piece ring additively manufactured in PC-ABS using fused deposited material technology. It utilizes features of the element to hold the masking ring in place around the head of the element. The cost of the reusable 3D-printed masking ring is \$15.00/ea. In order to minimize the cost of 3D printing the mask, the masking ring was designed to easily accept a shipping tube to mask the remainder of the element. Of the options available, a plastic tube with a rubber end cap provided the best economical solution at a cost of \$1.50/ea.

Initial testing of the prototype design yielded a 68% savings in the cost to mask the elements with good masking results. A slight improvement has been made to the masking ring to improve the ease of separating the tube from the ring. The tubing and end caps are being ordered to replace the 3D-printed tube used for the initial testing. Once the tubing and end caps are received, the final design will be batch-tested to validate the latest design, overall process, and initial savings.

After successful batch testing, the next steps will be determining if further improvements are desirable, identifying the best method(s) for cleaning the ring and tube sets, and looking for similar opportunities with similar high-volume masking operations.

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • Approximately 13,000 Phased Array Tracking Radar to Intercept on Target (PATRIOT) radar elements are overhauled annually at Letterkenny Army Depot (LEAD). • Masking and demasking the elements for paint operations is done by hand with masking tape. • Approximately 7.6% (\$30.42) of the cost of overhauling an element is associated with the paint masking and demasking operations. 	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> • Cost savings of 68%, putting the approximate cost to mask and demask each element at \$8.69. • Estimated annual savings of \$282k. • Less repetitive motion for the paint artisan. • Reduction in consumable masking material. • Created additional opportunities for similar repetitive masking operations.
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • Two-piece ring 3D printed in PC-ABS that fits around the head of the element, providing paint masking in accordance with the drawing. Cost of each ring set estimated at \$6.83. • Plastic tube with a rubber end cap used to mask the body of the element. Cost of each plastic tube and rubber end cap estimated at \$1.50. • 3D printed ring, plastic tube, and rubber cap are expected to be reusable. • Approximately 250 sets will be needed initially at a cost of \$3,790. 	<p style="text-align: center;">Graphic</p> <p>The graphic shows a vertical comparison. On the left, a single long, thin tube is shown, labeled 'Old' with a left-pointing arrow. On the right, a two-piece ring and a separate tube with a rubber cap are shown, labeled 'New' with a right-pointing arrow. The 'New' components are shown in two different orientations to illustrate their assembly.</p>

DIGITAL INVENTORY PLATFORM FOR ON-DEMAND SPARES

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Durable and adaptable supply chains make the difference between success and failure of extended operations. To ensure Warfighter readiness levels, DoD logistics expenditures in 2022 exceeded \$177B across supply, maintenance, and transportation. Deployed manufacturing initiatives like TACFAB and the Afloat Additive program place production equipment closer to the point of need and empower soldiers with tools to create their own critical components. These capabilities have produced high-value examples of field problem-solving, however, they also raise new challenges concerning component reengineering, performance, and certification. This proposal addresses this opportunity with a solution that provides speed and agility, coupled with a focus on platform security, part quality, and collaboration between DoD and outside suppliers.

The Digital Source platform delivers critical parts, where and when needed. Secure availability of technical information is provided to produce maintenance parts via deployed additive manufacturing

technology without the requirement of localized engineering resources. This platform provides a mechanism for the secure management of IP and encourages collaboration between field resources, technical centers of competence, and defense suppliers. Approved part print files are encrypted and tamper-proof, and accessible by select audiences for on-demand production. Machine telemetry feedback produces quality reports proving adherence to critical inputs such as device condition, material selection, and critical dimensional tolerances. Fleet usage data provides guidance into utilization trends and value, while also respecting the commercial interests of non-DoD IP owners. This platform could be deployed immediately across hundreds of existing devices within the DoD network and has potential to scale as a hardware-agnostic tool to maximize solution value.

Results from current deployments conservatively suggest a 10x reduction in both applicable component lead time and loaded cost per part. This is the only platform today which provides the

combination of security, collaboration, and public/private engagement needed to most effectively solve the maintenance and supply chain challenges facing complex organizations. The objectives of this application are to validate applicability and interest within DoD stakeholders and facilitate feasibility and deployment discussions.

<p align="center">PROBLEM STATEMENT</p> <p>Managing inventory and logistics operations is difficult task; near-impossible when considering unplanned demand for legacy components in austere deployed environments. Additive manufacturing (AM) technology presents a promising solution, enabling the creation of a wide array of high value parts on short notice, but that value has not yet been realized at scale.</p> <ul style="list-style-type: none"> • How can the right parts be made available, where and when needed? • If AM is an answer, where do print files come from, and how can it be ensured that these replacement parts are up to the task? 	<p align="center">BENEFITS</p> <ul style="list-style-type: none"> • Increased equipment uptime and readiness • Reduced cost of supply chain -via- • Shortened component lead time • Reduction in loaded cost per part • Streamlined integration with defense suppliers • Scale through collaboration between units
<p align="center">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • Digital warehouse of technical data packages, including certified print files. Controlled access granted to frontline users, AM experts, and the industrial supply base • Commercial platform for collaboration, replacing reverse engineering and isolated development initiatives • Quality control via in-process part inspection and device telemetry feedback loops deliver certified parts • Encrypted end-to-end security and STIG-compliant hardware 	<p align="center">PROCESS FLOW DIAGRAM</p>

ADDITIVE MANUFACTURING

COSINE ADDITIVE DUNNAGE PACKAGING SOLUTIONS

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In the realm of defense maintenance operations, an intricate challenge looms large: the effective management of packaging materials for transporting and storing delicate components. This predicament, characterized by the need for copious storage space and intricate logistics, significantly affects resource allocation and maintenance efficiency. To surmount these hurdles, Cosine Additive introduces an innovative technology solution that not only promises transformative benefits but also bears immense relevance to the defense sector.

Maintenance operations within the defense sector grapple with an acute problem—the formidable demands placed on storage space and the intricacies of packaging materials management. This quandary intricately impacts resource allocation and maintenance efficiency, prompting a closer examination of its nuanced facets: Space-Consuming Inventory, Logistics Complexities, and Resource Optimization.

At the heart of Cosine's pioneering technology solution are three core components that elegantly tackle these

challenges: On-Demand Dunnage Design, Pellet-Extrusion 3D Printing, and Sustainability and Resource Efficiency. Each element is underpinned by Cosine's cutting-edge additive manufacturing technology, renowned for its precision and efficiency.

The benefits ushered in by Cosine's technology solution are multifaceted and poised to revolutionize packaging materials management within defense maintenance:

Cosine's innovative technology solution offers an array of transformative advantages. By enabling on-demand production of packaging materials, it eliminates the need for extensive storage space, thereby maximizing the utility of available areas. Additionally, the ability to rapidly produce customized packaging materials tailored to delicate components simplifies logistics complexities, reducing costs associated with global management and transport.

Moreover, Cosine's technology empowers resource optimization through recycling. This sustainable approach allows unused or discarded packaging materials to be

efficiently repurposed into new dunnage, effectively minimizing waste, and aligning with eco-conscious practices. These combined benefits lead to significant cost savings, a crucial aspect for resource-constrained defense operations. The technology's rapid design and production of customized packaging geometries ensure the utmost safety of delicate components during transportation and storage, addressing a critical factor in defense maintenance.

In essence, Cosine Additive's groundbreaking technology solution transcends conventional practices in packaging materials management for defense maintenance. It redefines how maintenance operations can be conducted within the defense sector, introducing unprecedented levels of efficiency, sustainability, and cost-effectiveness. As the defense community continually seeks to optimize resources and enhance operational readiness.

PROBLEM STATEMENT

Today's problem, central to maintenance operations, is a multifaceted challenge characterized by the need for substantial storage space and the logistical intricacies of managing packaging materials.

This situation ultimately impacts resource allocation and maintenance efficiency. Addressing this problem is crucial due to its direct implications on resource optimization, cost-effectiveness, and the streamlined execution of maintenance processes within the defense sector. Understanding the scope of this problem, let's delve into its specific aspects:

- **Space-Consuming Inventory:** The current practice demands a significant inventory of packaging materials, occupying valuable storage space.
- **Logistics Complexities:** Managing, storing, and transporting these materials globally presents logistical challenges and costs
- **Resource Optimization:** Finding a solution is essential for optimizing resource allocation and improving maintenance efficiency.

BENEFITS

Cosine presents a transformative approach to packaging materials management. The key advantages include:

- **Space Optimization:** Remove the need for substantial storage space, freeing up valuable resources.
- **Streamlined Logistics:** On-demand dunnage design and 3D printing simplify the complex logistics of managing, storing, and transporting packaging materials, reducing associated costs.
- **Resource Efficiency:** The recyclability of packaging materials produced through 3D printing minimizes waste and optimizes resource allocation.
- **Cost Savings:** Reduced storage requirements, streamlined logistics, and efficient resource utilization translate into significant for maintenance operations.
- **Customization:** Enablement rapid generation of customized packaging solutions tailored to the unique needs of delicate parts, ensuring their safety during transportation and storage.

TECHNOLOGY SOLUTION

Cosine's technology solution offers a practical and innovative approach to addressing the challenges faced by maintenance operations in managing packaging materials. It can significantly enhance resource optimization, cost-effectiveness, and maintenance efficiency within the defense sector.

- **On-Demand Dunnage Design:** Development of a sophisticated dunnage design software capable of rapidly generating customized packaging solutions for delicate parts, creating packaging geometries that offer optimal protection, minimizing material use while ensuring component safety during transportation and storage.
- **Pellet-Extrusion 3D Printing:** Cosine's printers will be used to bring these dunnage designs to life. These printers rapidly produce complex and customized packaging materials directly from thermoplastic pellets
- **Sustainability and Resource Efficiency:** Our solution promotes sustainability by enabling the recycling of packaging materials. Any unused or discarded packaging can be ground down and reprocessed into new dunnage, reducing waste and optimizing resource allocation.

GRAPHIC OR IMAGE



Impact Resistant Cradle

NAVY COLD SPRAY TECHNOLOGIES

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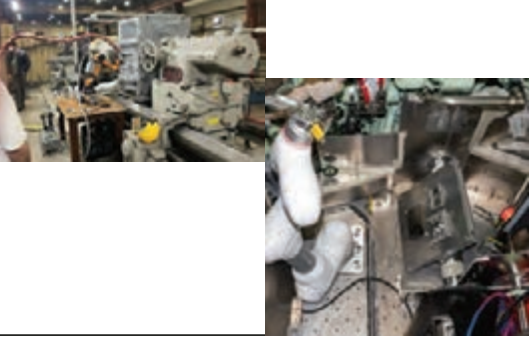
Cold Spray is an additive repair technology that facilitates supersonic deposition of metallic powder on a base metal to re-establish or improve base metal conditions. Cold spray technology is an alternative repair method to reestablish surface dimensions on mechanical components. Traditional repair methods such as welding often add requirements (such as heat treatment) and introduce risks (such as warpage). Repair methods such as high velocity flame spray, epoxy, and chrome plating present adhesion and performance limitations. In many cases, cold spray is shown to reduce cost and schedule. Since 2020, NAVSEA has established numerous organic and pop-up cell repair capabilities and is actively repairing ships components with cold spray. In addition, cold spray has proven effective in mobile, expeditionary, and shipboard environments.

In November of 2022, the NAVSEA cold spray team received an opportunity to complete a challenging cold spray in an enclosed space on a submarine. The shipboard cold spray repair was performed by Norfolk Naval

Shipyards at the General Dynamics Electric Boat shipyard in Groton, CT. This repair was the first shipboard cold spray repair conducted by a Navy activity. NAVSEA's cold spray team had to use robotic arms and cameras for each evolution. In addition, this repair was accomplished on a SUBSAFE component in proximity of a non-metallic seal; therefore, component temperatures had to be monitored during the entire evolution to ensure integrity of the seal. The available repair options were electroplating, cold spray, or component replacement via an unscheduled dry docking of the waterborne asset. Cold spray was selected as the repair option after an evaluation by NAVSEA, the Supervisor of Shipbuilding, Conversion, and Repair Groton and GDEB of all the repair options. Cold spray repair was completed within eight days of the NNSY/Penn State ARL cold spray team's arrival ultimately allowing the avoidance of an unscheduled 5-month dry docking. This repair established cold spray as a viable time and cost saving alternative to traditional repair methods, provide lessons learned for future expeditionary repair opportunities.

In January of 2023, the NAVSEA cold spray team was approached by Southwest Regional Maintenance Center regarding cold spray as a potential repair. The USS ESSEX was in dry dock in San Diego, and both rudders had been removed with extensive rudder stock damage identified. Traditional weld repairs carried risks both in schedule growth as well as execution. Ultimately a team consisting of Penn State ARL, VRC Metal Systems, MARMC, SWRMC, BAE and NAVSEA 05T1 supported the development and execution of two cold spray repairs which resulted in 24 days of dry dock avoidance for the ship.

Recognizing the value of cold spray from a depot level and expeditionary manner, NAVSEA continues to grow its cold spray capability and work with other DOD/Industry/Academic partners in those efforts.

<p style="text-align: center;">PROBLEM STATEMENT</p> <p>A repair method is needed to address components that are sensitive to heat distortion from welding/thermal spray processes, and also more durable than traditional epoxy/electroplating repairs.</p> <p>The repair method needs to be capable of being executed on components located at a traditional repair depot as well as in expeditionary/shipboard environments.</p> <p>The repair method needs to be executed faster than traditional repair methods</p>	<p style="text-align: center;">BENEFITS</p> <p>Virginia class submarine shipboard repair: Mobile cold spray was utilized to repair a component shipboard in lieu of a direct component replacement which would have required dry docking the submarine, saving five months of unscheduled maintenance. The repair was completed over the course of eight days.</p> <p>USS Essex rudder stock: Mobile cold spray was utilized to repair two rudders' stocks in lieu of traditional weld repair, saving 24 days of dry dock schedule. The repairs were completed over the course of eight days.</p> <p>Cold spray was utilized to repair and return to service more than 65 components. These repairs were conducted at pop up cells and organic US Navy cold spray facilities capability supporting current CNO availabilities.</p>
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <p>Cold Spray provides a low heat input repair, reducing distortion, to support dimensional restoration of components while providing more durability than a traditional epoxy/electroplating repair.</p> <p>Supporting technologies and capabilities (scaled cold spray components, mobile facilities, robotics, gas generation) were developed to allow cold spray to be utilized in mobile/shipboard applications.</p>	

ADDITIVE MANUFACTURING

BRIDGE TOOLING WITH ADDITIVE AT SCALE


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Problem Statement: Obsolete parts from manufacturers that no longer exist, and scarce parts extend delays for routine maintenance. Advancements in tool positioning, lighten the load, payload attachments, and product modifications need urgency to scale across the force. Traditional injection molded tools are exponentially more expensive, heavier and take longer to build than bridge tools with Additive at Scale. Legacy parts often lack specification files and/or manufacturing tolerances, Additive at Scale creates digital part files that allows parts to be generated on demand.

Technology Solution: Bridge tooling with Additive at Scale aims to exponentially change DoD's time to solution for obsolete, scarce, and innovative new parts. Over the past four years Additive at Scale has worked with companies whose molds have been trapped in China, to reshore their manufacturing. Additive at Scale leverages disruptive technologies in laser scanning, additive manufacturing, and injection molding to provide rapid advancements in cost and time to production of injection molded tools. Bridge Tooling with Additive

at Scale has successfully moved part scans and designs through Additive iterations, bridge tool production, and injection molded parts in as few as 5 days.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none">• Obsolete parts from manufacturers that no longer exist, and scarce parts extend delays for routine maintenance.• Advancements in tool positioning, lighten the load, payload attachments, and product modifications need urgency to scale across the force.• Traditional injection molded tools are exponentially more expensive, heavier and take longer to build than bridge tools with Additive at Scale.• Legacy parts often lack specification files and/or manufacturing tolerances, Additive at Scale creates digital part files that allows parts to be generated on demand.	<p>BENEFITS</p> <ul style="list-style-type: none">• Additive at Scale has successfully helped companies reshore their product manufacturing from China, utilizing bridge tooling to produce parts while traditional tools are being developed.• Bridge Tooling with Additive at Scale is "Exponentially Changing the World of Plastic Part Manufacturing:"<ul style="list-style-type: none">• Legacy Part to Injection Molded Part off Bridge Tool in 5-7 days• Expected lead time for mold machining is currently 3-4 months• 8 Cavity tool pictured below was produced for \$400, stainless steel tool cost \$18,000.
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none">▪ Bridge tooling with Additive at Scale brings together significant advancements in laser scanning, additive manufacturing, and injection molding. Additive at Scale has developed deep relationships in advanced materials, scanning, slicing and modeling software, while working with national standard associations to successfully scale designs into injection molded parts on additive manufactured bridge tools.▪ Bridge Tooling with Additive at Scale is a solution for DoD to exponentially shorten time to part, enhance sustainment of the part going forward, and allows for rapid tool iterations.	

PREDICTIVE MAINTENANCE TO ENABLE ADDITIVE MANUFACTURING REPAIR OF CRITICAL COMPONENTS

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To address the DoD logistic challenges and high sustainment costs, ARL Penn State has developed an innovative concept of combining advanced machine learning-based predictive analytics with additive manufacturing (AM) repair technology to provide a new sustainment approach for DoD assets. This approach is particularly well-suited to critical dynamic load-bearing components (ex. gears, journal bearings, splines, etc.) in ground vehicles, helicopters, ships, and submarines. We are currently applying these technologies to legacy ground combat vehicles for parts that are no longer produced where it is difficult and expensive to obtain replacement parts.

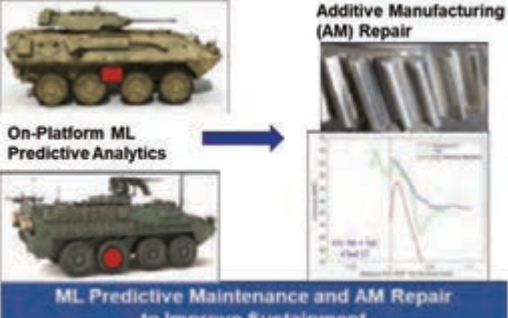
AM is a revolutionary technology that can repair damaged parts with low thermal distortion and superior mechanical properties, but to maximize the benefit for critical load-bearing components, the repair must be applied while the extent of the damage is low. ARL Penn State has developed machine learning-based on-platform predictive analytics that can detect low lubrication levels and early indications of faults of loading bearing components using a single low-cost MEMS

vibration sensor (~\$25/sensor). This provides the ability to identify and remove the critical parts from service with limited damage to ensure the best and longest-lasting repair. It should be noted that any DoD platform that has an existing predictive maintenance capability can be a candidate for the AM repair approach.

We have recently conducted technology development using U.S. Marine Corps amphibious combat vehicles and U.S. Army ground combat vehicles drive train components. The failure prediction capability has been shown to be effective for drive train components and many other applications. Our metallurgical characterization of failed and repaired parts suggests that repair is feasible in many cases. The AM technology repair of many different load-bearing parts also shows great promise of effectiveness.

The next technology development steps include (i) tailoring of predictive analytic algorithms across a wide range of asset classes, (ii) refining AM-based repair materials and processing strategies to optimize performance and ensure repeatability, (iii) developing qualification

strategies so the AM repair can be implemented at DoD repair facilities include Depots with AM capabilities.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> DoD assets, such as ground vehicles, helicopters, ships, and submarines, employ gears, splines, and bearings that become damaged and degrade until catastrophic failure. Remanufacture of such high-value components is expensive and time-consuming. Supply-chain issues involving these critical dynamic load bearing components degrade warfighter readiness. DoD Depots are acquiring AM technology capability but with limited application solutions. 	<p>BENEFITS</p> <ul style="list-style-type: none"> The marriage of advanced prognostics and additive manufacturing (AM) repair technologies will give the logistics and sustainment community an ability to cost-effectively repair critical parts that are difficult and expensive to remanufacture. Application of this technology for critical load bearing components will eliminate the high cost and long lead time to manufacture new parts, improving warfighter readiness. A CBA indicates a 20% savings from this process could save \$57M for the fleet of USMC LAV and USA Strykers.
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> ARL Penn State has developed an innovative concept that combines advanced machine learning (ML) based predictive analytics with additive manufacturing (AM) repair technology. Advanced on-platform machine learning based predictive analytics provides an early indication of the component fault that facilitates the ability to cost effectively conduct repairs with the AM technology. ARL Penn State has two decades of experience implementing and evaluating predictive analytics on DoD weapon systems, and more than three decades of experience in developing and transitioning laser-based repairs for the DoD. 	 <p>The diagram illustrates the integration of predictive analytics and additive manufacturing. On the left, a military vehicle is shown with the text 'On-Platform ML Predictive Analytics'. An arrow points to the right, where a graph displays a peak in a data series. Further right, the text 'Additive Manufacturing (AM) Repair' is shown above an image of a laser repair process. At the bottom, a blue banner reads 'ML Predictive Maintenance and AM Repair to Improve Sustainment'.</p>

DEVELOPMENT OF RESISTIVE FILM COATING AND COMPLETE MANUFACTURING SYSTEM FOR RESISTIVE FILM COATING

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The rapid development of printed electronics promoted development of conductive inks. Printed electronics allow for efficient, inexpensive, quick, and easy production of complex, multilayer circuitry without etching copper and numerous hands-on multi-lamination steps. The conductive inks used in additive electronic manufacturing (AME) are usually metal for increased conductivity. But there are also applications where conductive carbon based is a good choice. The conductive fillers of carbon-based conductive inks had the characteristics of wide source, low price, and good stability, and had great application value.

For printed resistive inks the application or additive process matters. Much is printed using screen printing, which is messy / difficult to control. There is a desire for a digitally controlled method of printing- this is achieved using inkjet technology. For inkjet printing, submicron particle sizes of carbon is needed. The goal is to establish a complete digital printing system for resistive coatings. The system will digitally print resistive coatings on a polyester (PET) and Kapton (DuPont trademark) films of up to 5

feet wide. ChemCubed can currently print wide format conductive and dielectric inks on a specially modified commercial wide format printer. This system will be evaluated for consistent quality and low variability and showing capability in making numerous resistive coating layers so multiple sheet resistances can be obtained. We will develop the final formulation of a resistive ink for a solvent based wide format ink jet printing system using the best carbon raw materials such as carbon nanotubes (CNTs), conductive carbon pigment, hybrid metal/carbon, conductive resins, or some combination of to use to obtain the best printability for the purpose of a resistive coating on a film. The two films to be used are: a PET & Kapton to show substrate versatility. To demonstrate & explore further versatility, creating a manner to dial in sheet resistance by varying print resolution and layering capabilities by printing with multiple printing channels and printheads at one time.

Conductive carbon pigments and their derivatives will serve in industries including automotive transportation, consumer electronics, consumer goods, wearable

electronics, commercial / residential floor / wall heating markets, aeronautical, aerospace, and military.

<p style="text-align: center;">PROBLEM STATEMENT</p> <p>Rapid development of printed electronics technology promoted the development of conductive inks. Printed electronics allow for efficient, inexpensive, quick and easy production of complex, multilayer circuitry without etching copper and numerous hands-on multi-lamination steps. Conductive inks used are usually metal for increased conductivity. But there are applications where conductive carbon based is a good choice such as wearables. The conductive fillers of carbon-based conductive inks had characteristics of wide source, low price and good stability, and had great application value.</p>	<p style="text-align: center;">BENEFITS</p> <p>The proposed material will be 3x more conductive than current screen printing resistive inks. Additional Benefits: (1) use of secure, abundant, domestic coal feedstocks (2) increased ink formulation wettability & transferability (3) ability to achieve higher solids loading in ink formulation suspensions, carbon black and graphene (4) exhibited low surface resistance/resistivities (5) significantly lower particle density relative to silver (6) lower curing temperatures than silver and potentially a wider range of compatible substrates (7) significantly lower cost than silver pigments</p>
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <p>ChemCubed will develop a new carbon-based resistive ink that will be 3 times more conductive than current screen printing resistive inks. The proposed project is more economically efficient than currently available options, and utilizes a secure, abundant, domestic coal feedstock. The digital printing aspect of this material will allow greater accuracy and flexibility in design, savings in energy and the ability to quickly replace damaged parts on the grid alleviating supply chain issues</p>	

COMPLETE END-TO-END ADDITIVELY MANUFACTURED ELECTRONICS SYSTEM FOR DOD SUSTAINMENT AND READINESS

DR. DAN SLEP

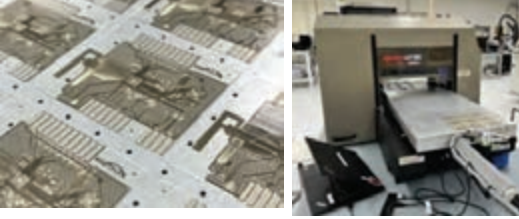
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The Department of Defense (DOD) currently relies on traditional methods for PCB design and manufacturing. Despite the incredible advances in all weapons systems, their foundation on PCBs limits or slows additional development. An additive manufacturing method that can build PCBs by depositing multiple materials with high accuracy has yet to be developed but is needed to manufacture the multilayer PCBs. The problem is that the technology is not widely adopted due to limitations of fully available and compatible end-to-end manufacturing systems that also include component mounting capabilities (Surface Mount Technology / SMT). ChemCubed proposes to put together the first end to end AME (additively manufactured electronics) system.

In addition to developing the best conducting ink available, C3 has also developed a system of products to use inkjet technology to print PCBs. This system has been branded ElectroJet and includes materials, printing equipment, and process capabilities that lay the foundation for this proposal. This proposed effort will merge the current printing technology of C3's Electrojet with

a fully compatible pick-n-place SMT for component mounting, as well as software integration/camera alignment systems. This combined end to end system and technology integration and enhancement will result in a complete system that fully produces an additively manufactured electronic device (circuit boards, IoT devices, and other more efficiently produced electronic circuits).

The current Electrojet printing system is at TRL 8. It has been commercialized as a stand-alone system but needs software and camera systems for automation purposes in an end-to-end system. Any standard commercialized pick in place system that can use reflow solder, as well as conductive adhesives, is acceptable, but a small footprint system would be desired for mobility. The Electrojet printing system has been tested as a proof of concept in numerous electronics applications. Repeatability testing has yielded to less than 1% deviation from targeted electronic testing in passive circuitry and PCB board applications. Components were placed manually or in small run automated pick and place system.

<p style="text-align: center;">PROBLEM STATEMENT</p> <p>The DOD currently relies on traditional methods for PCB design and manufacturing. PCBs are manufactured in a slow, expensive, hands-on way that undermines flexibility and turnaround speed. Current PCB production methods raise costs and increase time required for suppliers to meet the DOD's needs. There is currently no complete end-to-end manufacturing system to additively produce PCBs. Such a system would save the DOD time and money and enable new design and production capabilities.</p>	<p style="text-align: center;">BENEFITS</p> <p>The proposed solution will provide benefits of decreased lead-time, faster turnaround through capabilities of in-house design, development, prototyping, and manufacturing scale-up. Internal processes vs. outsourcing may save weeks to months, as well as enable protection of sensitive intellectual property. The advanced process is flexible in capabilities, enabling engineers to be more innovative with ability to explore multiple iterations and testing due to a digital process and time savings. The proposed E2E AME system also has tremendous non-defense commercial potential.</p>
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <p>The proposed technology is to be incorporated as an upgrade to C3s pre-existing ElectroJet solutions printer, and a capability extension to the product line in functional capabilities as a full end-to-end additive manufacturing process for printed electronic circuit boards and related devices. We have demonstrated proof of concept of the ink jetted electronics additive manufacturing system. Next steps are incorporating additions to the printer and make a small production run using a commercialized pick-and-place system with the ElectroJet printing system</p>	<p style="text-align: center;">Graphic</p>  <p style="text-align: center;">Printed with C3 printer at next flex</p>

DATA-DRIVEN PART QUALIFICATION FOR ADDITIVE MANUFACTURING

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The challenge of maintaining a fleet of aging aircraft, vehicles and equipment is immense across the Department of Defense.

According to Air Force Lt General Warren Berry, “an internal review showed 80% of all demand for aircraft parts is satisfied by a repair instead of a replacement...of those part repairs, 92% can only be performed by a single supplier. This situation presents not only a challenging, time-consuming process for identifying part suppliers but leaves billions of dollars of equipment sitting on the sidelines. The DoD has already identified one solution to fixing this problem: the use of Additive Manufacturing (also known as 3D Printing) as an alternate manufacturing pathway.

In order to realize the benefits of this technology, technical data packages and manufacturing operations need to be validated and qualified. This is essential to ensure the manufacturing information is transferred and implemented correctly, and that all steps along the product life cycle are documented and traceable. Failure to properly qualify parts has a high price: potential malfunction of key equipment,

damage to government property, and loss of life.

3Degrees' TraceAM system allows AM users to track all their critical information, organizes it for multi-purpose use, and most importantly enables users to share a streamlined data set with internal and external partners. The successful implementation of the TraceAM software would accelerate DoD capabilities to generate accurate, timely, and consistent data packages for existing and future components that could be 3D Printed locally or in the theater of war. Our team has been engaged in several DoD led efforts including a Phase II SBIR with the Air Force (AFRL/MX @Eglin AFB) as well as five funded projects with America Makes with AFRL/RX as the lead program manager.

<p style="text-align: center;">PROBLEM STATEMENT</p> <p>Additive Manufacturing (AM) has been demonstrated as a viable means of manufacturing maintenance and sustainment parts, but critical gaps remain. AM qualification is slow (>18 months) and expensive (\$1.5 million) per part per material per parameter set. This process is inefficient and negates many of AM's benefits. If current approaches continue, it would take over 600 engineering months and >\$80 million to validate just a single family of three commercial printers using only the basic commercially available materials. This situation presents not only a challenging, time-consuming process for identifying part suppliers but leaves billions of dollars of equipment sitting on the sidelines</p>	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> • 3Degrees' TRACEAM can reduce these cost and time hurdles by 70% and successfully doing so would increase aircraft availability, decrease depot labor time, and expand the Make capability outside of just the DoD depots. This will shorten supply lines and decrease theater dependence. • If the process to qualify additive manufacturing materials and processes is prohibitively expensive, the ability to push the capability down the supply chain is significantly limited. Ultimately failure to properly qualify parts has a high price: potential malfunction of key equipment, damage to government property, and loss of life.
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • 3Degrees' TRACEAM software is a streamlined platform designed to effectively organize, analyze, and deploy critical technical data packages related to Additive Manufactured parts. It is a secure and customizable interface ideal for use in development and sustainment operations, enabling rapid and qualified part solutions across DoD and its supply base. • Traction: We are engaged with several commercial customers and have been part of five funded America Makes (National Center for AM). projects. We have also recently been awarded a Phase II SBIR with the Air Force (AFRL/MX at Eglin AFB) 	<p style="text-align: center;">GRAPHIC</p>  

BLUE LASER ADDITIVE MANUFACTURING

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NUBURU's industrial, high-power blue lasers unlock a path to new designs for both conventional laser-metal machining and 3D printing, which are not possible with today's infrared and green lasers.

NUBURU's patented blue laser technology takes advantage of the high absorption characteristics of all metals at the blue wavelength to dramatically reduce the energy required to melt and print metal materials, resulting in a significant increase in print speeds over an infrared laser. NUBURU's blue laser is the ideal source for remote depots because of its ability to process any metal material. NUBURU can provide this capability whether printing titanium, aluminum, stainless steel, steel, or even copper, and all of their alloys.

NUBURU integrated a 150-Watt blue laser into an EOS-M100 3D printing system to demonstrate the inherent advantages of the blue laser light over infrared light. Stainless steel parts were printed with both the infrared laser and the NUBURU blue laser. The result was a significant decrease in the energy required to print the part and a 3x increase in printing speed. NUBURU

repeated this same test with copper and discovered that the infrared laser was incapable of printing a copper part for the same power level as the blue laser. A literature search revealed that a higher power infrared laser is capable of printing copper parts, but the blue laser was 3x faster than an infrared laser with over 2x the power resulting in a 6x improvement in build speed. NUBURU has also tested titanium with results similar to stainless steel. The next step is to upgrade the EOS-M100 system with a 250-Watt blue laser and repeat the previous tests. NUBURU's expectation is that even higher printing speeds will be achieved.

NUBURU has demonstrated broad traction for its blue laser products and 3D printing, is a publicly listed company, and has won an AFWERX SBIR Direct to Phase II for its 3D printing technology and a NAVSEA task order contract. NUBURU is currently focused on finding a stakeholder in MANTECH to support a Phase III continuation of the Phase II SBIR that is currently under contract.

PROBLEM STATEMENT

Current 3D printers are incapable of producing unique spare parts for maintenance and sustainment efficiently, quickly, and at a low price-per-piece.

Not only are they slow to produce parts, but small variations in each machine can result in small variations in produced parts, which, in turn, means they are not necessarily sufficiently strong and fail quickly.

If the component is critical, then the entire system in which it is used could be compromised at a vital moment in operation.

BENEFITS

Highlighted Impacts:

- NUBURU's unique blue laser 3D printing technology dramatically increases build speeds for materials including titanium, aluminum, stainless steel, copper and their alloys.
- The ability to print parts with high resolution and high speeds enables critical replacement parts for aircraft, which are obsolete or difficult to source, to be readily produced at depots, dramatically improving fleet readiness.
- The blue laser provides material agnostic printing capabilities, meaning that a single printer can print repair parts for virtually any military vehicle.

TECHNOLOGY SOLUTION

Blue laser printing provides enhanced absorption ranging from 1.3x to 66x for various metals over infrared.

Blue lasers' high absorption enables a much higher energy transfer to the powder bed, resulting in less energy being required to melt and fuse the powder (graph). The net result is a dramatic improvement in the blue laser's printing speed.

NUBURU developed a blue laser system that was integrated into an EOS M-100 laser printer, demonstrating speed and print density advantages.

300% Improvement in Build Speed Achieved



ALL-IN-ONE ROBOTIC MAINTENANCE VEHICLE

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The DoD has a massive footprint of asphalt and concrete that requires constant maintenance and repair. USAF bases alone contain over 2.2 billion square feet of asphalt. necoTECH is developing an All-in-One Robotic Maintenance Vehicle to provide a significantly improved alternative to the manpower and fossil fuel-based solutions in use at DoD installations around the globe. When developed, necoTECH's system will include a suite of interchangeable modules that provide full autonomy, or at least human-assisted automation, toward a wide array of maintenance and repair tasks.

Our current Robotic Crack Sealing Vehicle is at TRL 8 and can be used 24/7, at up to 2x the speed of a 'trained' crew, while reducing the number of workers needed, and keeping those remaining workers out of harm's way. We are currently exploring the electrification and automation of this vehicle as part of our SBIR Phase II. For three weeks in January, this vehicle was stress-tested at Luke AFB in Arizona with their 56th CE Squadron.

We have received two STTR Phase I awards to develop additional use cases for this

vehicle in pavement joint replacement and mobile 3-D concrete printing. Plus, we have submitted multiple other Phase I applications for future use cases and autonomy improvements. necoTECH has Cooperative Research and Development Agreements in place with the Air Force Civil Engineer Center and the US Army Engineer Research and Development Center. These relationships also include rapid concrete and asphalt patents that can be integrated into our All-in-One Vehicle in the future. Finally, this "All-in-one" concept was recently awarded Top 50 honors in the Army xTechSearch 7 competition.

This technology will allow DoD bases to conduct automated preventative maintenance year-round, catching small repairs before they become major overhauls. Saving valuable warfighter time and money while maximizing infrastructure life and improving warfighter readiness and installation resilience.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> The DoD has a massive footprint of asphalt and concrete infrastructure that requires constant maintenance and repair. USAF bases alone contain over 2.2 billion square feet of asphalt. The solutions currently in use around the globe are manpower and fossil fuel-based, plus require task-specific equipment. DoD bases need to move towards conducting automated preventative maintenance year-round, catching small repairs before they become major overhauls. 	<p>BENEFITS</p> <p>Save valuable warfighter time and money while maximizing infrastructure life and improving warfighter readiness and installation resilience.</p> <ul style="list-style-type: none"> Crack Sealing - Can be used 24/7, up to 2x the speed of a 'trained' crew, reduces number of workers needed, and workers are no longer in harm's way. <p>Coming soon:</p> <ul style="list-style-type: none"> Joint Replacement Pothole Filling Concrete Printing Etc.
<p>TECHNOLOGY SOLUTION</p> <p>When developed, necoTECH's system will include a suite of interchangeable modules that provide full autonomy, or at least human-assisted automation, toward a wide array of infrastructure maintenance and repair tasks.</p> <p>The first use case is our Robotic Asphalt Crack Sealing Vehicle which is at TRL 8, under a SBIR Phase II, and spent 3-weeks being stress-tested on an Air Force Base earlier this year.</p> <ul style="list-style-type: none"> 2 Phase I awards to develop additional use cases CRADAs in place with Air Force Civil Engineer Center and the US Army Engineer Research and Development Center This "All-in-one" concept was recently awarded Top 50 honors in the Army xTechSearch 7 competition 	<p>ROBOTIC CRACK SEALING</p> <p>The diagram shows a truck-mounted robotic system. Callouts include: Standalone Generator (Power: 100kW, 24VDC, 100A), SealMaster® Crack Pro (Electrical control system for robotic crack sealing), FANUC Robot (Robot used with the SealMaster), Integrated Blow Off (Blow off system for crack cleaning), Advanced Vision System (Vision system for crack detection and sealing), and Safety Barrier (Safety barrier for the robot).</p>

DEFENSELOGIX: GENERATIVE AI AND ML PLATFORM FOR PREDICTIVE MAINTENANCE


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Kilsars’s TRL 6 AI & ML predictive maintenance platform captures legacy knowledge of skilled technicians while enabling maintainers to quickly and more accurately diagnose and troubleshoot systems. This is done by fusing record data (from maintainers) and sensor data (from systems) via natural language understanding within proprietary large language models. Complex deep learning algorithms are then applied to make sense of the data and generate predictive insights on the maintenance of the system. Step-by-step workflows provide orientation and instruction guidance for maintainers to diagnose systems. Users can videotelenconference and chat in real-time with remote team members. Users can directly and easily query questions to the platform’s proprietary, conversational language model.

Kilsar’s platform directly enhances maintenance capabilities and improves workflow efficiency, resulting in faster cycle times, decreased requirement for manpower, increased readiness of fleets, improved safety, and decreased costs.

Kilsar conducted a feasibility study in May 2023 with the 48 MXG (USAF) which demonstrated savings of \$32k and a reduction of 160 maintenance hours with the KC-1. Kilsar is currently performing on a Direct-to-Phase-II SBIR with the 100 MXG to develop and refine the application for use in aircraft maintenance. Broader applications have been identified within maintenance depots, flightlines, shipyards, and for Army vehicles. Kilsar is currently working with DoD venture partners, Taffi/Stratfi, John Tester (Senate), Betty McCollum (Congress) for plus-ups and is utilizing the SBIR program to further develop and deploy the technology at scale.

PROBLEM STATEMENT	BENEFITS
<p>A Maintainer’s Experience, time to problem, and ability to troubleshoot & repair are 3 key factors that significantly impact the DoD’s ability to meet current and future mission requirements & objectives. Historical maintenance data (sensor and record-based) remains unanalyzed & underutilized for generating valuable insights to inform organizations & technicians’ decisions.</p> <p>Brendan Lawlor CEO Kilsar, Inc. UEI: JYJGRNH19KU4 CAGE: 9DU54 Brendan@Kilsar.com</p>	<p>Kilsar’s platform provides many benefits such as:</p> <ul style="list-style-type: none"> • Extended Lifespan of equipment • Lower Maintenance Costs • Less downtime of essential equipment and vehicles • Decreased time to train workforce • Budget Control • Enhanced Routine Maintenance capabilities • Preserved Legacy Knowledge
<p>TECHNOLOGY SOLUTION</p> <p>Kilsar’s TRL-6 software platform (currently under contract with DAF) captures legacy knowledge of your most skilled technicians through custom workflow & module creation, then uses generative AI to annotate data to give other maintainers on-demand access to this information, and more accurately diagnose and troubleshoot systems. Kilsar integrates with existing systems to capture sensor data of machines and blends this with the record-based data collected from experienced maintainers. Kilsar’s machine learning algorithms are applied to generate unique insights around things like expected part lifetime, part re-ordering, and equipment defects or anomalies. Currently, the U.S. Air Force utilizes Kilsar’s platform to reduce training time for new maintainers, while reducing the time maintainers spend diagnosing and troubleshooting vehicles. Preliminary results demonstrate a decrease of 30% in time-to-diagnose & repair-specific systems such as engines. Kilsar also works with several small aviation maintenance organizations.</p>	

AUTONOMOUS LOGISTICS

INVENTORY VISIBILITY AND VERIFICATION – AT THE SPEED OF MISSION

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The DoD is in the midst of a technological transformation, rapidly acquiring and fielding advanced systems necessary to win on the battlefield. These weapons systems and equipment will only enable strategic advantage if they are maintained and sustained—in CONUS, strategic support areas, and on the tactical edge. This will be even more critical during conflict when logistics will be contested. The volume and range of goods required to sustain this technologically advanced force has outpaced current inventory inspection and management tools, meaning soldiers must manually process packages to prevent incorrect or damaged components from reaching the warfighter. Spectrohm's automated screening of maintenance-related components would enable comprehensive and rapid inventory visibility and inspection—a precursor to effective force sustainment.


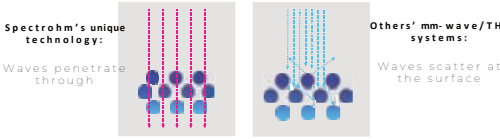

The Portal 20 uses a breakthrough internal imaging technology—transmission line tomography (TLT)—to enable safe non-intrusive screening. TLT leverages the fact that radio frequencies can image and gather material spectral signatures,

enabling devices that rapidly scan cargo, conveyances, and other items at standoff distances and at speed. The Portal delivers the fine resolution of short radio wavelengths and the deep visibility and material identification of long radio wavelengths. Radio technology requires no human operator to maintain radiation safety, enabling autonomous screening. It also gathers discriminating characteristics of individual materials even in a diverse bulk package, giving logisticians a comprehensive picture of their maintenance-related components. The Portal is fast, light, and safe, making it practical in austere environments.

Integrating the Portal into the logistics pipeline would support 100% inventory visibility. This would let commands know what spare parts and critical components they have, what condition they are in, and where they are located, dramatically decreasing equipment and material-related delays. Expired and damaged goods would never reach the warfighter, creating efficiencies and allowing soldiers to focus on more complex combat-related tasks. Incorporating RF ID-reading technology

would let the Portal alert when a piece of equipment, or component, needed inspection, maintenance, or replacement. Additionally, the system would detect concealed threats from explosives, flammables, contraband, and other dangerous materials in the supply chain.

The Portal is TRL-4 and we have a lab-tested prototype that can rapidly process packages and differentiate benign concealed materials from potential threats to air transport like oil and alcohol. We are refining it to detect these materials in even smaller volumes and identify a wider array of substances. It would take about 24 months to expand the detection library, integrate RF-ID technology, and increase hardware durability so that the Portal would have value-added in the operational environment.

<p>PROBLEM STATEMENT</p> <p>These boxes of critical components and force-sustaining supplies need to get into theater quickly...</p>  <p>...but are they the correct item and quantity? damaged? leaking? safe? expired? in need of inspection?</p> <p>...and then quickly sorted for expeditious delivery to the warfighter</p>	<p>BENEFITS</p> <p>Create efficiencies, save time.</p> <ul style="list-style-type: none">• Reduce equipment/weapon system down-time with more efficient inventory management and spare part delivery• Eliminate manual equipment inspection and reinvest human resources in complex tasks• Gain a comprehensive understanding of the logistics pipeline, including vulnerabilities and shortages <p>Protect personnel and equipment.</p> <ul style="list-style-type: none">• Alleviate the need for manual threat inspection• Prevent hazardous substances—including explosives, flammable liquids, and lithium batteries—from being inadvertently transported in air cargo
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none">• Our key to speed is radio wave technology that sees in 3D “color” to supercharge AI’s ability to identify materials• We have unique IP that lets us use long radio wavelengths. These can both see deep and identify materials  <p>For a more detailed technical explanation see: https://ieeexplore.ieee.org/document/9032975</p>	<p>SPECTROHM'S TRL-4 PORTAL 20 PROTOTYPE</p>  <p>SMALL FOOTPRINT Screen anything, anywhere</p> <p>FAST Multiple packages/second</p> <p>SAFE Non-ionizing</p> <p>SMART Identify materials</p>

MAINTENANCE DIGITAL ECOSYSTEM (MXDE)

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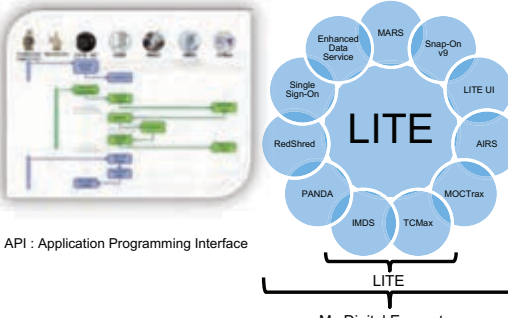
Users across maintenance & logistics spend large portions of their days doing low value-added activities because of stove-piped, ineffective systems and tools. Flight line maintenance studies show over 30% of an Airmen's day is spent on wasteful activities like redundant data entries, gathering cross-system SA, inefficient resource queuing, and cumbersome communications. These inefficient work activities reduce warfighting readiness by increasing aircraft downtime, inhibiting decision clarity and speed, and handicaps an Airmen's individual mission.

The Lighthouse Integration Technology Engine (LITE) is a technology integration platform built by Google that has cloud-based architecture, consisting of APIs and other applications. The Maintenance Digital Ecosystem (MxDE) is the collection of mission apps integrated through the LITE platform in a hub-and-spoke architecture. The hub being LITE and the spokes are a collection of mission apps. It is a user focused system of systems, fused to address activity value streams and data driven decision making capabilities. This creates one source of truth eliminating wasted time

in decision making allowing rapid execution of the core mission.

Currently MxDE is TRL7+. MxDE is currently under T&E at Nellis AFB on the F-15E flight line. In 6-8 months' time more data will be available to support operational suitability and business case validation.

Next steps are to continue to gather more supporting data at Nellis AFB. MxDE has capability to scale to the enterprise by adding new apps and workflows to solve problems across functional areas. This digital ecosystem can potentially reform many current processes across the DAF.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • Users across maintenance & logistics spend large portions of their days doing low value-added activities because of stove-piped, ineffective systems and tools – inhibits core mission • Flightline maintenance studies find over 30% of an Airmen's day is spent on wasteful activities like redundant data entries, gathering cross-system SA, inefficient resource queuing, and cumbersome communications as a few examples • Inefficient work activities reduce warfighting readiness by increasing aircraft downtime, inhibiting decision clarity and speed, and handicaps an Airmen's individual mission impact 	<p>BENEFITS</p> <ul style="list-style-type: none"> • Transform logistics operations and the pre-modern methods for system development and integration • The MxDE, through LITE allows for rapid coupling of data and system APIs in an expandable hub and spoke architecture to deliver a unified user workflow experience <ul style="list-style-type: none"> • Single Sign-On to ecosystem apps • Multi-Cloud & On-prem system architecture • Distributed user functionality • The utilization of digital tools improve flight line maintenance outcomes by reducing redundant documentation, increasing data integrity and improving communication flow • Increase situational awareness for precise and effective decision making • Capability to scale to the enterprise by adding new apps and workflows to solve problems across functional areas
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • Maintenance Digital Ecosystem (MxDE) is a hub-and-spoke architecture; integrates new and legacy systems at the spokes for two-way communication through the hub, LITE • Secure, seamless data sharing and user-centric workflows to streamline all flightline activities • Scalable and reusable; one connection requirement, exponential benefit as more systems are added • Lighthouse Integration Technology Engine (LITE) is the API management backbone, leverages Google's Apigee suite • TRL7+; in integrated T&E at Nellis AFB 	 <p>API : Application Programming Interface</p>

AUTONOMOUS LOGISTICS

ROBOTIC INCREMENTAL SHEET FORMING

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Traditional manufacturing methods do not support the speed and agility needed for the DoD. Hydroforming is one solution, but it has significant drawbacks. Hydroforming requires a single sided, machined, and hardened metallic die that is difficult to create due to the curvature, depth draw, and tolerances of the part. The difficulty in manufacturing the die results in long part manufacturing times, and lead time of 402 days to receive the panel. Furthermore, the hydroforming dies must be maintained and stored even if only used once.

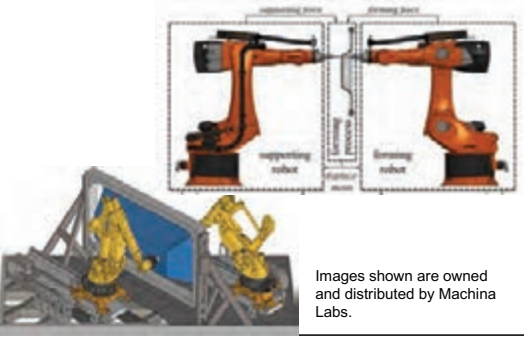
Robotic Incremental Sheet Forming (RISF) is a recommended alternative to hydroforming because of its short payback period, speed and flexibility, and high estimated life cycle savings over hydroforming.

Double-sided Robotic Incremental Sheet Forming is a process where two robots with end of arm stylus tools use a predefined CNC tool path to shape the sheet metal into a replacement part. Compared to conventional hydroforming, robotic incremental forming offers high formability and process flexibility.

A CBA Analysis generated by University of Dayton Research Institute (UDRI) estimates that double-sided incremental sheet forming has an estimated life cycle savings over hydroforming of \$108,367,699, a cost/benefit ratio of 8.52/1, and a payback period of only 1 year.

RSO Automation and Robotics team can be contacted for a copy of the report.

The RISF technology is TRL 7-9.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none">•Traditional manufacturing methods do not support the speed and agility needed for the DoD•Legacy methods, like Hydroforming have significant drawbacks including:<ul style="list-style-type: none">•High non-recurring tool costs•Unique dies can take months or years to manufacture•Complex parts with curvature are difficult to produce•Long lead time (up to 402 days for a panel)•Dies must be stored and maintained or risk failure	<p>BENEFITS</p> <ul style="list-style-type: none">•Increased responsiveness to operational needs•Avoid die design, build, and maintenance•Reduced time to produce•Rapid change between parts•Large cost savings•Cost/Benefit Ratio is 8.52/1•Payback period is 1 year•Estimated Life Cycle Savings for RISF over Hydroforming is over \$108M
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none">•Robotic Incremental Sheet Forming (RISF) is a process where two robots with end of arm stylus tools shape the sheet metal into a replacement part.•Compared to conventional hydroforming, RISF:<ul style="list-style-type: none">•Offers high formability•Increased flexibility•Shorter lead times for new parts	 <p>Images shown are owned and distributed by Machina Labs.</p>

FUTURE OF AUTOMATED FLIGHTLINES AND AIRFIELDS

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Problem Statement: Dispersed manpower, contested logistics, tyranny of distance, lightening the load, transportability of traditional loading equipment are all challenges for maintenance. Coordination of assets, asset specific parts, appropriately trained personnel, and proximity of the collective are critical for timely maintenance and repairs of aircraft, vehicles, roadways, and airfields. Traditional DoD assets can be produced so mission-specific that they lack utility for near similar tasks.

Technology Solution: Image a flightline with unmanned platforms delivering cargo, supplies, fuel, and maintenance from hangers to the flightline. With near field communications, and optics aircrafts on the flightline will generate requests at the flightline. Unmanned platforms emerge to fuel, report shortages, and rapidly replenish needs on the flightline. Upon landing in an austere environment, the Multi-Purpose Expeditionary Platform can clear trails, setup base of operations and then provide secondary battery back for HVAC and Communications. Tracks North America (Tracks NA) offers DoD the application of multi-purpose, unmanned, ground-robotic

platforms. Tracks NA is working to swarm airfield damage repairs, pick-up and deliver parts, packages, and cargo.

Tracks NA's network of partners like Apronnik, Blueforce Development, Wilcox, and SAFE Structure Designs are working to automate the flight line and future Airfield Damage Repair.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none">▪ Dispersed manpower, contested logistics, tyranny of distance, lightening the load, transportability of traditional loading equipment are all challenges for maintenance.▪ Coordination of assets, asset specific parts, appropriately trained personnel, and proximity of the collective are critical for timely maintenance and repairs of aircraft, vehicles, roadways, and airfields.▪ Traditional DoD assets can be produced so mission-specific that they lack utility for near similar tasks.	<p>BENEFITS</p> <p>Future of Automated Flightlines and Airfields</p> <ul style="list-style-type: none">• Tracks NA's platforms are specifically designed for simplicity and versatility. Upon landing in an austere environment, the Multi-Purpose Expeditionary Platform can clear trails, setup base of operations and then provide secondary battery back for HVAC and Coms.• On a single pane of glass, Tracks NA will provide DoD real-time tracking of maintenance kits, assets, and the personnel. Loading, fuel, ammo, and munitions will be semi-autonomously dispatched to specific aircraft on the flight door.
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none">▪ Tracks North America's unmanned, ground robotic platforms along with our partnerships with companies like L5VEL, SAFE Structures, Blueforce Development, Wilcox, and Apronnik offers DoD access to multipliers that can be leveraged for automating flightlines and airfields.▪ Image a flightline with unmanned platforms delivering cargo, supplies, fuel, and maintenance from hangers to the flightline. With near field communications, and optics aircrafts on the flightline will generate requests at the flightline.▪ Unmanned platforms emerge to fuel, report shortages, and rapidly replenish needs on the flightline.	

AUTONOMOUS LOGISTICS

GIANT MOVEABLE FOOD FACTORY (NOAH'S ARK)

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Giant moveable food factory (Noah's Ark)
 (Ocean greenhouse farming)

In this proposal, we present a concept for a colossal mobile food production facility acted as the Noah's Ark, based on our PTCA (plant tissue culture automation) project. The objective is to construct a mammoth automotive food generation vessel of cruise or cargo size that can sustainably produce food for a specified number of individuals without interruption or the need for external resources or land docking. To achieve this goal, the ship will integrate various disciplines and technologies to optimize its operations.

Project description(brief): The objective is to utilize the entire ship as a greenhouse for ocean farming, dividing the various deck areas into movable grid layers dedicated to different species of plants. These grids are installed on tracks that allow them to be relocated across different decks and rotating light incubators.

This automated food generation vessel will be equipped with a perpetual energy source (if normal power does not match), such as nuclear power, enabling it to navigate the

ocean for extended periods without the need for docking. It will efficiently produce an abundant supply of food to sustain a designated population, let's say 5000 individuals, in a sustainable manner over prolonged durations, spanning years.

By implementing this project, we aim to create a functioning vending machine-like automated system that enables users to seamlessly select, grow, and cook their preferred food items through an autonomous process. Ordering and cooking can be easily managed and completed through tablets or phones, with AI or remote control overseeing the entire system. All crops undergo cycling growth.

To facilitate the necessary tasks, several operational platforms have been established within specific areas of the ship, each with its own responsibilities, as outlined below:






1. Main dedicated plant tissue robot operation platform:
2. 2Greenhouse sensor and robot management platforms:
3. Lower decks automated storage area:

1. Other facilities on the ship automatedly serve for other functions:

These facilities and platforms work together to ensure the smooth operation and efficiency of various tasks necessary for the ship's operation and self-sustainability.

Significance:

1. This project aims to develop an innovative ocean farming ship model that can sustainably generate food for both civilian and military purposes.
2. By integrating various techniques into a single platform, this project seeks to automate food production and present ocean farming as a viable alternative to traditional mainland agriculture.
3. Based on the building ship size, and selected crop species, this ocean farming model can provide abundant food for a certain number of people in a cycle sustainable way for years.
4. This automated/remote control operation model would eventually be developed to automotive drive vessel controlled by satellites served in supply chain.

<p style="text-align: center;">PROBLEM STATEMENT</p> <p>Ocean transportation functions as a versatile mode of travel, linking every continent through the ease of maritime vessels. Ensuring sustainable food production in the ocean is vital for civilian and military needs. This practice not only ensures the security of the fleet's supply chain but also addresses food shortages during conflicts, aiding war-stricken areas.</p>	<p style="text-align: center;">BENEFITS</p> <ol style="list-style-type: none"> 1. Sustainably generate food for both civilian and military purposes in ocean missions. 2. Based on the size, and selected crop species, this ocean farming can provide abundant food for a certain number of people in a cycle sustainable way for years without land docking. 3. Can be remote/satellite control served in supply chain.
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <p>This proposal presents an innovative idea for an enormous mobile food production facility, inspired by the concept of Noah's Ark and built upon our PTCA (Plant Tissue Culture Automation) project. The goal is to create a massive self-sustaining food production vessel, comparable in size to a cruise or cargo ship, capable of generating food continuously for a specific number of people without relying on external resources or land docking throughout its mission. This floating food factory will have the ability to stay at sea for extended periods, traveling without the necessity of docking on land. It will sustainably produce enough food to support a designated population for a considerable duration, ensuring a consistent and uninterrupted food supply in an eco-friendly manner.</p>	<p style="text-align: center;">Moveable giant food factory (Noah's ark)</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p><small>Giant cruise or cargo ship</small></p>  </div> <div style="text-align: center;"> <p><small>PTCA platform</small></p>  </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="text-align: center;"> <p><small>Tissue storage</small></p>  </div> <div style="text-align: center;"> <p><small>Light irradiation Nutrient hydroponics</small></p>  </div> </div> <div style="text-align: center; margin-top: 10px;">  </div>

SUSTAINABLE ECOSYSTEM ON THE MOON (LUNA-10)

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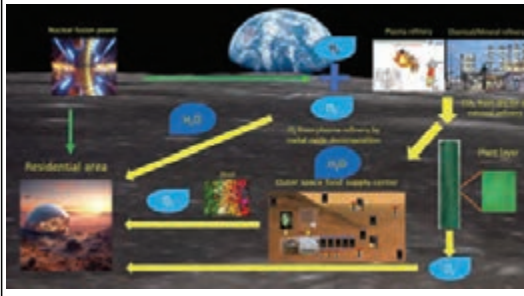
Our closest celestial companion, the Moon, has been associated with specific mineral deposits ever since the Apollo missions set foot on its surface. Establishing a viable ecosystem on the Moon holds significant importance for future human endeavors in colonization and exploration. To ensure the enduring success of human presence on the Moon, it's imperative to create a self-sustaining ecosystem that fulfills the basic needs of inhabitants while harmonizing ecological health with human activities.

A major obstacle in developing a sustainable Moon ecosystem is the absence of a natural atmosphere. The Moon's lack of atmosphere results in extreme temperature fluctuations and the absence of oxygen, rendering it unsuitable for human habitation and conventional Earth-like vegetation growth. Additionally, limited natural light and weak gravitational forces pose further obstacles. However, the crucial role of lunar minerals present on the surface lies in supplying vital elements, particularly nitrogen, phosphorus, and potassium (NPK), essential for promoting plant growth. Additionally, substantial reservoirs of argon and helium on the Moon create the

possibility of establishing a plasma refinery to extract resources from its terrain. Utilizing high-temperature decomposition (plasma refinery) of metal oxides would effectively produce oxygen for human use in outer space. Notably, the process of plant photosynthesis also generates oxygen by converting carbon dioxide. Moreover, synthesizing water becomes feasible by tapping into hydrogen from the Moon's atmosphere. This dependable source of essential nutrients establishes the foundation for sustainable plant cultivation on the Moon, thus facilitating the creation of a self-sustaining ecosystem that supports prolonged human exploration and drives advancements in lunar economics.

Given the challenges posed by the lunar environment, including the absence of oxygen, minimal natural light, drastic temperature variations, and weak gravity, it is advisable to utilize autonomous or remotely controlled platforms for the initial exploration of the Moon. Once a self-reliant local nutrient source for plant growth is established, our Outer Space Plant Breeding and Cultivation Apparatus (PTCA), developed for NASA, seamlessly fits this framework.

This innovative concept, which merges plant development with biotechnological breakthroughs and automated crop breeding, presents a holistic solution with the genetic modification of cell lines, plants, and biomaterials. This approach aims to facilitate sustainable production of oxygen and food in outer space, addressing the challenges posed by the lunar environment.

<p>PROBLEM STATEMENT</p> <p>Our closest celestial companion, the Moon, has been associated with specific mineral deposits ever since the Apollo missions set foot on its surface. Establishing a viable ecosystem on the Moon holds significant importance for future human endeavors in colonization and exploration. To ensure the enduring success of human presence on the Moon, it's imperative to create a self-sustaining ecosystem that fulfills the basic needs of inhabitants while harmonizing ecological health with human activities.</p> <p>A major obstacle in developing a sustainable Moon ecosystem is the absence of a natural atmosphere resulting in extreme temperature fluctuations and the absence of oxygen, rendering it unsuitable for human habitation and conventional Earth-like vegetation growth. Limited natural light and weak gravitational forces pose further obstacles.</p>	<p>BENEFITS</p> <ul style="list-style-type: none"> • This exceptional automated crop generation platform has been specifically designed to fulfill the demands of outer space, serving as an unmanned crop breeding system. • It has the capability to operate within an outer space greenhouse module or facilitate aerial crop breeding in a manner that promotes sustainability. • Serving as a dependable food source, it has the potential to ensure a continuous and sustainable supply of nourishment. • Offering a viable operational framework, it paves the way for the advancement of outer space crop breeding.
<p>TECHNOLOGY SOLUTION</p> <p>Utilizing lunar surface minerals and atmospheric resources, we present a concept aimed at establishing viable ecosystems for the initial lunar inhabitants. Our proposal involves employing the PTCA NASA outer space crop breeding platform to cultivate essential oxygen, water, and food resources. This system incorporates a self-sustaining local nutrient source in the Moon, ensuring self-reliant plant growth to support the needs of the lunar residents.</p>	<p>Sustainable Ecosystem on the Moon</p> 

MANUFACTURING INTEGRATION AND INTELLIGENCE

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Letterkenny Army Depot's (LEAD) mission requires shop floor artisans and other production specialists to interact with the system of record, Logistics Modernization Program (LMP). Some of these interactions include various administrative tasks: start/stop/completion of jobs, job prioritization and assignment flow, printing of shop floor documentation, and creating a measurable catchup plan for backlogged work.

LEAD saw an opportunity to simplify and reduce time spent on each task by utilizing Manufacturing Integration and Intelligence, MII, reporting system, a subset of LMP, to create a suite of custom graphical user interfaces. LEAD utilizes MII's web application for personnel to access the four tools, descriptions following.

Shop Floor Artisan Liaison (SEAL) currently provides a one stop shop for artisans to quickly process operation start/stops/complete, sending messages to Complex Assembly Manufacturing Software (CAMS) on their behalf, saving each direct employee an estimated 7.5 (one job a day) to 11.5 (two jobs a day) minutes per day compared


to traditional CAMS entries. Artisans can start jobs in a crew of two or more utilizing manual entry and bar code data from work-in-process (WIP) Tags, input shop and inspection notes and view relevant production data all in one spot. The next steps in development are standard text entry, non-conformance module, self-certification, skips and serial number entries.

Work In Progress Allocation and Strategic Priority (WASP) provides artisans a live, digital visual of the queue of work within their work center. WASP relieves supervisors from distributing work, organizes work based on a first in first out basis and shows a wealth of vital production information. WASP reduces the amount of indirect time spent managing detailed schedules, which is nearly impossible when working within the remanufacturing realm.

WIP Tag tool condenses information found on traditional CAMS shop floor travelers and adds new essential information that is typically handwritten after the fact. The tool prints barcodes for each unique operation so that artisans can utilize the capability

in SEAL and provides a 72% reduction in paper production tags. LEAD prints over 3000 shop floor identification packets per year, to ensure all items sent through depot processes are labeled to comply with Aerospace Standards.

Strategic Intervention Generator (STING) displays backlog and current workload for a work center or group of work centers. STING is a visual tool that allows a supervisor to drag and drop backlog into the current work schedule to determine how many resources, including people or overtime, might be required to complete an item to generate a measurable recovery plan. Prior to STING, supervisors had no tools for capturing or visualizing backlog or recovery plans, which made it difficult to project viable completion dates. STING allows supervisors to display the recovery plan to ensure proper accountability for artisans within the work center.

PROBLEM STATEMENT	BENEFITS
<ul style="list-style-type: none"> Time consuming reporting for shop floor artisans at Letterkenny Army Depot (LEAD) and other organic industrial base(OIB)sites. No digestible visual for shop floor work priority queue that automatically reflects active work. High paper use for work in progress (WIP) tags that are required for shop floor routing and lack barcode scanning capability. No simple way to create an intervention plan for late work. 	<ul style="list-style-type: none"> (SEAL) Reduction of computer administrative time for artisans: <ul style="list-style-type: none"> 1 job per day: 7.5 minutes per day(27 hours per year), 2 jobs per day: 11.5 minutes per day(42 hours per year). 2D Barcode scanning enabled (WASP) Provides artisans live digital updated priority of work with out the daily intervention of supervision giving out job taskings. Shows a wealth of vital production information in one spot. (WIP Tags) Reduced paper use by an average of 72% percent. Includes 2d barcodes that integrate with SEAL and WASP. Encompasses all pertinent information on less paper than traditional CAMS paperwork. (STING) Provides a "drag and drop" interface for supervisors to visualize backlog within their cost center and develop a clear recovery plan. The tool allows for additional resources like overtime or extra personnel.
TECHNOLOGY SOLUTION	
<ul style="list-style-type: none"> LEAD created a series of tools in Manufacturing Integration and Intelligence (MII) within Logistics Modernization Program (LMP). Shop Floor Execution Liaison (SEAL) allows artisans to quickly record mandatory production data such as: starts/stops/completes on operations, shop notes Work In Progress Allocation and Strategic Priority (WASP) provides a digital visual of work in a cost or work center that prioritizes jobs based on first in first out logic. WIP tags are condensed from prior Complex Assembly Manufacturing Solution (CAMS) travelers and include barcoding on each operation. Strategic Intervention Generator (STING) is a tool that helps supervisors create back log plans. 	

DEEP TIER VALIDATED SCRM FOR SUPPLY ASSURANCE AND DMSMS

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Supply Chain Risk Management (SCRM) is crucial for the Department of Defense (DoD). Maintenance and Sustainment offices can improve business processes and partnerships using SCRM for assured supply and identification of diminishing manufacturing sources and material shortages (DMSMS) to become more agile, effective, efficient, and affordable.

Resilinc's multi-tier supply chain mapping solution helps map, monitor, and manage risk across the supply chain. It has been deployed in production for over 13 years. The mapping and early-warning alert systems monitor and predict potential disruptions across suppliers, sites, and materials. The key component to mapping an accurate supply chain is site and part location provided directly by sub-tier suppliers. Resilinc has a database of 800K+ suppliers participating augmented by Artificial Intelligence (AI) to identify the most likely supply chain where gaps exist. The platform enables organizations such as DLA, DIU and USAF OCEA to illuminate and collaborate closely with Tier-1 to Tier-n suppliers.

85% of disruptions are because of Tier 2+ players. To assure supply, Resilinc has a proven methodology of identifying disruption early at all tiers using Natural Language Processing (NLP), (AI), and Machine Learning (ML) to monitor 104M+ news and data sources globally in 100+ languages. These disruptions could be caused by natural disasters, corporate restructuring, cybersecurity, geopolitical events, accidents and more. To become more agile, effective, and efficient, the platform also allows war-gaming of potential events to assess risk before it happens. Using playbooks to establish plans of action between supplier and DoD, the right players can be prepared to manage potential risks such as embargoes, invasions, hurricanes and more.

Resilinc has also allowed our commercial and DoD clients to get in front of DMSMS issues thousands of times over the last 10+ years. Most DMSMS issues are rooted in disruptions that occur at low tiers with their existence slowly flowing up the supply network, sometimes taking over a year to reach the end buyer. The mapping and collaborative structure will allow suppliers

at all tiers to notify DoD when parts have reached end of life signifying a last time to buy date. The supplier and DoD can arrange life of type buys or develop alternate sources to make sustainment much more affordable than a costly emergency re-design effort with an OEM.

Lack of visibility is the key deterrent to agile, effective, efficient, and affordable business processes and partnerships. With the Resilinc approach, DoD will establish direct visibility of suppliers at deep tiers and have open lines of communication to mitigate and manage risk. With this visibility, DoD can remove uncertainty in the supply chain that exists today by relying on prime contractors alone to manage unforeseen shortages and DMSMS preparing acquisition organizations for the next disruption, like the recent Chinese export bans.

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • DoD Maintenance and Sustainment need to become more agile, effective, efficient and affordable by developing collaborative business relationships with suppliers. • Current limited business relationships cause the DoD maintenance and sustainment programs have delays in repair due to unavailability of key parts supplied by deep tier vendors 	<p style="text-align: center;">IMPACT</p> <ul style="list-style-type: none"> • Key parts are delayed, and platforms are not maintained/repared in a timely fashion • Key parts are discontinued by a low-tier vendors without notice and programs require a costly re-design with potential impacts to availability and readiness • Geopolitical events (Russia-Ukraine), trade wars (Gallium-Germanium) or other events (PFAS/PTFE) can only be addressed reactively
<p style="text-align: center;">SUSPECTED CAUSE</p> <ul style="list-style-type: none"> ▪ DoD lack of visibility to low tier vendors, locations and part manufacturing/distribution. ▪ Lack of alerting for global events that impact continuity of supply. ▪ Reliance on prime contractors alone to manage sub-tier vendors. ▪ Aging programs with parts that are reaching end of life. 	<p style="text-align: center;">Corrective Action</p> <ul style="list-style-type: none"> • Validated mapping of the supply chain to the Nth Tier capturing supplier locations and part availability. • Proactive alerting of potential global impacts to the supply chain. • War-gaming capability for what-if scenarios • Direct collaboration capabilities with all suppliers at any tier to mitigate and manage risk.

DIGITAL ECOSYSTEM TO SUPPORT REAL TIME ANALYSIS

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With 3000+ pieces of Industrial Plant Equipment, 1800 of which are ready to connect, the Oklahoma City-Air Logistics Complex (OC-ALC) needed a digital solution for a historically analog problem. A real-time view and overall trend analysis aimed at machine tool data from levels including machine, shop, and department were needed to calculate overall equipment effectiveness (OEE). Previously machine health and utilization data were manually obtained, resulting in inaccurate numbers due to human error and costing over \$6M in personnel hours annually and millions in material waste. The need for a solution is imminent.

OSIsoft is a leader in their field as a data historian, visualization tool and data analytic. The PI system monitors production, enabling troubleshooting and root cause analysis. Engineers can create efficiency and production reports, define optimal processes, configure early warning signs for predictive maintenance, increase equipment reliability, tune controllers to reduce utility consumption, and create visualization tools for production and

management. PI includes all software required to monitor, troubleshoot, and analyze our equipment without having to authorize new software from other providers for engineering or shop support.


CNC machines require model creation to produce a part. Predator PDM allows for remote program transfer, traceability, and archiving of modeled parts. Using PDM to create parts standardizes the time and quality increasing the overall OEE.

- Real-time production and monitoring
- Increased production
- Decreased Waste, Downtime, and Personnel hours
- On-condition preventative maintenance

Machine connections have reduced downtime events. Previously, downtime investigations could span 4 hours to 4 weeks. There was no method to target the root cause of downtime without troubleshooting each asset within the machine. Access to machine data enables personnel to determine the root cause minimizing the downtime impact over 60%.

OC-ALC created an enterprise network for industrial plant equipment, connecting machines, providing the ability to store operational data, track machine parameters, and capture run state, using Next Gen Cisco network products, AVEVA PI Systems, and Predator Software dashboard components. OC-ALC implemented PI data analytics to provide reports using real time data to lower inaccuracy of manual data collection. This initiative also strives to automate reporting and streamline digital data digest.

Dashboards are a tool used by OC-ALC Commanders and Supervisors to track operations and effectiveness of the shop floor machine tools that create and test airframe parts and engines. Without dashboards, leaders and maintenance personnel use several systems to track work processes; the dashboards bring the data together in one pane of glass using real-time data. Data trends determine if processes are following standards set to ensure production rates and quality metrics are met.

<p style="text-align: center;">PROBLEM STATEMENT</p> <p>With over 3000 pieces of Industrial Plant Equipment, 1800 of which are ready to connect, the Oklahoma City - Air Logistics Complex (OC-ALC) needed a digital solution for a historically analog problem. A real-time view and overall trend analysis aimed at machine tool data from levels including machine, shop, and department were needed to calculate overall equipment effectiveness (OEE). Previously machine health and utilization data had been manually obtained, resulting in inaccurate numbers due to human error and costing over \$6M in personnel hours annually. Added to millions in material waste the need for a solution was imminent.</p>	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> • Real-time production and health monitoring • Increased parts produced • Decreased Material Waste • Decreased downtime • Decreased personnel hours • On-condition preventative maintenance • Established multi-state functions for operational status, technical data, and environmental compliance
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • OC-ALC created an enterprise grade network for industrial plant equipment, connecting machines, and provided the ability to store operational data, track machine parameters, and capture run state, using Next Gen Cisco network products, AVEVA PI Systems, and Predator Software dashboard components. • OC-ALC implemented PI System's data analytics to provide reports utilizing real time data to alleviate the inaccuracy of the previous manual collection. This initiative also strives to standardized automatic reporting and streamline digital data digest, additionally providing cyber security previously non existent. 	<p style="text-align: center;">Graphic or Image</p> 

FAMILY OF SUSTAINMENT ASSISTING ROBOTICS (FOSAR)

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The Family of Sustainment Assisting Robotics (FOSAR) program will develop and demonstrate multiple technologies under one common and synergistic architecture to enable the Navy and other stakeholders' access to a common user-interface and common tools, that will dramatically reduce maintenance & sustainment costs. The capabilities, provided by multiple companies, will include robotic systems, payloads and sensors, digital solution tools that include AR/VR/MR/XR, Logistics Internet of Things, and Exoskeleton technology for use by maintenance & sustainment personnel.

Common components, open architecture software, and user interfaces reduces training times and times and costs associated with maintaining many different payloads and spares. The "plug n' play", or interchangeable payloads, increasing worker efficiency between different delivery platforms offered by the members of the FOSAR community. Success will be a reality once capabilities are implemented and workers recognize these capabilities by stating, "that's a FOSAR capability" regardless of the supplier providing that capability.

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • The defense industrial base has significantly deteriorated over past two decades. • Years of knowledge is being lost with the retiring workforce. • New workforce is not excited or attracted to sustainment and maintenance jobs. • Budgets shortfalls requires establishment of cost efficient and effective solutions. • Weapon system availabilities still too low. 	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> • Adds advanced capabilities at a lower overall cost. • Captures/retains experience and knowledge before it leaves. • Extends access to the retired or retiring workforce • Increases efficiency of sustainment and maintenance. • Reduces training costs through commonality and standards • Reduces spare parts costs. • Reduces non-recurring engineering costs – avoid companies re-inventing the wheel. • Reduces pressure to buy more systems by keeping existing systems available. • Reduces specialization and propensity to buy the same payload for each different platform.
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <p>Family of Sustainment Assisting Robotics (FOSAR)</p> <ul style="list-style-type: none"> • Creates common tools and capabilities to extend effectiveness of fewer available workers. • Captures "gray hair" knowledge and extend access to those willing to work part-time. • Provides advanced and train visual and smart connected tools attractive to new workers • Provides commonality, open software, reduced spare part amounts and costs, and reduce training time • Keeps our weapon systems "in the fight"; increasing competitiveness of our private and public facilities. 	<p style="text-align: center;">GRAPHIC</p> <p style="text-align: center;">Developing/Demonstrating New Maintenance & Sustainment Technologies</p> <p style="text-align: center;">We are developing and providing robotic systems and digital tools to assist workers in the execution of their jobs.</p> <p style="text-align: center;">Reduce Danger to Workers</p> <p style="text-align: center;">FOSAR speeds work execution, reduces costs and keeps our weapon systems ready for the fight (when they are needed).</p> <p style="text-align: center;">Reduce Hours to Maintain</p>

OPTIMIZATION THROUGH SYSTEM OF SYSTEMS DATA MESH MODELING

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Digital Twins and AI are offering new ways to assess changes within an enterprise. What is not always available in the models is the ability to view how a simulation is affected by and will affect connected assets, systems, people, and processes. Making adjustments to a manufacturing plant model may give a user an immediate output of improved throughput but might not give them the expected revenue or profit earnings with that change. It also might not tell the user that the supplier of the required components is unable to support the increase in materials. By integrating the various digital twins deployed by an enterprise, the user can see what supplier constraints exist for the change in a shop floor and whether the expected earnings will justify the change.

Our solution ties together a system of systems to give users better decision-making tools. By integrating simulation technologies across the enterprise, easy-to-read data visualizations are presented to users showing the data chain of the desired change. In manufacturing, if a shop wishes to shift resources, the impacted data points in the process are

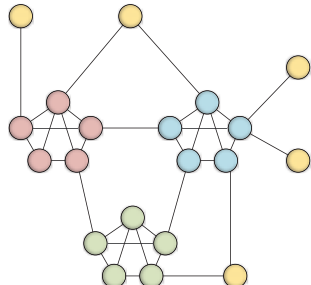
highlighted upstream, such as suppliers and procurement lead times, and downstream, like production time and transportation frequencies. If a manufacturer changes the composite of a component, this will feed into the asset production which in turn would update the throughput. This allows for quicker impact assessments that can be shared with leadership.

Along with the system and infrastructure twins that are commonly thought of when referring to digital twins, human processes, project plans, and staffing plans, are also able to be modeled. While process twins, often embedded within other digital twin software, can simulate human movement and actions they do not simulate human decision making that would normally come through policy and leadership.

These types of inputs can still be included in a system of system of systems model though static data sets. The solution does not only function by changing input data, but also through changing desired outputs. By utilizing AI, an update to values like asset production, recommendations are made to

achieve that new goal. This could lead to recommended changes in shop floor layout, equipment scheduling, resource planning, or supplier adjustments. Users can see what data leads to their benchmarks allowing them to create a path forward that may not have otherwise been considered.

Our product is currently early in development with plans to continue building with our solution partners. Through collaboration with numerous providers, the solution will be able to enhance each aspect within the system of systems.

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • Though digital twins play an integral part in digital modernization, it is not always easy to identify how a change made in a simulation will impact other areas of the enterprise. • A system of systems contains layers of inputs which are not always considered. Directives, policy, workforce, and social factors all lead to inputs which may be part of the data chain in manufacturing. • Directives often give clear goals and benchmarks while workers are left to sift through unclear option to achieve these goals. 	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> • Perform quicker impact assessments to connected systems, people, and processes when a digital twin simulation is updated. • Create connections to systems regardless of the target platform. • Identify how external changes impact the shop floor and how shop floor changes impact the business. • Previously unconsidered options are made available to implement in order to achieve goals. • Improve upon already proven achievements in digital twin technologies.
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> ▪ Integrate the digital twins across the system of systems landscape with a hybrid data mesh approach. Some nodes communicate with a central hub while others do not. ▪ Use a virtual database to connect with any number of disparate systems and create a uniform data set as if all data resided in one database. ▪ Provide data visualization showing data chains between systems. Highlight impacted data points when data is changed. ▪ Utilize AI to provide recommended data changes to achieve desired outputs. 	<p style="text-align: center;">Graphic or Image</p>  <p>Different layers exist to the SoS. Databases have close ties, decision makers as well, along with policy and social factors. These all connect through any number of integration points. External systems like suppliers and customers feed and receive data while not being fully visible to the enterprise.</p>

LEVERAGING GENERATIVE AI TECHNOLOGY FOR MAINTENANCE

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Problem Statement: The maintenance of DoD equipment, systems and subsystems presents a formidable challenge due to the extensive library of maintenance manuals and the reliance on human expertise. Traditional practices are time-consuming, error-prone, and hindered by dependence on individual memory. These inefficiencies impact maintenance costs, safety, readiness, and manpower requirements. To address these issues, there is a pressing need for a technology that can streamline maintenance, enhance accuracy, and reduce reliance on human experience.

Description of the Technology: Valkyrie Intelligence & GPT For Readiness (VIGR). Innovative Generative AI technology designed for complex technical documentation. Key features include:

- **Unlimited Data Ingestion:** VIGR can process an unlimited number of pages from electronic technical manuals, granting access to the entirety of the maintenance knowledge repository.
- **Natural Language Interface:** VIGR offers a user-friendly chat interface, allowing natural language interactions

for troubleshooting and maintenance guidance.

- **Offline Operation:** VIGR operates offline, ensuring data security and preventing misinformation.
- **Explain Tab:** VIGR provides detailed explanations and supports recommendations with specific page and paragraph references from selected manuals.


Current Development Status: VIGR is in an advanced development stage, undergoing extensive testing. It has been prototyped and demonstrated in controlled environments, showing promising results.

- **Efficiency Boost:** Our SMEs estimate VIGR reduces troubleshooting time by 40%, cutting cycle time and manpower needs.
- **Enhanced Accuracy:** VIGR achieves a 98% accuracy rate in maintenance instructions as rated by SMEs, minimizing operational risks.
- **Reduced Errors:** VIGR decreases human errors by 30% compared to manual methods, enhancing safety.

- **User Satisfaction:** Users praise VIGR's usability and the clarity of its technical recommendations.

Next Steps/Potential Benefits:

- **Refinement and Integration:** VIGR will undergo further development and more comprehensive testing on maintenance actions.
- **Cost Reduction:** VIGR reduces operational costs through faster, more accurate maintenance actions and decreased downtime.
- **Knowledge Retention:** VIGR ensures critical maintenance knowledge remains accessible, independent of individual expertise.
- **Cross-Service Applicability:** VIGR can benefit all military service branches and the Defense Logistics Agency.
- **Feasibility for DoD:** VIGR is a viable solution for DoD maintenance needs, with strong test data supporting its performance claims.

<p>PROBLEM STATEMENT</p> <p>Navy ship maintenance presents a formidable challenge due to the extensive and intricate nature of maintenance manuals. These manuals often require exhaustive searches, leading to time-consuming troubleshooting procedures. The reliance on individual experience further compounds the problem, resulting in high error rates and inefficiencies. This, in turn, adversely affects maintenance costs, jeopardizes safety, hinders readiness, and demands a substantial manpower commitment.</p>	<p>BENEFITS</p> <p>VIGR substantially enhances maintenance efficiency by significantly reducing the time required for troubleshooting and issue resolution. VIGR minimizes downtime and optimizes the utilization of available manpower. VIGR's ability to provide precise maintenance instructions translates into a reduction in operational errors, enhancing safety and reducing the risk of mission-critical failures. VIGR's ability to retain critical maintenance knowledge ensures accessibility even when experienced personnel are unavailable.</p>
<p>TECHNOLOGY SOLUTION</p> <p>Valkyrie Intelligent GPT for Readiness (VIGR) possesses the capability to ingest an unlimited volume of technical data, simplifying access to maintenance manuals. Its natural language interface is user-friendly and approachable, allowing for intuitive and efficient interactions. VIGR operates offline, ensuring data security and mitigating the risk of misinformation. VIGR includes an "Explain" feature that provides detailed explanations supported by specific page and paragraph references from selected manuals.</p>	 <p>The image shows the VIGR logo, which consists of a stylized 'V' with red and blue vertical bars, followed by 'IGR' in white. Below the logo is a hand holding a smartphone that displays a chat interface with a blue header and a white background. The text 'CHAT GPT' is visible on the screen.</p>

PART ACQUISITION AND ASSEMBLY INTEGRATION AND TEST

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Problem Statement: Sustainment success depends on data access. When more people and departments are involved, communication, collaboration, and traceability become more crucial, and it becomes more necessary to eliminate information silos.

Accessing information is part of the challenge, from offices to assembly areas and warehouses. Even with technology, managing these obstacles can leave room for costly missteps that delay operations and impact deliveries.

Manufacturers need to reduce the risk of operational delays and subsequent costly rework through technology investments. With Eontes' PART ACQUISITION & ASSEMBLY INTEGRATION & TEST solution, they can manage product information and provide transparency while supporting workers and products across the entire value chain.

Technology Description: Model-based product lifecycle management software, such as Aras Innovator, makes it possible to ideate, create, analyze, manage, and sustain products. With Eontes' customizations to

Aras Manufacturing Process Planning (MPP), digital work instructions support product builds with critical features.

The MPP Assembly Procedure structures the build instruction. Engineers create a digital assembly procedure that simplifies and speeds up the build process.

An assembler follows the build instructions and captures essential facts with the MPP Execution Record. It is generated automatically and notes the assembler's build details, deviation records, and capture information.

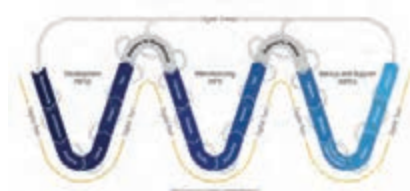
View the Execution Record parameters to see the physical components defined in the build process. Engineers match the required physical parts, based on their unique characteristics, e.g., batch or serial numbers, revision, and vendors, to their design counterparts defined in the engineering bill of materials. Linking the physical parts and resources is a crucial digital feature that provides an accurate build definition.

For modifications, redlining provides editing features. The system captures,

organizes, and tracks changes as a redline to the procedure.

The companion Eontes mobile app provides real-time connectivity to shop floor instructions, and the system builds and ensures a shipped product configuration is captured.

A Technical Data Package documents the validated assembly process and build configuration with an automatically generated Microsoft Word file.

<p style="text-align: center;">PROBLEM STATEMENT</p> <p>Sustainment support and success depend on data access. Complexity grows when manufacturers prioritize product innovation, operational efficiency, revenue growth, and customer retention. When more people and departments are involved, communication, collaboration, and traceability become more crucial, and it becomes more necessary to eliminate information silos.</p> <p>Accessing information is part of the challenge, from offices to factory assembly areas and warehouses. Even with technology, managing these obstacles can leave room for costly missteps that delay operations and impact product revenue.</p> <p>Manufacturers need to reduce the risk of operational delays and subsequent costly rework through technology investments. With Eontes' solution, they can manage product information and provide transparency while supporting workers and products across the entire value chain.</p>	<p style="text-align: center;">BENEFITS</p> <p>Manufacturing is complex, the Eontes solution maintains up-to date assembly activities while providing real-time flexible access to product information. With Eontes, technicians can roam work areas, resulting in increased productivity. With the solution, shop floor instructions, the build execution, and the shipped product's configuration are in sync.</p> <ul style="list-style-type: none"> • Engineers can seamlessly transition product information from design and manufacturing into assembly and integration. • Leverages engineering data throughout the product build process. • Digitizes the work instructions and assembly execution activities. • Provides traceability throughout EBOM > MBOM > ABOM • Adds flexibility to build process with Mobility
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <p>Model-based product lifecycle management software, such as Aras Innovator, makes it possible to ideate, create, analyze, manage, and sustain products. Engineers can seamlessly transition product information from design and manufacturing into assembly and integration. By customizing Aras Manufacturing Process Planning (MPP), digital work Instructions support product builds with critical features.</p> <p>The MPP Assembly Procedure structures the build instruction. This feature enables engineers to create a digital assembly procedure that simplifies and speeds up the build process.</p> <p>Aras Manufacturing Process Planning (MPP) with its new Eontes built features and the Eontes mobile app. See a demo live here: https://www.youtube.com/watch?v=cBU5L8TMZ5o&t=4s</p>	<p style="text-align: center;">Digital 2 Physical 2 Value</p>  <p>Streamline complex ecosystems, facilitating heightened clarity and connectivity at the intersection of the digital landscape and the physical realm. This synthesis enhances client value, profitability, efficiency, and quality and encapsulates Eontes' distinctive paradigm, aptly named Digital2Physical2Value®.</p>

CATALYZING TRANSFORMATION: INNOVATIVE BUSINESS PROCESSES AND PARTNERSHIPS FOR SUSTAINABLE GROWTH

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Our submission centers on the critical importance of reimagining business processes and fostering strategic partnerships to drive sustainable growth and prosperity in a rapidly changing business landscape. In an era characterized by dynamic market conditions, digital disruption, and evolving customer expectations, the ability to innovate business processes and cultivate meaningful partnerships is paramount for organizations seeking to thrive.


Key highlights of our proposal include:

- **Process Optimization and Automation:** We explore cutting-edge strategies for streamlining and automating key business processes, reducing operational costs, enhancing efficiency, and liberating valuable human resources for strategic activities.
- **Data-Driven Decision-Making:** Our submission delves into the role of data analytics in making informed, agile decisions, supporting organizational resilience, and improving customer experiences.

- **Ecosystem Collaboration:** We showcase the power of strategic partnerships, alliances, and collaborative ecosystems, demonstrating how they can amplify value, foster innovation, and create win-win scenarios for all stakeholders.
- **Sustainability and Corporate Social Responsibility (CSR):** We discuss how innovative business processes and partnerships can be leveraged to integrate sustainability and CSR goals into the heart of an organization's operations.
- **Customer-Centricity:** We emphasize the pivotal role of aligning business processes and partnerships with customer-centric principles to meet and exceed customer expectations.

Our submission underscores the transformative potential of innovative business processes and strategic partnerships, aligning with the 2023 Maintenance Innovation Challenge's objectives. We eagerly anticipate the opportunity to share our insights and novel strategies, illustrating how these elements can drive sustainable growth and

organizational success in a rapidly evolving business environment.

<p>PROBLEM STATEMENT</p> <p>Many businesses today face the challenge of achieving sustainable growth in an ever-evolving market. They grapple with inefficient processes, limited access to the latest technologies, and a lack of strategic partnerships. This hinders their ability to adapt to changing circumstances, reduce their environmental footprint, and meet the demands of conscious consumers.</p>	<p>BENEFITS</p> <p>Enhanced Efficiency: Streamlined business processes will lead to increased efficiency, reduced operational costs, and improved productivity.</p> <p>Sustainable Growth: Implementing sustainable practices will allow businesses to meet environmental goals, reduce their carbon footprint, and ensure long-term viability.</p> <p>Competitive Advantage: Leveraging innovative technologies and partnerships will enable companies to stay ahead of the competition and cater to evolving customer needs.</p> <p>Improved Resource Management: Sustainable growth will help businesses optimize resource utilization, reduce waste, and minimize environmental impact.</p>
<p>TECHNOLOGY SOLUTION</p> <p>Digital Transformation: Implement cutting-edge technologies like AI, IoT, and blockchain to optimize processes, automate tasks, and enhance decision-making.</p> <p>Data Analytics: Utilize data-driven insights to make informed business decisions, anticipate market trends, and tailor strategies for sustainable growth.</p> <p>Renewable Energy Integration: Adopt renewable energy solutions, such as solar and wind power, to reduce carbon emissions and lower energy costs.</p> <p>Sustainable Supply Chain: Implement traceability technologies and sustainable sourcing practices to create a transparent and eco-friendly supply chain.</p> <p>Strategic Partnerships: Foster collaborations with like-minded organizations, research institutions, and NGOs to jointly develop sustainable solutions and expand market reach.</p> <p>Employee Training: Invest in training programs to equip your workforce with the skills and knowledge needed to support innovative business processes and sustainable growth initiatives.</p>	<p>Graphic or Image</p> 

INSTRUCTIONAL OPERATIONS NETWORK HUB

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Current maintenance methods are based on instructions that are not informed with live data metrics or interactive courses of action. Although advancements in vehicle and craft technologies have made tremendous advancements, the maintenance methods are based on individuals reading about a process and following guidelines. VisualOPS allows for interactive instructions to be influenced by real time data and the creation of agile networks that include the Operator, Maintenance Crew, Supply and Manufacturer.

When the key stakeholders can come together on an as needed basis, we unleash the power of aligned teams on clear measurable objectives.

VisualOPS is a software-based operations hub designed to fuse together communication, processes, and AI. Our hub enables team members to be aligned and follow step by step instructions (which are multimedia and interactive based). Each hub can be connected together to form private secure networks of aligned collaboration. Our hubs are hardware agnostic with our beta platform being

a raspberry pi 4. The fundamentals of the platform are designed to work in a formfactor that represents messaging UX/UI with the added value of an advanced State Machine. This integrates with your own custom processes or a process that has been designed by a 3rd party (manufacturer, team leader, HQMC, etc.) in order to instruct on complex processes.

The current version has had multiple real-world deployments around the coordination of OSINT and OSINF streams of data. Since we do not require any cloud support, the platform is able to expand and contract on an as needed basis little one-time costs. Point to point communications are encrypted and the sharing of stream data is based on a two party buy in process.

Our use cases have been in the intelligence community so our data is collected from multiple sources and fused together. We have data and use cases that reflect the coordination of HVT VIP's and the instructions provided to them to move them to safety out of Afghanistan. Instructions was provided when collecting OSINF on events

in Iran and the processes that were used in order to categorize and index these streams of data with coordinated individuals around the world.

This vision was inspired by my years of work in the intelligence community (Interrogation and Counterintelligence HUMINT) and a vision of maintenance surfaced with the Marine Corps NexLog unit out of the Pentagon. We are currently deploying with some customers in DDIL environments and for OSINT purposes as we raise funding in our pre-seed stage. Once main aspect is that we needed to keep the costs at a min in order to make the vision affordable and flexible. This has been proven since the raspberry pi 4 platform is already overkill for our needs. We envision the formation of custom hardware at scale in order to enable each individual with a personal operations hub for all of their MOS responsibilities.

<p style="text-align: center;">PROBLEM STATEMENT</p> <p>The maintenance process chain is centralized and analogue. Updates and advances to maintenance do not take into account real time metrics which impact planned events and the prediction of unplanned events when it comes to preventative maintenance and downtime.</p> <p>The lack of data capture or real time analytics is key to timelines and resources that will be needed both from the maintenance team and the supply chain.</p>	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> • Ensure all parties have situational awareness • Allow for teams to be formed and represent themselves in the maintenance process (encourages excellence). • Allow for real time communication up and down the chain • Enable invitation style collaboration. • Encourage the communication of ideas and needs that do not always fit in an existing process. • Allow for unstructured communication to exist next to structured process.
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <p>A trusted distributed network comprised of participating individuals, teams, and sensors all along the maintenance chain. The network is highly agile with resources leaving and joining as needed. While the equipment is operating, logging sensors store key metrics. The metrics are then sent to a node in the network. These nodes are the hubs that allow for maintenance crews, supply sources, and equipment operators to have a common operating picture on the status of their equipment and timeline views of planned and predicted events. The node provides the preprogrammed COA's that are selected / influenced based on input from the sensor logs. The COA's can be rich in nature using multimedia (Video, Audio, Images, AR, Interactive forms, buttons, etc) to address complexity. As the COA's are executed they coordinate all resources to ensure everyone is on the right track.</p>	<p style="text-align: center;">Graphic or Image</p>

EDGE MX: STREAMLINING THE MAINTENANCE WORKFLOW

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Military maintenance procedures have seen little improvement since the 1980s, relying heavily on paper forms for over 35 years. This approach has resulted in thousands of hours wasted manually inputting written maintenance records, waiting for tools, and tracking work. Handwritten notes have to be digitally recorded—if and when there’s a desktop available. EdgeMX changes that.

EdgeMX is a mobile solution designed to streamline maintenance workflow, supporting the entire organization from supervisors to maintainers to crews across all military branches. With EdgeMX, when a supervisor assigns work, the app automatically notifies the maintainer and submits a request for parts and tools to the supply crews. Crews gather supplies based on the work order and alert the maintainer that supplies are ready for pick up. This integrated process empowers crews to identify if a maintainer’s tasks have overlapping requirements, allowing the crew to create a customized package with only the necessary supplies. Real-time tool and part availability information in the app allows maintainers to request supplies knowing when and where they can expect the request

to be fulfilled. EdgeMX’s user experience design mirrors common rideshare and food delivery apps, minimizing ramp-up time.


EdgeMX runs at the Edge—be it an atoll with no connectivity, an aircraft carrier, a forward deployed location in Iraq—in AWS GovCloud at IL-5/FedRAMP HIGH and in AWS Secret regions out of the box, unlike any solution on the market today. The app can operate in classified environments, with or without connectivity, and in environments where wireless isn’t available. The app can also cache data offline for an indefinite period of time and is underpinned by Zero Trust to authenticate every transaction. This Edge-first mentality maximizes capabilities of mobile devices, both online and offline no matter the mission’s location. EdgeMX brings the power of your mobile device to your mission—from the flightline to the frontline.

EdgeMX builds upon a revolutionary mobile app developed in collaboration with USAF Headquarters A4. This app allowed maintainers to document maintenance at the point of repair using iPads, resulting in time savings of one to three hours daily

per maintainer and return on investment of \$8,500 per user, per year.

For future conflicts, deterring or defeating near peer adversaries requires data federation, which involves collecting data from diverse sources and converting it into a common model. EdgeMX does this in real time, integrating with systems such as BLADE, AMBS, and JADC2—as well as other EdgeMX instances. This provides insight to facilitate rapid decision making.

With AWS’s Snow series of Edge Computing devices, EdgeMX can be deployed anywhere. The Edge server can collect data and transfer it back to the primary cloud when connectivity is reestablished. On a base with no cell coverage, 500 feet underwater—no matter where your mission—EdgeMX is the solution.

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none"> •Maintainers currently rely on legacy systems, paper forms, and notebooks to record work done. When deployed, they rely mostly on pen and paper. •Handwritten notes need to be input into a digital system, which can only be done on an internet-connected laptop or desktop computer. •Supervisors need to assign maintainers work, but they currently don’t have a system to track progress besides contacting maintainers as they work. •Maintainers currently need to wait in line at a tool shop to request kits, wait for the kits to be assembled, and potentially return if parts or tools aren’t available. 	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> •EdgeMX goes where the mission goes, whether it’s a classified environment, with or without connectivity, or even in environments where wireless isn’t available •EdgeMX runs at the Edge in AWS GovCloud at IL-5/FedRAMP HIGH and in AWS Secret regions out of the box—unlike any solution on the market today. •The app can also cache data offline for an indefinite period of time and is underpinned by Zero Trust to authenticate every transaction. •EdgeMX builds upon a revolutionary mobile app developed in collaboration with USAF Headquarters Air Force A4 which resulted in time savings of one to three hours daily per maintainer and a return on investment of \$8,500 per user, per year.
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> •EdgeMX is an Edge-capable mobile solution architected to work in classified environments. •Supervisor: EdgeMX automatically notifies the maintainer of a work order, submits a request for parts and/or tools to the supply crews, and provides real-time status updates. •Crew: EdgeMX shares which parts and supplies are needed, creates a custom package if a maintainer’s tasks have overlapping requirements, and notifies the maintainer that tools and parts are available for pickup. •Maintainer: EdgeMX provides real-time notifications from supervisors and crews, provides an interface to directly record work details, and provides tool and part availability information so maintainers know when and where they can expect a request to be fulfilled. •Leadership: EdgeMX provides real-time data federation, which involves collecting data from sources such as BLADE, AMBS, and JADC2 and converting it into a common model. This capability provides the insight to facilitate rapid decision making. 	

JOINT DATA STANDARDS FOR LOGISTICS AND MAINTENANCE

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INTRO: We aim to improve the Joint/ Coalition OODA loop (Observe, Orient, Decide, Act) over our adversaries to enhance logistics and maintenance outcomes.

PROBLEM: Data is siloed across DoD. DoD culture is broken because leaders are uncomfortable sharing unit level information with unfamiliar ecosystem participants. Gaining joint data advantage means knowing what data every unit has + enabling secure, zero-trust, cross-domain access to it. Maintenance Data is not referenced in a centralized, accessible, searchable location. For example, maintenance resources are often mismatched when coordinating maintenance for reserve units with active-duty units, adding an unnecessary burden because information is not effectively shared. This problem compounds at an enterprise level when equipment, vehicles, aircraft, and ships realize delays with repairs and upkeep from poor data sharing or even lack of data sharing between common systems. Trends are not improved across the joint force because they are siloed. The ability to become more agile, effective, efficient, and affordable is hindered because

data sharing is limited without every branch embracing common data standards for logistics (to find relevant parts) and maintenance.

TECHNOLOGY DESCRIPTION: We propose a DoD Data Reference Library to enhance useable intellectual property life cycles by transforming traits from accountable to acclamable, accessible to absorbable, and actionable to accelerable. Intellectual property comprises knowledge capital inside all organizations. Quantifiable capital requires accountable IP. Organizations must comprehend all of the IP in their custody. Once an organization quantifies the IP in their possession, they must make sure their IP is accessible so that their people can apply it within organizational projects. Once accessed, IP must be actionable in order to support innovation. Without the ability to act upon IP, an organization is destined to sequester its intellectual property and stifle impact yielding innovation

NEXT STEPS: Creating a DoD Data Reference Library enables accountable data and IP to become acclamable by recognizing and rewarding the people that

created it, even if they submit data insights anonymously, resulting in happier staff and decreased turnover. Feedback is more likely to occur, yielding a C2 improvement in control. IP is useful for the organization whose resources can access it and consume it, but accessibility rarely extends to private sector partners, suppliers, and other USG organizations with ease. A DoD Data Reference Library makes accessible IP absorbable for all parties by using a secure common platform that improves access to data without leaking to unauthorized locations. Email and paper systems cannot rapidly encourage an organization's resources to leverage actionable IP. A DoD Data Reference Library makes IP accelerable to rapidly and securely authorize adoption and transition of both internal and external IP.

<p align="center">PROBLEM STATEMENT</p> <p>Data is siloed across DoD. DoD culture is broken because leaders are uncomfortable sharing unit level information with unfamiliar ecosystem participants. Gaining joint data advantage means knowing what data every unit has + enabling secure, zero-trust, cross-domain access to it.</p> <p>Maintenance Data is not referenced in a centralized accessible location. <i>For example, maintenance resources are often mismatched when coordinating maintenance for reserve units with active-duty units, adding an unnecessary burden because information is not effectively shared. This problem compounds at an enterprise level when equipment, vehicles, aircraft and ships realize delays with repairs and upkeep from poor data sharing or even lack of data sharing between common systems.</i></p> <p>Trends are not improved across the joint force because they are siloed. <i>The ability to become more agile, effective, efficient, and affordable is hindered because data sharing is limited without every branch embracing common data standards for logistics (to find relevant parts) and maintenance</i></p>	<p align="center">BENEFITS</p> <p>Sustainment data standards in a trusted data environment enable the organic industrial base, industry software developers, and allies to leverage data that is accountable, accessible, and actionable to:</p> <ul style="list-style-type: none"> • Leverage Human/Machine teaming for strategically integrated supply chain for materials along with manufacturing planning to enhance service speed + quality • Enhance CBM+ to help depots leverage data from the tactical edge through standardized/optimized bandwidth to integrate into depot maintenance planning • Algorithmic superiority through higher quality data sets that drive machine learning enhancements; improved end-to-end supply chain intelligence assessments • Reduce delays in development to help developers get paid faster while delivering/deploying sustainment solutions faster
<p align="center">TECHNOLOGY SOLUTION</p> <p>Improve Logistics (Parts) & Maintenance (Service) Data Standards</p> <ul style="list-style-type: none"> • Establish clear, standardized contracting language for solutions that utilize data • Define common data fields & formats; adopt international standards where possible • Make a common format for sharing data b/w systems (XML schema for API calls) <p>DoD Data Reference Library: A Trusted Data Environment</p> <ul style="list-style-type: none"> • Zero Trust: Use a "Trust but Verify" method; see but not take sensitive data • Set up strong connectors (APIs) so company tools and government systems can share data smoothly • Allow developers/contractors to query data inside a secured enclave (microservices) • Try new software inside a secure environment w/o risking data removal • Monitor and improve cybersecurity posture regularly (CMMC Compliance) • Design a Comprehensive Data Inventory and Access Visualization System • Catalog all datasets stored among every military branch and DoD-related entity, associating each with a responsible custodian; incentivize a system like "Kaggle" • Secure access management; outputs are screened for sensitive information • Real-time Metric Dashboard on data request information 	

MARINE CORPS PLATFORM INTEGRATION CENTER (MCPIC) ELECTRONIC QUALITY MANAGEMENT SYSTEM (EQMS)-USMC LOGCOM/CGI FEDERAL PARTNERSHIP

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Problem: Commanders/Supervisors lack real-time digital visibility of maintenance operations and data in all types of operating environments to monitor quality standards conformance and to allow correction of non-conformance to maximize and expedite force and materiel readiness. Relevance: “the complexity of the tasks involved in supporting a high technology force also increases as the sophistication of its weapons and equipment increases...quite simply, the more advanced the equipment, the harder it is to fix.” Outdated maintenance quality and readiness reporting methods leave Commanders with sub-optimal visibility of data critical to operational planning and decision making. A modernized standardized system to monitor and capture inspections using real-time, trustworthy quality data capable of pinpointing effectiveness- and efficiency-diminishing actions in any environment was needed to mature maintenance management and operations to maximize readiness.

eQMS’ immutable event-driven, sensor-based IoT architecture provides performance measurement, automated work instructions and notifications, forensics-enabling

history, and real-time event chronology in a scalable enterprise solution. eQMS promotes stakeholder data sharing, mitigates inefficient processes by bridging non-integrated systems, interoperates with USMC and DoD property accountability systems, and provides a modern commercial grade end-to-end maintenance management data capability to inform decision-making for operational advantage. Cloud Hosting– optimizes cost; affordably/agilely scales; native tools unleash data potential. System Sustainment–Agile, user-experience-based SecDevOps governance delivered 5 major enhancements in 2 years. System Modernization – architected to ease technology integration seeking efficient effectiveness. Auditability–delivers auditable solutions to satisfy ISO and other industry quality standards. Cybersecurity–authority to operate/connect via DoD Risk Management Framework and DISA compliancy. Automated Information Technology–A network of global RFID, bar codes, cameras, handheld tablets, fixed-readers, and mobile antennae with disconnected operations data-synching. Training–web-based, help desk (Tier 0 pending (affordability)) and

onsite. Field Support Representative–cross-trained mobile training teams ensure affordable effectiveness.

eQMS is currently operational at 2 USMC bases and depots globally and has been rigorously proven in numerous joint DoD operations/exercises. To date, unit maintenance activities have performed 7,000+ materiel inspections resulting in over 500 documented and corrected non-conformances.

The government-owned eQMS functionality and data can viably and affordably scale across the DoD and within all operating environments to analyze maintenance operations effectiveness, and eQMS outputs afford actionable digital insights to expedite, validate and increase materiel readiness to benefit Commanders at all levels.

<p>PROBLEM STATEMENT</p> <p>Commanders lack real-time digital visibility of maintenance operations and data in all types of operating environments to monitor quality standards conformance and to allow correction of non-conformance to maximize and expedite force and materiel readiness.</p> <ul style="list-style-type: none"> Maintenance task complexity increases as the sophistication of weapons and equipment increases...quite simply, the more advanced the equipment, the harder it is to fix Outdated maintenance quality and readiness reporting methods leave Commanders with sub-optimal visibility of data critical to operational planning and decision making A modernized, standardized system to monitor and capture inspections using real-time data to pinpoint effectiveness- and efficiency-diminishing actions and operate in any environment was needed to mature maintenance operations & maximize readiness 	<p>BENEFITS</p> <ul style="list-style-type: none"> Improved materiel readiness via standardized, real-time digital maintenance and quality inspection process visibility and data Ability to operate in disconnected, denied, intermittent and/or with limited bandwidth (DDIL) (e.g., contested) environments Technology resides in the GOCO (government owned, contractor operated) MCPIC suite of applications = enhanced affordability Expandable to nearly all applications requiring standardized inspection performance and data collection Collected, processed, analyzed and visualized raw data generates digital operational intelligence/insights to improve readiness Mature solution in use at 2 USMC Commands supporting operations and exercises worldwide
<p>TECHNOLOGY SOLUTION</p> <p>Immutable event-driven, sensor-based IoT architecture, provides delivery measurement, automated work instructions and notifications, forensics-enabling history, and real-time event chronology in a scalable enterprise solution</p> <ul style="list-style-type: none"> Communicates securely with host servers via military or commercial internet connection Simplified, intuitive user interfaces Ruggedized secure hardware & sensors ideal for in-field use Secure CAC-enabled access Data synchronization algorithm ensures data integrity and desired data outcomes including in disconnected operations 	<p>The diagram illustrates the MCPIC eQMS architecture. It shows a central 'MCPIC eQMS Application' box. Above it are 'GOCO/MC Maint. System' and 'F2M Catalyst Maint. Code'. To the right is a 'Top 10 Defect Codes' bar chart. Below the main application are 'Assets with Disconnected Quality Actions' and 'Enter real-time or last known asset location (eQMS mode dependent)'. The diagram also includes text boxes describing data integration with 'GOCO/MC Maintenance via GCS/MC Maintenance Module Using eQMS Sensor-Based Visibility-Checked Data' and 'Real-time validated data to provide asset visibility and readiness data for Commanders'. Other text boxes describe 'Capabilities/Readiness by Category of Principal End Item and Readiness Governing Codes (Defect Codes)', 'Federal Units in Garrison or Deployed', and 'Operational Level Support Command Logistics Command Sustainment Command'. The MCPIC logo is at the bottom.</p>

METALSCAN: REAL-TIME OIL DEBRIS SENSOR FOR EARLY DETECTION OF BEARING AND GEAR DAMAGE IN CRITICAL DRIVE-TRAIN COMPONENTS

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Problem: 3d Marine Logistics Group (3d MLG) has a two-part problem for ground motor transportation (MT) assets. On the average, these assets spend 60 days in shop for corrective maintenance (CM). Additionally, the preventative maintenance (PM) requirements of the fleet is \$1M and 15K man-hours.

Description: In 2018 we knew CBM+ was the solution to our maintenance problem. However, we were not clear how to proceed within the 3 facets of people, process, and technology. Out of the 2019 Maintenance Symposium we realized our epiphany moment when the keynote speaker made the following 2 statements: 1) Good technology overlaid on bad, unrefined, and unimproved processes results in bad technology. 2) Relying on the addition of manpower, funds, or structure is unsustainable. These two statements shape our CBM+ solution focusing on changing our processes and empower our people thereby ensuring the effectiveness of the forthcoming enterprise CBM+ technology solution. Applying these concepts to CM, we

eliminated administrative non-value-added business steps not directly contributing to the restoration of the asset. Moreover, a system of standardization of work centers, workspace ownership, quality assurance, and minimizing physical movement has been implemented to increase efficiency. In the area of PM, a side-by-side comparison between the owner/operator monthly service checks were found to be more in-depth compared to the annual PM. Strictly enforcing the owner/operator annual monthly service checks had enabled us to remove the redundant tasks found on the annual PM resulting in a reduction of man hours. Furthering the concept, interval and time-based PM material replacements were changed to condition-based replacement resulting in a reduction of material cost. The totality of the process changes have enabled no cost, immediate positive effects in the morale of the owner/operators/mechanics and improved tactical level equipment availability.

Current: As of this submission, we have fully implemented CM/PM process changes in ground motor transport assets. Additionally,

we codified these changes in directives, maintenance standard operating procedures, obtained a service level maintenance process waiver, developed, and delivered training to 600+ personnel, and perform formalized CBM+ compliance inspections.

Data: Our initial baseline data for CM of 60 days in shop compared to the improved CBM+ process data of 19 days in shop have indicated we have reduced the days in shop by 41 days, a 60% improvement. Similarly, our initial baseline data for PM \$1M and 15K man-hours, as required by the technical manuals has improved to \$200K (80% reduction in material cost) 1K man-hours (90% reduction time effort).

Next Steps: Expand to Engineer equipment including both Heavy and Utilities equipment, scale up to the service level component adopting the process changes into policy, and empower individuals to think about maintenance in a condition-based context.

<p style="text-align: center;">PROBLEM STATEMENT</p> <p>The mechanical components of aircraft engines and drive-trains operate under severe conditions of load, speed and temperature. Under these conditions, component damage can progress rapidly from the onset of initial damage to component failure, sometimes in a matter of only a few hours of operation. Debris monitoring in the form of magnetic-based electric chip detectors has been typically employed to detect the failure of internal components thus triggering mission abort events.</p> <p>These magnetic chip detectors rely on the oil-borne debris particles making contact with and being captured by the magnetic sensor head. The operational reality is that these devices suffer from unreliable detection, yield ambiguous results and provide poor indication of the health of the oil-wetted drivetrain components. Furthermore, there is no trendable data and no detection of non-ferrous based metals.</p>	<p style="text-align: center;">BENEFITS</p> <p>Maximize Mission Readiness</p> <ul style="list-style-type: none"> • Early damage indication - avoid deploying aircraft with latent drive-system faults • Eliminate nuisance chip lights – prevent mission disruptions • Improve fault isolation – reduce troubleshooting times <p>Reduce Maintenance & Support Costs</p> <ul style="list-style-type: none"> • Proactively plan maintenance- maximize Maintenance Free Operating Period (MFOP) • Extend Chip Detector (MCD) & Overhaul Inspections (On-Condition) • Eliminate routine oil sampling (On-Condition) • Significantly reduce Maintenance Ratio <p>Improve Safety</p> <ul style="list-style-type: none"> • Eliminate In-Flight Shutdowns and Major Drivetrain Events • Avoid Minor Faults progressing to Major Damage
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <p>MetalSCAN is a real-time, online, oil debris monitoring system which:</p> <ul style="list-style-type: none"> • Advanced technology sensor detects the earliest onset of damage to oil-wetted bearings and gears...100's of hours before failure. • Quantifies and trends the degree of damage, providing reliable advanced warning of impending failure. • Determines remaining safe operating life, enabling true prognostics. • Flow through design for 100% particle detection efficiency. • Provides online real-time data of particle size, type (Fe or Non-Fe), total accumulation and rate that directly correlates to component damage. • Full-flow, or bypass sensor options easily integrated within the lube system for minimized system weight. 	<p style="text-align: center;">GRAPHIC</p>

ANOMALY-BASED DETECTION WITH CONFIDENCE (ABC) TOOL

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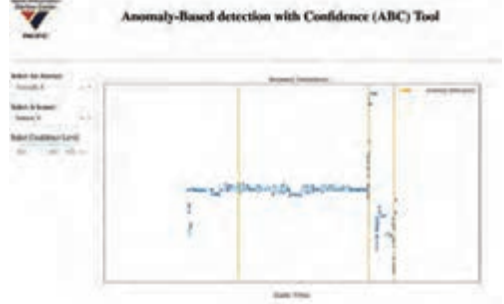
Robust anomaly detection in mechanical systems provides a means with which to drive condition-based maintenance, so that critical maintenance actions can be taken before catastrophic failures occur; more importantly, high-precision detections help minimize asset downtime due to unscheduled maintenance events and maximize readiness. Modern platforms (ships, aircraft, ground vehicles, etc.) are instrumented with sensors that collect data in a sparse, event-driven manner: the sensors record data in very low frequencies, and the recordings are triggered only when certain pre-defined extents take place. Thus, any data-driven anomaly detection methodology must extract actionable insights from restrictive data sets. Furthermore, the algorithmic complexities must be abstracted from the end users, for whom the detections are used for making maintenance decisions. Finally, any anomaly detection is naturally associated with a degree of uncertainty, which must be incorporated into the decision-making process.

We present the Anomaly-Based detection with Confidence (ABC) tool.

The software tool provides a framework to house an arbitrary number of specialized algorithms, each of which is built to find specific characteristics from the sparse, event-driven sensor data for anomaly detection. Moreover, each algorithm is built using one of the following methodologies: physics-based methodology, machine learning-based methodology, and topological data analysis-based methodology. The strengths of these methodologies are leveraged and aggregated into a single detection output for a given time period; the detection results are shown in an intuitive dashboard. The end-user can indicate a desired confidence level in the output via an adjustable slider in the dashboard, and the anomaly detections with the corresponding confidence levels will be shown.

Currently, the ABC tool is in prototype development stage, where we are using the V-22 aircraft sensor data as exemplar to guide the development of the algorithms as well as the software tool. The tool has shown to be effective on use cases for the V-22 aircraft, and we have shown that the tool has the capability to provide anomaly detection

prior to catastrophic events. We plan to expand the capability of the tool to provide anomaly detection to cover the entire V-22 aircraft, regardless of use cases, as well as expand the capability to cover other aircraft types and platforms (e.g., ships).

<p>PROBLEM STATEMENT</p> <p>Robust anomaly detections in mechanical systems provides a means with which to drive condition-based maintenance, so that critical maintenance actions can be taken before catastrophic failures occur; more importantly, high-precision detections help minimize asset downtime due to unscheduled maintenance events and maximize readiness. Modern platforms (ships, aircraft, ground vehicles, etc.) are instrumented with sensors that collect data in a sparse, event-driven manner: the sensors record data in very low frequencies, and the recordings are triggered only when certain pre-defined extents take place. Thus, any data-driven anomaly detection methodology must extract actionable insights from sparse, event-driven sensor data. Furthermore, the algorithmic complexities must be hidden from the end users, for whom the detections are used for making maintenance decisions. Finally, any anomaly detection is naturally associated with a degree of uncertainty, which must be incorporated into the decision-making process.</p>	<p>BENEFITS</p> <ol style="list-style-type: none"> 1. The framework produces results at the appropriate level of confidence, indicated by the end user <ul style="list-style-type: none"> • Critical for contested environments when the end users must weigh the consequences of false positives vs. false negatives 2. The algorithms are data-driven, free of human bias 3. The tool can accommodate any number of anomaly detection algorithms, and the framework automatically aggregates the output into a single detection result for a given time period 4. The dashboard is an intuitive interface for the end users 5. The framework is general purpose, and can be applied to any system which are instrumented with sensors
<p>TECHNOLOGY SOLUTION</p> <p>The Anomaly-Based detection with Confidence (ABC) tool is a framework that houses an arbitrary number of specialized algorithms, each of which is built to find specific characteristics from the sparse, event-driven sensor data for anomaly detection. Furthermore, each algorithm is built using one of the following methodologies: physics-based methodology, machine learning-based methodology, and topological data analysis-based methodology. The strengths of these methodologies are leveraged and aggregated into a single detection output for a given time period; the tool shows the detection results in an intuitive dashboard. Furthermore, the end-user can indicate a desired confidence level in the output via an adjustable slider, and the anomaly detections with the corresponding confidence levels will be shown in the dashboard.</p>	

DIGITAL MAINTENANCE ADVISOR FOR FORWARD DEPLOYED TROOPS

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The current CBM+ (Condition-Based Maintenance) program of record needs to improve its ability to support an island-hopping campaign, especially when confronted with a near-peer adversary capable of disrupting communications. This disruption directly impacts the Air Force's crucial ability to project air power effectively.

Recognizing this critical shortfall, the Rapid Sustainment Office (RSO) and the F-16 System Program Office (F16SPO) are embarking on a strategic initiative. Through a two-phase approach, starting with a Small Business Innovation Research (SBIR) Phase I & II and then supplemented with additional government funding, they aim to enhance the capabilities of CBM+ specifically for the INTERMEDIATE and FORWARD ECHELON.


By doing so, the primary objective is to enable the Air Force to project air power forward effectively. This concept encompasses maintenance activities that ensure the operational integrity of aircraft and provide crucial readiness insights to Commanders. This means that even in scenarios where there is a disconnection

from U.S. databases, the Air Force will have the capacity to generate sorties, thereby maintaining a high level of operational readiness.

This initiative is poised to significantly enhance the Air Force's operational flexibility and resilience in complex and challenging scenarios, particularly island-hopping campaigns with formidable adversaries. The infusion of additional capabilities to CBM+ and a forward-looking approach to technology integration are central to achieving this objective. Once deployed the Combat Air Forces and the Mobility Air Forces will be better equipped to navigate and succeed in dynamic and high-stakes operational environments through this effort.

The anticipated benefits of the current CBM+ (Condition-Based Maintenance) program of record capability increase for supporting an island-hopping campaign, particularly in scenarios involving a near-peer adversary capable of disrupting communications, are substantial. Here are the key expected advantages:

1. Reduced Dependency on Communication Networks: In situations where there is a disruption in communications or disconnection from U.S. databases, the Air Force will still have the capacity to generate sorties, maintain data integrity, and once connected again, upload new data.
2. Better Equipped Combat Air and Mobility Forces: Both Combat Air Forces and Mobility Air Forces will be better equipped & trained to navigate and succeed in dynamic and high-stakes operational environments.
3. Enhanced Readiness Insights: CBM+ will provide crucial readiness insights to Commanders .
4. Operational Flexibility and Resilience: Operational Flexibility and Resilience.
5. Capability for Island-Hopping Campaigns.
6. Improved Technology Integration.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • CBM+ does not address labor issues nor provide necessary solutions to enable multi-capable airmen (MCA) in the forward fight under the Agile Combat Employment (ACE) concept • Shortfall in experienced maintainers is pressuring Readiness levels across the military • Gaps in fleet insights and predictive capabilities from non-sensored components and systems • Current debrief process results in inaccurate or insufficient information delivered to maintainer for effective troubleshooting • There are currently no innovative solutions embedded into the maintainer workflow • Ineffective troubleshooting exasperates parts & supply chain issues due to erroneous parts ordering and "rip and replace" 	<p>BENEFITS</p> <ul style="list-style-type: none"> • Improve maintenance outcomes for agile, less experienced forces, enabling operational effectiveness at the edge • Capture "better data" via Augmented Debrief feature • Deliver "actionable guidance" via Corrective Action Recommender feature and quickly retrieve relevant tech manuals • Inform "better decisions" for leadership with real-time fleet health and insights via Monitoring and Analytics feature • Capture tribal knowledge and turn 3-levels into 9-levels • Reduce stress, OPTEMPO, and turnover of maintenance personnel • Reduce rework, Mean Time to Repair, increase Mission Capable rates • Link issue diagnosis to inventory and supply chain insights
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • Digital Maintenance Advisor (DMA) is a workflow integrated, prescriptive maintenance solution that leverages AI and Natural Language Processing (NLP) to ingest and analyze a range of inputs such as manuals, maintenance logs, sensor/time-series data, and parts-availability data • DMA is able to re-train models to adapt to changing conditions and minimize false positives • AI surfaces relevant documents from multiple data sources to eliminate manual searching • DMA continuously learns from past, present, and future events • Single platform and real-time view of tactical KPIs • Layered Readiness data with flexible viewing that's tailored to the user 	

ANCHORING THE DIGITAL THREAD WITH AN UNCLONABLE PHYSICAL IDENTIFIER

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To ensure resilient sustainment operations, the DoD must consider the fragility of commercial technologies adopted in past decades with the goal of efficiency. Consider a day in the life of a 546th PMXG maintainer at Tinker AFB tasked to manually enter - “fat finger” - worn serial numbers on the F135 engine, only to receive turn backs days later. The outdated approach fails the needs of our warfighter. Technologies widely used in retail stores, adopted for military use, (RFID, 2D Data Matrix) do not offer a total “fool proof” solution to a maintainer’s assessment of a part’s provenance and pedigree.



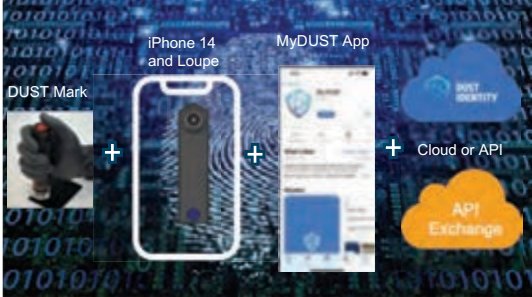
New capabilities for advanced digital analytics are emerging, promising to drastically improve weapon system readiness through optimized depot velocity and spares positioning. Large language models can be leveraged to facilitate movement of materiel around the world during peacetime and, if needed, in a contested environment. But today, these capabilities are built upon a foundation of vulnerable barcodes and RFID tags, leading to more technical debt each day we fail to act.

We must think of the problem differently. Technology exists to give an identity based on true randomness to each and every part. This approach – similar to biometrics – establishes the foundation of data accuracy to unlock emerging analytics capabilities.

Diamond Unclonable Security Tag (DUST) uses a deposition of microscopic diamond particles in a host material to impart a highly unique and unclonable “fingerprint” that persists throughout each object’s life cycle. At TRL-7, the durability and read accuracy of this cost-effective approach has been tested to MIL-STD-810G environmental extremes at third party labs. DUST affords a massive serialization space with no EM signature. A cloud-based digital ledger of provenance change records is built from each transaction using an iPhone – technology today’s maintainers are accustomed to. For mission users, a fully disconnected kit is available for edge workflows in environments with degraded communications.

Current and future work will facilitate data sharing across disparate data silos and DoD Agency practices/policies through open-standard APIs. The seamless data

exchanges will allow for a near-real-time single version of truth shared across today’s systems (ERP, MES, PLM). Metadata and supporting documents will flow with the part in a contemporary data mesh approach. Warfighters will have immediate attestation of authenticity, digital confirmation of ready-for-issue (RFI) status, and access to configuration management, maintenance records, instructions, flight hours, calibration schedules, high-risk certifications, DMSMS, etc. The value of the persistent identifier extends across life cycle management, audit readiness, supply chain illumination and risk management, demilitarization, and disposal.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> Commercial barcode and RFID technologies adopted for military use have introduced fragility to sustainment operations; MIL-STD-130N fails warfighter mission readiness needs. Technical debt is accruing each day we attempt to apply emerging analytics on top of vulnerable physical identifiers – we need an approach similar to biometrics. Maintainers lack a ruggedized, mission-ready asset management solution for cradle-to-grave traceability of critical assets 	<p>BENEFITS</p> <ul style="list-style-type: none"> Provides a robust, durable, unclonable, unattributable serialization capability: a cyber-physical anchor. A ruggedized, mission-ready asset management solution provides cradle-to-grave traceability of critical assets. 
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> DUST applies a non-intrusive deposition of microscopic diamond particles to each object based on true randomness; 750 bits of entropy. Durability tested to environmental extremes of MIL-STD-810G Rapid in-field application or integrated with materials at OEM. TRL 7  <p>In-flight and undersea testing</p>	 <p>DARPA • OUSD(R&E) • NAVSEA • Kleiner Perkins • LM Ventures • Airbus Ventures DUST Identity, Inc. POC: Phil Doherty (617)571-6474</p>

A FULLY CONNECTED MAINTENANCE ENTERPRISE FOR AGILITY AND AFFORDABILITY

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The Problem: Military technologies have evolved from analog to digital. However, maintenance practices are still rooted in the past – despite modern software tools and methods. Maintenance processes are still largely siloed and fragmented. Predictive capabilities that improve reliability, performance, and audit control, and driving down costs, are limited. Missing is a modern approach that autonomously and securely connects all IoT device-driven capabilities to their maintenance actions, providing visibility and governance across complex maintenance ecosystems.

The Technology Solution: Software AG's hybrid integration platform offers an open architecture, vendor agnostic, Zero Trust environment for maintenance integration – allowing learnings from historical data and putting insights into action. Thoughtfully integrating three low/no-code COTS platforms, users are free from time-consuming, error prone manual processes to manage the entire maintenance lifecycle.

1. IoT and Analytics: Customizable management capabilities with service

history for any device or system, and dashboards for monitoring sensor data from each asset.

2. Integration and API: Integrate with hundreds of cybersecure pre-built endpoint connectors for applications such as ServiceNow, Remedy, SAP, or legacy systems.
3. Process Intelligence: Auditable insights through a 360-degree view of all processes that includes a comprehensive view of every process step. Monitors and alerts for non-conformant and unwanted activities.

Dashboarding, monitoring, managing, and measuring activities and outcomes are all part of a secure, automated, interconnected environment that can be managed centrally in the Cloud, hybrid, and edge – operated independently in D-DIL environments.

The Technology Benefits:

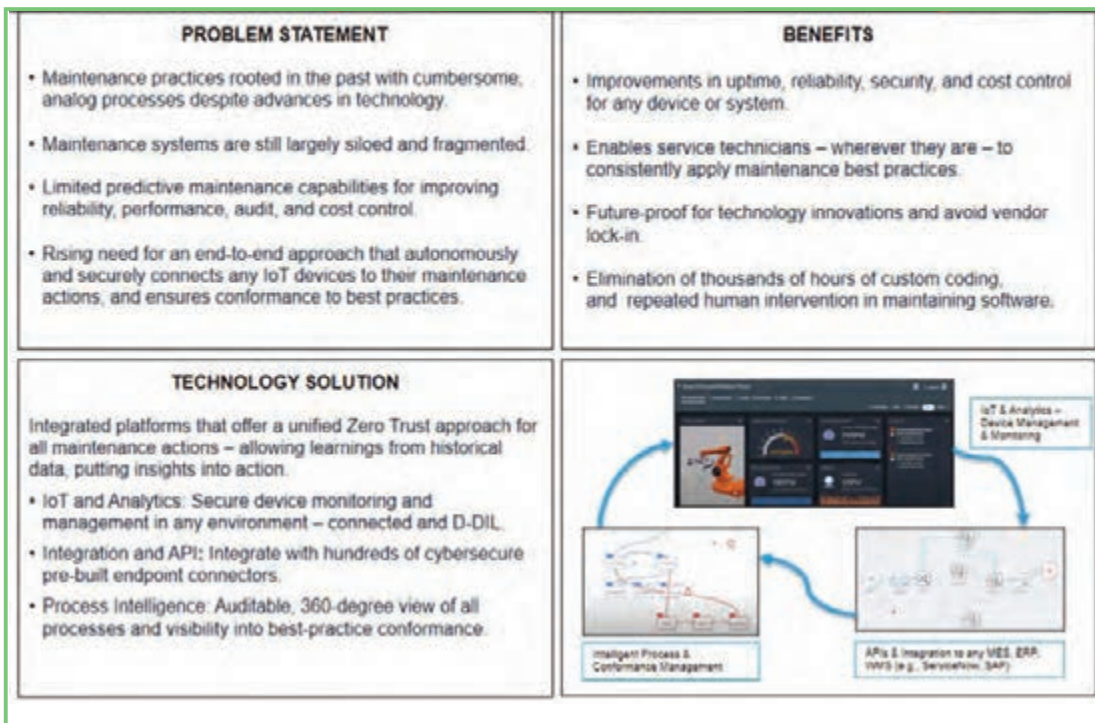
1. Improvements in uptime, reliability, and maintainability of new and legacy equipment.

2. Enables service technicians to consistently apply maintenance best practices.
3. Future-proof for technology innovations and avoid vendor lock-in.
4. Elimination of thousands of hours of custom coding and repeated human intervention in maintaining software.

Mission partners can quickly setup applications to gain insights from running analytics over device and enterprise data, triggering, and automating actions such as starting a task, process, or workflow, automatically opening, and closing work orders and purchase requisitions, and monitoring processes for conformance to best practices.

Rock Island Arsenal Success:

These mature platforms have connected over 200 machines at Rock Island Arsenal, who are operating under the GAO-19-242 guidance. System users created key metrics and applied them on the floor. Issues were detected by applying real-time streams against the metrics. Processes were automated and changed based on Big Data analysis. This unified solution is applicable to all service branches of the military and the DLA and has been tested in partnership with the MxI Innovation Lab with the DOD.



EQUIPMENT MAINTENANCE THROUGH INTERACTIVE AI CHATBOTS AND 3D VISUALIZATION

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In today's fast-paced digital era, the ability to access and comprehend information instantly is no longer a luxury but a necessity. Edlore artificial intelligence (AI) stands at the forefront of this paradigm shift, especially in the realm of equipment maintenance. By fusing advanced artificial intelligence with sophisticated 3D visualization capabilities, Edlore AI is redefining the way professionals interact with equipment documentation, achieving efficiency gains of over 70%.

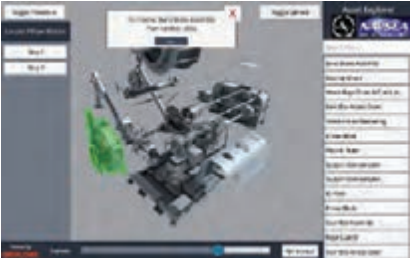
At the heart of this transformative approach is the Edlore AI chatbot. Unlike traditional chatbots that cater to consumer queries or general information retrieval, the Edlore AI chatbot is intricately designed for equipment-centric conversations. It's akin to having an intelligent digital assistant, proficient in the intricacies of equipment manuals, ready to provide insights in real-time. Imagine querying the chatbot about a specific component of a machine, and instead of combing through hundreds of pages of manuals or diagrams, the chatbot instantly provides the required information. But Edlore AI goes beyond mere text.

One of the standout features is its ability to integrate 3D visualizations directly within the chat interface. If a technician or engineer is inquiring about a specific part or mechanism, the chatbot can pull up a detailed 3D model of that component. This is not just about visual appeal; it's about practicality. The 3D models are interactive, allowing the user to rotate, zoom, and dissect parts as needed. Such visualization is invaluable, especially in scenarios where textual descriptions can be ambiguous. A 3D representation offers clarity, ensuring that the technician or engineer understands the equipment part in its entirety, mitigating the risks of errors or oversights.

The efficiency gains are staggering. In traditional scenarios, professionals often spend a significant amount of time searching through documentation, trying to understand diagrams, or seeking clarifications. With Edlore AI, the time to information is reduced dramatically. The instant conversational responses of the chatbot, coupled with the clarity provided by 3D visuals, mean that tasks that previously took hours can now be completed in minutes. When this efficiency is scaled across multiple equipment types,

maintenance schedules, and even across entire industries, the cumulative time savings are immense, contributing directly to operational efficiency and cost savings.

Furthermore, the implications of this technology are vast, especially for training and onboarding new technicians. Instead of spending weeks or even months familiarizing themselves with equipment manuals, new personnel can be trained using the Edlore AI platform, accelerating their learning curve and ensuring they are field-ready in a fraction of the traditional time.

<p>PROBLEM STATEMENT</p> <p>Existing equipment maintenance processes lack efficiency, safety, and data utilization, resulting in increased downtime, suboptimal schedules, and potential errors. Limited access to manuals, inadequate understanding of complex components, and a lack of real-time expert guidance contribute to these challenges. Capturing and leveraging critical maintenance data is essential for predictive and preventative maintenance. A comprehensive AI driven software platform is needed to streamline access to manuals, enhance understanding, provide remote expert support, and enable proactive maintenance practices for reduced downtime and optimized operations.</p>	<p>BENEFITS</p> <p>Our software platform optimizes equipment maintenance with streamlined access to manuals, interactive exploded view 3D visualizations, real-time expert support, and data-driven insights. It reduces errors, improves accuracy, and saves time. Proactive maintenance practices based on critical data analysis minimize downtime, enhance operational readiness, and generate cost and time savings. With increased efficiency and safety, organizations achieve higher productivity and reliability while optimizing maintenance processes.</p>
<p>TECHNOLOGY SOLUTION</p> <p>Edlore technology solutions, transforms equipment maintenance processes with a comprehensive platform. Leveraging mobile and desktop devices, it provides streamlined access to manuals, interactive exploded view 3D visualizations, real-time expert support, and data analytics. By incorporating cutting-edge technologies like AI and ML, it enables proactive maintenance practices, minimizes downtime, and optimizes schedules. The solution empowers maintainers and organizations to achieve higher efficiency, safety, and cost-effectiveness in their equipment maintenance operations.</p>	<p>Graphic or Image</p> 

WAVE RELAY MOBILE AD HOC NETWORKING (MANET) TECHNOLOGY IN SUPPORT OF DISTANCE SUPPORT FOR REAL-TIME CBM AND BATTLE DAMAGE ASSESSMENT

EDWARD LEOPOLD

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Persistent’s Wave Relay® MANET can connect surface, sub-surface, ground, and aerial platforms to sailors/marines and data, all on a resilient, scalable, low-latency, high-bandwidth wireless network to deliver a truly modernized network to the Navy anywhere in the world, without connecting to any infrastructure (or connected to infrastructure to enable Cloud Relay™).

Persistent developed the Wave Relay® MANET technology with efficient routing algorithms to allow mobile end users, ships, boats, and manned / unmanned platforms – all geographically dispersed over hundreds of miles – to incorporate a vast number of sensors, cameras, Commercial Off the Shelf (COTS) tablets, smart devices, and C2 communication and control links into a flat, unified IP transport network. Persistent’s capabilities match the Navy’s vision to create a modern Navy Operational Architecture (NOA) by having all sensors, smart devices, connected devices, surface/ground forces, and mobile platforms in a battlespace on the same network with reliable data links/communications, able to exchange critical intelligence information in real time. We designed our COTS, wireless,

fault-tolerant, scalable technology to deliver high-performing route selection. This ensures peak network throughput – without relying on any existing infrastructure. The differentiating capabilities of the Wave Relay® MANET are its ability to deploy hundreds of nodes on a single frequency and on-demand bandwidth at each node for transporting multimedia services.

Problem Statement:


- Providing a high-throughput (100+ Mbps), secure data link (AES-256 Type II) to connect sailors, sensors, and unmanned systems for real-time situational awareness in any condition-based maintenance (CBM) CONOP
- Wirelessly networking shipboard assets with minimal NRE (less than 1 day - depending on the size of the ship) through bulkheads, doors, etc...
- Connecting wirelessly networked assets to the Enterprise via one node connected to any Enterprise link (i.e. Starlink, Iridium, Verizon, AT&T, etc...) to provide internet access to all nodes with minimal NRE (less than 1 day)

Technology Solution Statement:

Persistent System’s Wave Relay® Mobile Ad Hoc Network (MANET) unites the internet of battlefield things (IoBT) in a high-throughput, self-forming, and self-healing network. Using Wave Relay® enables the connection of sailors, sensors, unmanned systems, and cameras in a dynamic network that goes beyond mesh. In terms of shipboard CBM, the MANET enables real-time retrieval of documentation, video chats with SMEs, and distance-supported (tele) maintenance in any space on a ship with minimal NRE costs.

Benefits Statement:

- Rapidly deployable and currently fieldable wireless networking solution to enable real-time condition-based maintenance actions/resolutions
- Robust/secure/resilient Line-of-Sight (LOS) wireless networking anywhere in the world to connect battlegroups to one another and over the Enterprise using any SATCOM

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • Wirelessly networking shipboard assets/sailors rapidly for real-time condition-based maintenance or battle damage assessment with minimal NRE and reduced Size, Weight, and Power-Cost (Swap-C) requirements (less than 1 day - depending on the size of the ship) through bulkheads, doors, etc... • Connecting wirelessly networked shipboard assets/sailors to the Enterprise via one node connected to any Enterprise link (i.e., Starlink, Iridium, Verizon, AT&T, etc...) to provide internet access to all nodes with minimal NRE (less than 1 day) • Providing a high-throughput (100+ Mbps), secure data link (AES-256 Type II) to connect operators, sensors, and unmanned systems for real-time situational awareness in any condition-based maintenance (CBM) CONOP 	<p>BENEFITS</p> <ul style="list-style-type: none"> • Rapidly deployable and currently fieldable wireless networking solution to enable real-time condition-based maintenance actions/resolutions • Robust/secure/resilient Line-of-Sight (LOS) wireless networking anywhere in the world to connect battlegroups to one another and over the Enterprise using any SATCOM or Cellular connections • Reduced SWaP (1 lb) hardware that can interface with any existing systems/networks (no NRE) via Ethernet, USB, or Serial connections - no effect on Center of Gravity of any ship • MIL-STD-810G, HERO/HERP/HERF, and IP68 (submersible to 20m for 30 min) certified hardware • Cloud Relay™ solution will be CSfC by June 2024 • Provides data, GPS, video, Command and Control, and digital audio capabilities on a flat, single-frequency IP-based network • Runs Android OS to enable applications to run directly on the MPUS - further reduction of SWaP required for any operations
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • Employ a Wave Relay® Mobile Ad Hoc Network (MANET) using MPUS Wireless Smart Radios located throughout any ship class’ mission critical spaces in less than 1 day to enable real-time connectivity/battle damage assessment/condition-based maintenance throughout a ship while ensuring AES-256 Type II encryption across all nodes. • Connect the MANET to any Enterprise link (SATCOM or Cellular) to enable reach back over the Internet for live Subject Matter Expert (SME) guidance, manuals, maintenance procedures, Preventive or Corrective Maintenance Schedules (PMS/CMS), Allowance Parts Lists (APLs), etc... 	 <p>DD-963 SPRUANCE-class</p> <p>MPUS Smart Radio</p> <p>DD-963 CLASS</p> <p>MPUS being used with Google-like Glasses for real-time condition-based maintenance with wireless connectivity to the Enterprise in a machinery space</p>

CBM+ MAINTENANCE-EDGE DATA CAPTURE & PROCESSING

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The Rapid Sustainment Office's (RSO's) Condition Based Maintenance (CBM+) Program Office (PO) has developed Sensor Based Algorithms (SBAs) which require capture of valuable aircraft (A/C) platform Unstructured Data. Once captured, the raw Unstructured Data requires pre-processing to transform into a format digestible by the CBM+ Predictive Analytics and Decision Assistant (PANDA) "predictive maintenance" toolkit. The RSO CBM+ PO has architected a robust solution for the Capture, Transfer and Storage of Unstructured A/C Data, that can be leveraged in an Edge-contested environment and scaled into an Airforce or DoD enterprise solution.

Edge-contested environments present numerous challenges. Many Enterprise-based applications require constant cloud connectivity to function properly. Disconnection from DoD or service clouds will cause loss of critical edge-warfighter tools, capabilities, and possibly data. Edge-connectivity (Satellite) also has bandwidth limitations and requires limited and prioritized data up/download constraints. Large data files cannot

consume precious bandwidth and be shipped up to DoD clouds for processing. Multi-Capable Airmen (MCA) may face maintenance problems that require access to 'difficult to locate' necessary and required data. The MCA do not have experience or significant skill training in IT or computer hardware background or knowledge. Maintainers will be required to monitor and track Aircraft Ground Equipment (AGE) in order to locate, move and maintain this support infrastructure. Also, data card removal and data collection may not be the Maintainer's top priority. This may result in low data collection rates, as the maintainer is focused on keeping equipment in the fight.

To fully understand the maintainer-challenges at the Edge, RSO is developing an MBSE model of Edge-Maintainer job functions (A/C, Fuel, Munitions, Personnel, Intel). This will reveal functions effectively covered, and which need SW applications tools & support. Also, we now understand an Edge-Compute device may be a significant part of our logistics infrastructure kit. Edge-Cloud / Edge-Compute devices will enable

uninterrupted access to Enterprise Apps in a disconnected environment, and provide reliable data capture & pre-processing locally, reducing burden on DoD cloud WAN bandwidth, uploaded data, processing, and storage. Also, the MBSE model of Edge-Maintainer function can help us develop AI/ML targeting support of the Edge-maintainer MCA. We understand there will be knowledge gaps for the MCA and believe AI/ML can be leveraged to address these needs. When possible, Wireless data capture will minimize the Maintainer labor burden. Smart tagging will automate the process of tracking Aircraft Ground Equipment (AGE), enabling the GPS location and current State of Health (SoH) determination. This can be reported back to MOB for real-time understanding of fleet equipment location and health.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • Large amounts of Unstructured Data are not captured or available to DoD organizations within DoD cloud spaces • Unstructured Data, like cell phone data, has huge potential maintenance opportunity, but no formal infrastructure exists to capture, pre-process, store, or data-mine the data • When Edge-warfighters are disconnected from enterprise or DoD cloud links, Enterprise Apps may be non-functional • DoD data capture tools and infrastructure may not work at the battlefield-edge in a disconnected-OPs environment • AF Multi-Capable Airman (MCA) maintenance job function is interrupted by heavy administrative and overhead burden 	<p>BENEFITS</p> <ul style="list-style-type: none"> • Unstructured Data is a huge untapped opportunity for AF & DoD organizations to data-mine for real-time situational awareness and current State of Health (SoH) of the force • AF is focused on Aircraft (A/C) Unstructured Data as a source for A/C SoH and for immediate use for Mx and OPs on the flight-line and for Mx & OPs mission debriefs • Edge-Clouds offer persistent 'Edge data & apps availability' • Edge-Compute does key function locally, reducing DoD Cloud burden, data upload, WAN Bandwidth, etc. • Edge-AI/ML will support success of the Maint Edge-MCA
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • Edge-Compute devices enable Unstructured Data capture, pre-processing, storage, and analysis into high-value data products – at the Edge. Data pipeline & App updates flow down to Edge-devices, guaranteeing the availability of valuable enterprise data resources • Enterprise Data pipelines are Edge-enabled, & maintained by CAC-accessed SWEG, OEM, or contractor partners • Wirelessly collected A/C Platform Data offloads maintainer workload, and increase collection from 50% to >95% • TRL 2-4; among components 	

PRECISE - PAUL REVERE ENTERPRISE CLOUD-BASED INFRASTRUCTURE SOLUTION FOR THE EDGE

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Problem Statement: Optimizing asset readiness and utilization is a key challenge for commanders in the Department of Defense. There are several needs to optimize readiness listed below:

- Need to “make weapon system and equipment maintenance and sustainment more agile, effective, and affordable.”
- Need to efficiently predict equipment failures, perform unscheduled and schedule preventative maintenance
- Need the ability to simulate the behavior of an asset over time
- Need to interface multiple data sources into one comprehensive system of systems providing single point of actionable information
- Need to provide levels of security depending upon specific user groups responsibilities and need to know

Description of the Technology: The technology developed by BMC Software and our SDVOSB partner DMAero, monitors and analyzes the performance and behavior of unique devices and

applications. Machine learning is used to achieve early issue identification by detecting anomalies in operational performance metrics. The ML is then applied to predict equipment failures and schedule maintenance. Auto-remediation, where possible, enables changing machine operating parameters or issuing commands to modify processes. The software enables the creation of a digital twin to simulate the behavior of an asset over time. The platform takes the issues identified and creates tickets and automates workflows to update databases and inform all levels of responsibility of readiness status.

Current Development Status of the Technology: TRL-7 – system prototype demonstration in an operational environment

Test/Simulation Data supporting performance claims: Details available under NDA. BMC and DMAero have run multiple scenarios to validate the efficacy of the solution recommended here. Further, BMC is engaged globally with myriad customer and partners across a broad interdisciplinary set of operational problems

ranging from aircraft operations and maintenance to smart cities to electricity generator monitoring and maintenance.

Next Steps/Potential Benefits: The DMAero/BMC Team recommends immediate engagement to validate this solution with operational data.

The benefits map directly to the problem statement. The solution can make weapon system and equipment maintenance and sustainment more agile, effective, and affordable; efficiently predict equipment failures; plan unscheduled and schedule preventative maintenance and enabling simulation of the behavior of an asset over time. Multiple data sources, enrichment data and aggregation to support advanced AI/ ML analysis and digital twinning, with highly secure, role-based information dissemination are the hallmarks of this solution.

This will lead to:

- Fewer equipment failure
- Reduced MTTR
- Increased asset lifetime
- Verification of repairs efficacy
- Improved workplace safety
- Increased ROI
- Increased configuration management database accuracy

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • Need to “make weapon system and equipment maintenance and sustainment more agile, effective, and affordable.” • Need to efficiently predict equipment failures, perform unscheduled and schedule preventative maintenance • Need the ability to simulate the behavior of an asset over time • Need to interface multiple data sources into one comprehensive system of systems providing single point of actionable information • Need to provide levels of security depending upon specific user groups responsibilities and need to know 	<p>BENEFITS</p> <p>Rapidly generate high-fidelity digital models that can ingest real data to:</p> <ul style="list-style-type: none"> • Model system Status, Model system Performance, Model system Diagnostics • Ability to change parametrics to explore edge cases of system performance/response <p>Fewer equipment failures, Reduced MTTR, Increased asset lifetime, Precise asset data, Verification of repairs efficacy, Improved workplace safety, Increased ROI, Increased Configuration management database accuracy (sources, dependencies and traceability)</p>
<p>TECHNOLOGY SOLUTION Tech Readiness Level - 7</p> <ul style="list-style-type: none"> • Monitor and analyze the performance and behavior of your unique devices and applications • Use Machine Learning (ML) to achieve early issue identification by detecting anomalies in Operational Performance metrics • Use ML to predict equipment failures and schedule maintenance • Auto-Remediate situations by changing machine operating parameters or issuing commands to modify processes • Digital Twin - Simulate the behavior of an asset over time, predict failures and schedule maintenance accordingly. • Easily Integrate with existing ticketing and workflow management systems 	<p>Graphic or Image</p>

INTELLIGENT INFRASTRUCTURE RAPID REPAIR (I2R2)

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Description: Intelligent Infrastructure Rapid Repair (I2R2) is a generative Artificial Intelligence (AI) tool which reviews historical diagnostic and repair reports, analyzes current user symptoms via a large language model (LLM) chat interface, and suggests actionable solutions to address unplanned maintenance issues. Initially trained on information technology (IT) troubleshooting data, this solution framework is easily transitioned to asset maintenance and has the capability of reducing the time to find solutions and infrastructure mean-time-to-repair (MTTR) from hours and days to potentially minutes. This ability to help keep information and wartime assets functioning, particularly in contested operating environments, is essential to mission readiness when time is a critical factor.

Background: Current methods for equipment troubleshooting are highly variable and can lead to wasted time and resources due to misdiagnosis, inefficient repairs, or supply chain restrictions. For example, help desk platforms flag issues for IT personnel but can result in time-consuming trial-and-error troubleshooting. Furthermore, finding the right solution may require spending

significant time combing through multiple data sources. Operators and maintainers, especially when supporting combat operations, need a faster way to identify solutions and address equipment issues to maximize equipment readiness.

Performance: I2R2 creates a new repair process by using generative analytic tools to summarize relevant information into solutions that users rank or refine by conversing with a chatbot. This process can incorporate a variety of data sources ranging from work orders in the maintenance management system to OEM manuals. Through natural language processing (NLP), data is embedded and stored in a database where an LLM retrieves and creates augmented generation to produce solutions in a matter of seconds. Users have the option to further refine their question or problem by conversing with a chatbot that produces new or improved responses. The entire tool is containerized, meaning it can be easily moved between different organizational firewalls and retrained to specific types of data using repeatable fine-tuning techniques, creating a consistent experience. I2R2 is currently in the prototype phase and has

been successfully tested on a database of over ten thousand IT-related documents.

Benefits: By utilizing NLP and LLM, I2R2 can quickly retrieve information from multiple data sources and accurately summarize the proper repair instructions for the user without wasting as much time or money as traditional troubleshooting. This results in less frustration for the user, quicker MTTR, and reduces variability in corrective maintenance actions taken. The tool results in a troubleshooting process that takes a matter of minutes instead of days which can improve mission capability rates and increase man hours spent on mission critical tasks to support combat operations.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> Current methods for equipment troubleshooting leave too much room for error and lead to wasted resources due to misdiagnosis, inefficient repairs, or supply chain restrictions In contested environments, organizations need a faster way to identify problems, troubleshoot, and repair unplanned equipment issues, to accelerate the mean time to repair and maximize equipment readiness Often, the solution for a troubleshooting issues requires combing through multiple data sources <ul style="list-style-type: none"> Historical maintenance records, OEM Manuals, Drawings, Bill of Materials, IoT sensor trends Need a way to streamline the troubleshooting process DoD users face additional hurdles of having limited access to troubleshooting tools and connectivity to Unclassified inputs in limit communication situations 	<p>BENEFITS</p> <ul style="list-style-type: none"> I2R2 creates a new corrective maintenance process by using generative analytic tools to summarize relevant information into solutions that users can rank or refine through a ChatBot in seconds <ul style="list-style-type: none"> Results in less time and money spent searching for information, speaking to end users, and formulating responses Improves mission capability rates of infrastructure and assets Customized framework to a variety of data sources to extract all relevant information <ul style="list-style-type: none"> Intakes logs, sensors, and other types of customized data Semantics fine-tuned to specific maintenance and DoD language to adapt to variety of use cases Containerized system can be moved across firewalls <ul style="list-style-type: none"> Provides users consistent repair capabilities regardless of operating environment or connectivity
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> Through natural language processing (NLP), data is trained on user data and embedded in a queryable database Large language models (LLM) use retrieval augmented generation to produce solutions in seconds Users have the option to further refine their question or problem by conversing with a chatbot which can produce new or improved responses Questions can be tagged to specific types of issues for easy recall and views of open/past tickets to examine patterns An expanding prototype supports preventative maintenance for mechanical systems Researching how the system may perform routine diagnostic testing to augment recommended solutions 	<p>USER EXPERIENCE AND DATA PIPELINE</p>

LOGPACE: INTEGRATING LOGISTICS WITH ADAPTIVE COMMUNICATION STRATEGIES

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Problem Statement: Ground vehicle Condition Based Maintenance Plus (CBM+) implementation frequently encounters challenges in maintaining seamless data communication during varied operational scenarios. The absence of a standardized Primary, Alternate, Contingency, and Emergency (PACE) plan for selecting communication methods exposes CBM+ processes to potential disruption, with differential needs during peacetime and wartime environments further complicating data transfer strategies as well as adoption of processes. Ensuring consistent, secure, and adaptable communication, irrespective of the operational context and environmental constraints, is pivotal to optimize maintenance logistics and safeguard mission-critical data transmission.

Technology Description: Introducing “LogPACE”: an innovative communication management system designed to fortify maintenance processes in ground vehicle operations. LogPACE ingeniously integrates QR codes and Li-Fi technology, alongside traditional communication methods, into a comprehensive PACE plan. Tailoring communication strategies based on

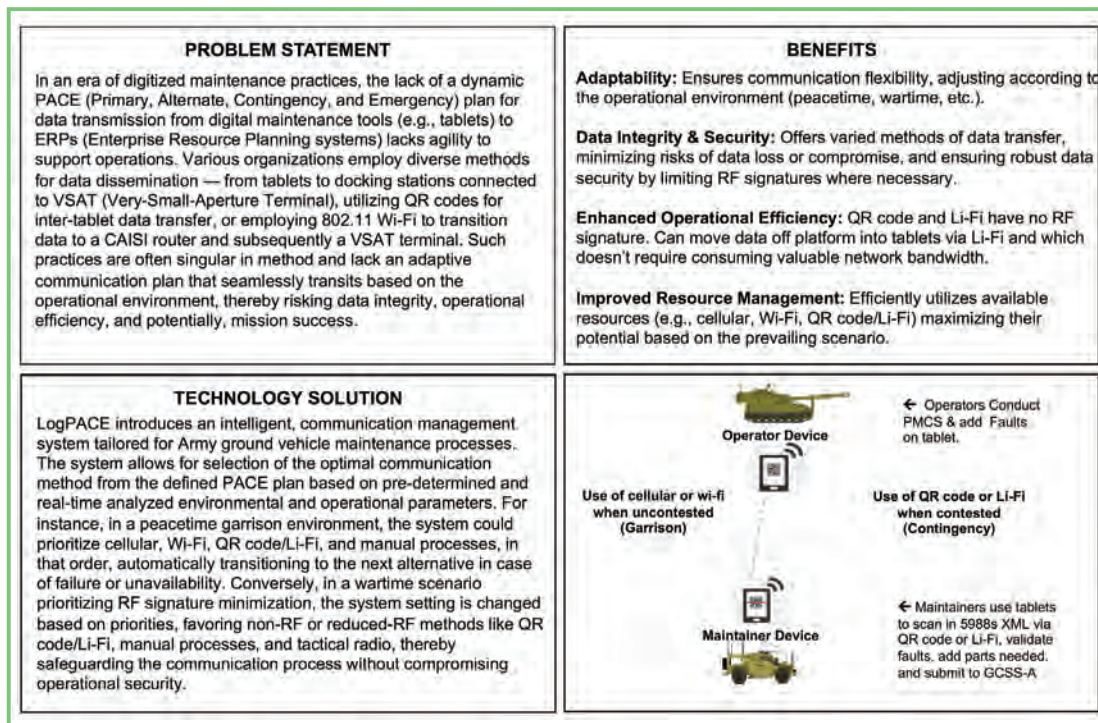
operating environment, the system allows for selecting between RF or Non- RF communication methods. Cellular, Wi-Fi, and manual processes may be favored in a peacetime garrison environment, field environments require non-RF or reduced-RF methods like QR code/Li-Fi, manual processes, and tactical radio.

Development Status: LogPACE is in the advanced development stage, having undergone testing in operational scenarios reflective of peacetime garrison and contingency environments. The conception of the LogPACE model was derived from Soldier touch-points within an Active Duty Armored Brigade Combat Team (ABCT) where the need to shift between communication methods was witnessed as the unit changed from a garrison operational environment to a contingency environment in NTC.

Test/Simulation Data: Testing in operational environments underscored LogPACE’s adaptive communication capabilities, ensuring no loss of maintenance data across all scenarios (Garrison vs field). When operating in the field, Soldiers transitioned

from Wi-Fi to QR code technology, ensuring continual data flow while minimizing RF signature. Li-Fi technology provides a robust alternative in scenarios requiring rapid data transfer without RF engagement, underscoring LogPACE’s multifaceted communication capabilities. We were able to move 450 Megabytes of data from a vehicle to a computer via Li-Fi in 5 seconds.

Next Steps/Potential Benefits: LogPACE, moving forward, is looking to partner with Army Applications Laboratory (AAL), to develop a cohort of industry solvers to fine tune the LogPACE model for a range of operational environments. Fine-tuning the technology based on field-testing feedback, addressing real-world challenges, and further honing user experience will be pivotal. Subsequent iterations will explore applicability across Joint logistics use cases.



PIONEERING CONDITION-BASED BATTERY MAINTENANCE FOR THE DOD

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As stated by Deputy Secretary of Defense Dr. Kathleen H. Hicks, “Battery technology, and lithium-ion batteries specifically, are the lifeblood of electrification and the future auto industry, but batteries are also essential to thousands of military systems.” Optimal battery maintenance is becoming crucial for mission success and operational efficiency. Current practices lack the granularity needed for effective battery management, leading to unexpected failures and increased costs. On top of this, the battery supply chain currently relies on potential adversaries, posing an even greater risk to the DoD’s ability to achieve its objectives and putting even greater pressure on optimizing the use of each battery in its inventory.

Our technology currently focuses on electric aviation, where the stakes for battery safety and reliability are exceptionally high. In collaboration with AFWERX and key industry stakeholders, we’ve engineered cutting-edge algorithms that can predict vital battery health metrics—such as remaining cycle life, State of Health, and weak cell detection—specifically for electric aircraft applications. While UAVs are the direct dual-use counterpart, our algorithms

are largely application-agnostic and can integrate into a wide range of existing DoD battery asset programs such as ground vehicles, unmanned submersible vehicles, or satellites, and the DLA program offices that support them.

Funded partly by AFWERX and the NSF, we’ve developed “off-the-shelf” models for common lithium-ion battery chemistries. We are currently integrating these cloud-based algorithms into one of our partner’s diagnostics dashboards for battery-powered assets, and we’re developing interfaces for data ingestion and results distribution to easily integrate our solutions with other partners to make them scalable.

The military currently lacks reliable methods for predicting battery end-of-life in fielded systems during normal daily use. Any kind of battery diagnostics incurs system downtime, as batteries must be cycled in lab environments to gather the necessary data. Our field-ready neural network models have shown promising lab results, achieving a 5.2% error rate in estimated cycle life for LFP batteries compared to the 9.1% error rate of other state-of-the-art laboratory methods.

Using data from Sandia National Laboratory, we’ve forecasted battery health with similar accuracy using as few as 40 cycles, which represents months or even years of time savings on battery testing campaigns.

Our vision is to become the DoD’s preferred partner for battery condition-based maintenance, and we are actively pursuing opportunities to apply our battery predictive maintenance capabilities in the field. Several programs are under development, including supporting a Space Force ISR mission with autonomous drones and supporting the MRO of aviation batteries through the DoD’s Operational Energy Capability Improvement Fund (OECIF).

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none"> Deputy Secretary of Defense Dr. Kathleen H. Hicks states, "Battery technology, and lithium-ion batteries specifically, are the lifeblood of electrification and the future auto industry, but batteries are also essential to thousands of military systems." The DoD Lithium Battery Strategy 2023-2030 aims to facilitate the rapid adoption of new battery technologies. Current DoD battery maintenance lacks granularity, leading to unexpected failures, increased costs, and compromised mission success. Reliance on foreign supply chains controlled by potential adversaries adds further risk and puts even greater pressure on getting the most out of each battery in its inventory. 	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> Enhanced Operational Readiness: Our predictive algorithms ensure batteries are at peak performance, reducing the risk of unexpected failures and increasing the reliability of mission-critical systems. Significant Cost Savings: Knowledge of battery health minimizes the need for emergency replacements and reduces the total cost of ownership for battery-powered assets. Secure, Domestic Battery Analytics enhances national security. Alignment with DoD Energy Strategy: Our solutions align with the DoD’s Operational Energy Strategy, particularly in enhancing energy command and control capabilities.
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> Cutting-edge algorithms for predicting battery health metrics (e.g., remaining cycle life, state of health, weak cell detection) and hence enabling battery condition-based maintenance (CBM) Application-agnostic design: Integrates with existing DoD battery asset programs across all branches Models are ready to be deployed for testing in the field for common Li-ion chemistries Currently integrating our algorithms into a commercial partner’s diagnostics dashboards and developing interfaces for easy data ingestion and results distribution, making strides toward product scalability. 	<p style="text-align: center;">Astrolabe eVTOL Analytics System Block Diagram</p> <p>The diagram illustrates the data flow within the Astrolabe eVTOL Analytics System. It starts with 'Flight Data (E, X, T) System metadata' and 'Characterization Test Data' as inputs. These feed into a 'Battery Model' and 'Parameters'. The Battery Model outputs 'State of Health (SoH) Algorithm', 'State of Power (SoP) Algorithm', and 'State of Charge (SoC) Algorithm'. The SoH algorithm leads to 'Remaining Useful Life (RUL)'. The SoP algorithm leads to 'Remaining Hover Time'. The SoC algorithm leads to 'Remaining Cruise Time'. These three metrics are then processed by 'Condition-Based Maintenance (CBM) Dashboards' and 'Operator Health Up Displays (OHU)'. A legend indicates that blue boxes represent inputs, green boxes represent algorithms/processors, and red boxes represent outputs.</p>

DIGITAL LOGBOOK

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Problem Statement: Future military operations are expected to require Expeditionary Maintenance and Forward Sustainment Repair within a Contested Logistics environment. Digital Maintenance solutions are needed to enable real time equipment health status, increased PMCS efficiency, Predictive Logistics analyses, and the ability to echelon complete and accurate condition-based maintenance information for rapid repair and resupply in disconnected operations.

Description of Technology: Digital Logbook (DLB) is a versatile software application that enables secure real-time maintenance operations in connected and disconnected environments. DLB resides on mobile devices for Operators/Maintainers to conduct PMCS and repair operations, and on laptop/desktop computers at any echelon to view equipment readiness status within an AOR. Capabilities of DLB include:

- Digital Equipment Maintenance Forms (e.g., 5988E) and Ammo Forms (e.g., DA4949)

- Auto-populated forms with complete and accurate real-time vehicle and supply data
- Seamless integration with IETMs, RPSTLs and GCSS-Army
- Dashboards to view vehicle health status
- Secure bidirectional data migration from the Tactical Edge to the Army Enterprise

Current Development Status: DLB is executing Phase 3 of development in a collaborative effort between Ricardo Defense, PEO CS&CSS, DEVCOM GVSC and JPEO Armaments & Ammunition. DLB Phase 3 further matures digital PMCS, repair, and ammunition supply operations in connected and disconnected environments. Equipment usage, fault, maintenance, resupply, and consumption data is automatically collected and populated onto digital records (e.g., 5988E) with the ability to echelon these records in a disconnected environment and deliver the information directly to G-Army when network connectivity is re-established.

Data Supporting Performance Claims: DLB has completed Soldier Touch Points and

Soldier Operational Experiments at multiple locations, including the National Training Center, Ft Stewart, Ft Johnson, Ft Cavazos, Camp Grayling, and Project Convergence (PC21, PC22). These events have verified DLB's capabilities, while incorporating Soldier feedback to refine requirements and improve user experience. Validated results include reduced manual entry workload, fewer errors, verified preventive actions, elimination of over-ordering parts, simplified maintenance workflows, connectivity to G-Army and accurate equipment configuration management.

Next Steps/Potential Benefits: DLB Phase 3 will be completed in FY24, including its Authority to Operate, and will be ready for fielding in FY25. In addition to the benefits of improved maintenance and repair operations in both connected and disconnected environments, there are potential cross-service benefits in Contested Logistics maintenance and supply operations. DLB Phase 3 will demonstrate Class V (Ammunition) supply, and future extensions of this technology can be applied to Class III (POL), Class VIII (Medical Supplies), etc.

PROBLEM STATEMENT

Digital Maintenance solutions are needed to meet the challenges of Expeditionary Maintenance, Forward Sustainment Repair, and Predictive Logistics (PL) within both Connected and Contested Logistics environments. These challenges include:

- Providing real time status of platform's health and key consumables (fuel, ammunition, etc.)
- Providing autonomous data offload from platform to enterprise
- Storing engineering data, parametric data, and environmental data
- Digitizing maintenance processes to minimize manual inputs
- Allowing units to immediately address platform deficiencies and replenish parts more efficiently
- Transporting platform maintenance data in a disconnected environment
- Providing visual display of Platform PL Data for Command-at-Echelon Decision Support

BENEFITS

- Reduced manual entry workload for PMCS and Maintenance tasks
- Simplified PMCS and maintenance workflows through seamless digital integration between manuals, forms, and records
- Increased data accuracy (fewer errors) through auto-population of 5988E forms and direct connection to GCSS-Army
- Elimination of over-ordering parts or ordering incorrect parts
- Complete and accurate equipment configuration management
- Time studies verified that DLB Dashboard views and Digital Forms achieved a 50% time reduction for motor pool operations that include collecting, reviewing, and prioritizing maintenance activities when a unit returns from the field
- Digital tracking of Class V (Ammunition) delivery and consumption can be applied to other supplies (medical, fuel, water, etc.)

TECHNOLOGY SOLUTION

Digital Logbook (DLB) is a software application that resides on Operator/Maintainer tablets for maintenance operations, and on laptop/desktop computers for Command-at-Echelon decision support.

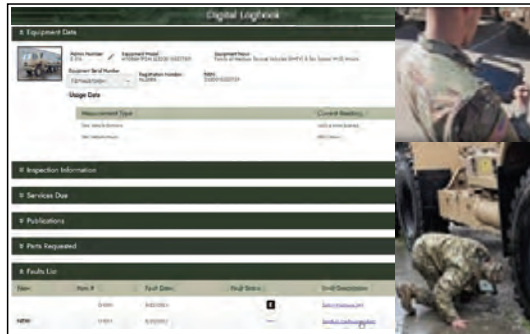


Capabilities

- Autonomous data offload from platform-to-tablet via wired or secure wireless connection
- Real Time status of platform health and consumables (usage, faults, fuel, ammunition, power, energy)
- Digital workflows for maintenance, repair, and supply operations
- Fully integrates with IETMs (EMS and IADS)
- Transports data from edge-to-echelon, including GCSS-Army
- Stores and Distributes data in disconnected environments

ATO in FY24

Field-ready in FY25



ENRICHED SENSOR DATA: THE CRITICAL ELEMENT TO EFFECTIVE PREDICTIVE MAINTENANCE, AND HOW TO UNLOCK IT

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PROBLEM: America’s military platform, fleet, and weapon systems readiness is the most crucial component of global security today. We rely on these exquisite machines, heavily computerized and equipped with operational technology systems, to enable warfighters with overmatching capabilities to deter our adversaries. But aging legacy systems and complex vehicles, aircraft, spacecraft, and ships are costlier to maintain. Earlier this year, a survey of DoD leaders was fielded to explore the state of predictive maintenance across the DoD and to identify critical challenges to adoption, implementation, and expansion. Study participants identified a lack of observability of their dynamic and constantly evolving onboard data – the inability to access raw onboard sensor data, put that data into context, and derive analysis or insights at speed and scale.

SOLUTION: Capturing and analyzing fleet-wide weapon system sensor data in real time – then translating it into graphically simple, human-readable format – enables maintenance crews, cyber incident response teams and operators with the ability to more rapidly identify, triage, monitor and respond to mechanical and cyber incidents.


In this discussion, you will learn how this mostly unused sensor data is a critical component for achieving effective predictive maintenance. This TRL-9 certified edge technology performs continuous, full-take data capture from any and every onboard source fleetwide – every frame, every serial bus, every protocol. Equipped with real time anomaly detection and insights from onboard sensors, this capability enables: (1) faster support of degraded systems, (2) reduction of no fault found maintenance events, (3) improved readiness and availability for increased mission capability rates, (4) reduced sustainment phases, (5) reduced maintenance costs, (6) real-time cyber intrusion alerts for pilots, (7) and data translation into meaningful visuals enabling real-time operational decisions and research.

TECHNICAL MATURITY: This technology has achieved Technical Readiness Level 9.

CROSS-SERVICE APPLICABILITY: This technology applies to both CBM+ and cybersecurity needs. When implemented across fleets, this technology enables cyber analysts and maintenance crews to conduct thorough incident investigations

within existing workflows and equips warfighters with real-time cyber intrusion alerts. Data captured can be seamlessly fed and integrated into various DoD GovCloud platforms, data lakes, and Systems of Records such as Advana and Panda – without requiring additional manipulation, to (1) provide real-time fleet data to maintainers and commanders across the joint force, and (2) better train AI/ML algorithms needed for the future fight. Shift5 also supports Security Information Event Management platforms, allowing for alerts to be streamed off vehicle in human readable format.

FEASIBILITY: This technology is in active implementation across all Service branches & applicable to the DLA.

PROBLEM STATEMENT	BENEFITS
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • Edge computer conducting continuous, full-take data collection and monitoring across all onboard networks, able to identify faults with associated indicator and sensor data. • Onboard real-time anomaly detection and alerts to crew, enhances flight safety and risk assessment. • Computer integrated with aircraft digital comms for near-real-time reporting to maintenance support. • Software provides data translation, baselining, AI/ML algorithms, and data connectors to Enterprise Cloud Systems. • See Appendix 1 & 2 for test/simulation data supporting performance claims 	 <p>The diagram illustrates a 2.5-hour timeline of an aircraft's flight and maintenance process. At 12:00, an edge computer on the aircraft monitors various sensors (temperature, pressure, etc.). At 12:15, a fault report is automatically sent to the ops center while the aircraft is still in flight. At 13:00, as the aircraft approaches the airfield, the ops center alerts maintenance. At 14:30, maintenance directly engages the aircraft upon landing to perform repairs, streamlining the process.</p>

CBM+/PREDICTIVE MAINTENANCE

MIDE TECHNOLOGY CORPORATION SMARTCLAMP

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To combat the billion-dollar costs associated with Electrical Wiring Interconnection System (EWIS) chafing issues as reported by the Joint Intermittent Testing Team Working Group (JIT WG), Midé Technology Corporation has developed a self-powered (with no additional system power/wires/ batteries needed to install) Radio Frequency Identification (RFID) capable, user programmable, patent pending technology called SmartClamp. SmartClamp was designed to be a preferred Defense Logistics Agency (DLA) replacement spare part for legacy EWIS and hardline fuel and hydraulic (dumb) MIL21919 Adel clamps installed in DOD weapons systems, support equipment, and industrial infrastructure equipment worldwide. In addition to performing normal clamping functions, SmartClamp autonomously monitors, stores, and reports abnormal chafing/vibrations issues it detects during system use to maintainers allowing for assessment and repair of the detected issue before a costly and potentially dangerous system failure occurs. To accomplish this, RFID scanning is

completed periodically by maintainers to transfer clamp information to the SmartClamp which notifies maintainers of the anomaly.

Thousands of inspection and repair maintenance man-hours will be averted. Hundreds of millions of dollars in maintenance costs will be saved, and system safety will be vastly improved for each DOD and commercial system that adopts SmartClamp technology. Data collected with SmartClamp can be used to support DOD's ongoing Condition Based Maintenance (CBM) efforts. No other technology of this kind exists to wirelessly detect chafe/vibration anomalies making this technology unique and novel. Mide's user friendly software allows users the ability to program clamp detection levels and customize software dashboards, system reports, and data analytic algorithms giving users complete control of SmartClamp installation and system monitoring. SmartClamp is built with the TRL-9 core technologies based on Midé's enDAQ sensor line (formally SlamStick), Midé's CBM data analysis algorithms

and commercial off the shelf (COTS) RFID equipment. Mide's SmartClamp technology is currently at TRL-5. SmartClamp sensing technology has been successfully prototyped and tested to be repeatable and accurate as tested on Mide's laboratory EWIS test bed.

The next steps would be to demonstrate SmartClamp in a relevant environment such as an F/A-18, JSF, V-22, M1 tank or Depot. Mide is searching for sponsors to support validation of this technology.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> Electrical wiring interconnect system (EWIS) and hydraulic/fuel/hard-line chafing issues are a multi-billion-dollar issue for the DOD and Original Equipment Manufacturers (OEMs) Currently there is no technology available that provides a reliable, self-powered, easily retrofittable, low cost, data analytics driven, Condition Based Maintenance (CBM) compatible solution to combat this issue 	<p>BENEFITS</p> <ul style="list-style-type: none"> No wires/power required during installation CBM approach vastly improves system safety and readiness, fix it before failure Greatly reduces cycle time and necessary manpower numbers by reducing/eliminating routine inspections and related repair maintenance man-hours Increases Time on Wing (TOW) by detecting preventable failures Installed as preferred MIL21919 part, no installation ECP required reducing cost Detects vibration hot spots, systemic, one-off installation issues, and system design issues Applicable to DOD and OEMs worldwide
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> SmartClamp is self-powered (no batteries), wireless, user programmable, and CBM compatible Maintainers scan for anomalies with RFID handheld device for upload to SmartClamp system software Notifies maintainers if an abnormal clamp vibration is detected providing clamp location Preferred replacement part for MIL MIL21919ADEL/ hydraulic/fuel/hard-line clamps and requires no engineering change proposal (ECP) to retrofit No other capability for this detection exists in the world Allows for remote monitoring in difficult to inspect locations TRL-5 has been demonstrated in our laboratory 	<p>Midé Technology Corporation's SmartClamp System</p>  <p>The diagram illustrates the SmartClamp system architecture. It shows a vehicle with wires and SmartClamp sensors attached. An RFID scanner is used to interact with the SmartClamp sensors. The data is processed by Condition Based Maintenance Software, which is connected to a Vehicle Database. The software outputs information to a Dashboard and sends email notifications to maintenance personnel. The system is designed for inspection and actions.</p>

DATA COLLECTION SYSTEM FOR MILITARY VEHICLE OPERATIONS

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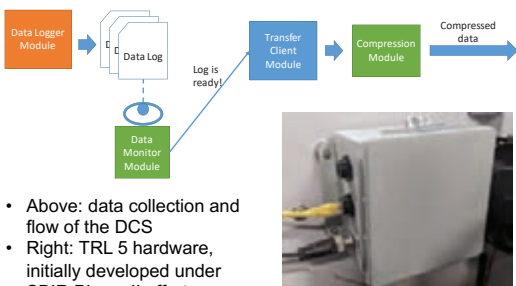
The Data Collection System (DCS) is an innovative, on-vehicle solution utilizing artificial intelligence to monitor and analyze vehicle telemetry data, identifying normal and anomalous behaviors. This innovative system enables continuous assessment of equipment and vehicle readiness during active operations, minimizing downtime and mission risk through proactive maintenance alerts.

By reducing vehicle downtime and supporting both legacy and next-generation military vehicles, the DCS enhances fleet readiness and empowers commanders to make data-driven, risk-based decisions during operations. Seamlessly integrating with legacy systems, it offers real-time monitoring, anomaly detection, and maintenance recommendations for a wide range of military vehicles, including land-based combat vehicles, tactical wheeled vehicles, aircraft, naval vessels, and unmanned systems.

A key feature of the DCS is its ability to learn normal behavior over time, adapting to detect anomalous behavior, enabling commanders to make informed decisions

to ensure safe and effective operations. The DCS software records vehicle data, prepares it into a common format, runs AI analysis, and provides a reporting portal for easy access to crucial information. It also ensures smooth data flow and high security across sites and fleets through centralized reporting.

Proven effective through a SBIR Phase II demonstration for the Army, the DCS has potential for adoption by the Department of Defense (DOD) to address critical maintenance needs and optimize performance. In summary, the Data Collection System is a promising addition to the military's arsenal, revolutionizing vehicle maintenance and fleet management, and enhancing overall mission success.

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none"> Timely maintenance of combat vehicles will provide a significant operational advantage for U.S. Armed Forces. The current health of vehicle components is currently gauged with subjective checks and preventative maintenance. Inconsistent checks and inadequate maintenance drive up fleet costs for the military. Overall, there is a critical need to know that all vehicles are going to be able to complete the mission and identify <u>potential</u> issues during military operations A significant challenge is ensuring data flows smoothly from components to data analysis systems to achieve a high level of security and reliability with a low level of latency. 	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> Reduce mission risk: continuous assessment of equipment and vehicle readiness and active operations Minimize down time: proactive alerts to imminent failure based on vehicle historical data Support for legacy and next-generation vehicles Learn normal behavior over time, and learns to detect anomalous behavior Continuous assessment of equipment and vehicle readiness and active operations Enables Commanders to make data-based, risk driven mission decisions to ensure safe and effective operations Increased fleet readiness with decreased maintenance costs
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> An on-vehicle intelligent agent that collects vehicle data, learns normative behavior, detects anomalous behaviors, and recommends known solutions Hardware platform for integrating with legacy systems Software that: <ul style="list-style-type: none"> Records vehicle telemetry data Prepares the data into a common format Runs Artificial Intelligence analysis engines Has a reporting system portal Transfers data for centralized reporting across sites and fleets Identifies normative and anomalous behaviors 	 <ul style="list-style-type: none"> Above: data collection and flow of the DCS Right: TRL 5 hardware, initially developed under SBIR Phase II effort

SURFACE CLEANLINES ANALYZER

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Surface cleanliness is a difficult to measure, critical factor to ensure proper adhesion of paints, coatings, and sealants. Lost system availability and the cost of repairing adhesion related failures is a huge problem for the DoD. For proper adhesion, surfaces must be adequately cleaned so applied materials can wet the surface. Some contamination is always present, and monitoring the amount is critical to preventing subsequent adhesive failures. Surface contamination is often localized and invisible to the eye. A simple method is needed for sampling surface cleanliness, especially hard-to-reach areas that are difficult to clean.


Amount of surface contamination can be determined by measuring the wettability angle formed by a water droplet on a surface. Contact angle is proportional to the degree of contamination. Prior belief was the only way is in a laboratory, using a special microscope that shines a light sideways on a water droplet to measure the contact angle with the surface. Since that is impractical in a maintenance environment, we rely on a simple water break test. Water is sprayed on a surface to see if droplets form which indicate contamination. Simple, but it is

prone to sampling and user interpretation errors. It does not provide a numerical measure of contamination, and it is not practical for use on many localized areas, complex geometries, or vertical surfaces. Results cannot predict and diagnose root cause of most subsequent adhesion related failures. The question is always: was it a problem with the applied material, improper application technique, poor/incomplete surface prep, or did the surface get contaminated during removal of the water break spray?

A surface analyzer (SA) was developed taking a totally different innovative approach to measuring wettability angle. It combines printing industry ink jet technology, a miniature high-resolution camera, and machine vision software to provide the first practical, objective measure of surface cleanliness. The portable, handheld, battery operated SA emits a pulsed micro-stream of pure water onto a surface creating a single 2 μ l droplet light enough to adhere to even bottom facing surfaces. Using the known droplet volume and its measured diameter, the SA can calculate, without directly measuring, the wettability angle. It provides a

reading in 2 seconds. In a matter of minutes, the SA can sample both easy and difficult to clean surfaces. In direct comparison to conventional NIST traceable laboratory equipment, the SA produced equivalent and more consistent results. Cleanliness limits can now be developed to prevent the majority of maintenance repairs related to surface contamination by answering the questions, what is clean enough, and is it really clean?

The SA has been commercialized and seeing limited use in the aerospace and automotive industries. In a production line test monitoring bonding 3,000 nut plates on a 5th generation fighter, use of the SA reduced bond failure.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none">• Improper and inconsistent surface preparation negatively impacts adhesion of paints, coatings and sealants• Adhesion failures are most often delayed field occurrences• Surface contamination reduces reactivity of a surface necessary to promote adhesion of applied materials• Surface contaminants are often invisible to the eye• Contamination is often localized in difficult to clean areas• Monitoring substrate surface cleanliness requires measurement of surface energy / reactivity<ul style="list-style-type: none">• Through measurement of liquid droplet wettability• Traditional objective cleanliness measurement requires laboratory environment and angle measurement equipment<ul style="list-style-type: none">• i.e. side view of angle formed by water droplet to surface	<p>BENEFITS</p> <ul style="list-style-type: none">• 1st field-level quantified measure of surface cleanliness• Self contained portable handheld instrument• Designed for manufacturing floor / field-level use• Non-destructive test utilizing single droplet of purified water• Accuracy not dependent on operator technique• First instrument capable of evaluating cleanliness in difficult to access and clean areas<ul style="list-style-type: none">• Vertical, curved, and bottom facing surfaces• Inside recessed grooves and raised protrusions• Use will eliminate field and depot scrap, rework, and production delays related to poor adhesion and improper surface cleaning
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none">• Jointly developed with help from AFRL and Lockheed Martin• Determines contamination by measuring surface wettability• More accurate than current water break test• Previous quantitative instruments limited to laboratory use• Eliminates need to measure actual water drop contact angle<ul style="list-style-type: none">• Uses a single precisely dispensed microdroplet of water• Calculates water wettability angle from known droplet volume and measured diameter• Water droplet is dispensed in series of ink-jet type bursts<ul style="list-style-type: none">• High velocity overcomes surface roughness issues• Small droplet size not effected by gravity• Droplet adheres to vertical and bottom side surfaces• Provides quantitative surface cleanliness data in 2 sec	 <p>Distribution Statement A. Approved for public release; distribution is unlimited.</p>

3D PRINTED OVERBOARD DISCHARGE SCUPPERS TO ELIMINATE HULL STAINING

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Liquid discharge from overboard discharge pipes causes stain and rust streaks to develop on the hulls of U.S Navy ships. A significant amount of hull staining can develop with 100-200 discharges per ship that requires hull maintenance by ship's personnel and shipyards. Hull preservation is time consuming and requires boom lifts or paint skiffs to access the ship hull. Metal scuppers are currently welded or bolted to the hull to push the water away from the hull, but these require costly hot work for installation and are subject to corrosion and damage by tugboats.



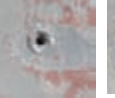





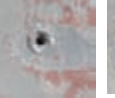





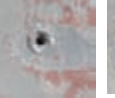



3D printed scuppers when attached, with very high bond tape, to the hull will reduce the ship hull staining and the need for difficult ship's hull maintenance by ship's force or shipyards. The scuppers can be easily removed for hull preservation and then replaced. Computer models for 3D printed components can be easily modified to accommodate different configurations and files can be electronically shared with 3D printing facilities around the world (ashore and afloat), allowing for quick response to

maintenance requests. Scuppers can be printed using flexible material that provides additional impact resistance to tug hits. In addition, the scupper lip length can be modified to take into account the ship hull profile.

The Naval Surface Warfare Center, Carderock Division (NSWCCD) has been working with the Mid-Atlantic Regional Maintenance Center to print five kits of approximately 20 scuppers for demonstration on five destroyers at four different homeports in FY23 and providing additional kits to OCONUS based destroyers in FY24. NSWCCD personnel has developed installation guidelines, YouTube videos and provided hands on training to ship's force to aid the fleet in the transition of the technology. To date six ships, in three homeports, have been trained and provided initial scupper installation kits. Naval Sea Systems Command Additive Manufacturing Technical Data Packages have been developed for the two families of scuppers (flanged and eyebrow). Once approved, these will be posted on the NAVSEA AM library of approved parts with all the required

print files and materials information available for download.

There has been significant interest in this technology from U.S. Navy active-duty ships, Military Sealift Command and United States Coast Guard vessels. The simple installation materials and processes have been well received from ship's force. It is expected that once installed the scuppers will significantly reduce the staining on ship hulls which will lower the maintenance time required to maintain the hull. Improved ships readiness and reduction in shipyard sustainment costs and schedules are also expected with wide scale adoption of the 3D printed overboard discharge scupper technology.

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none"> Liquid discharge from overboard discharge pipes causes stain and rust streaks to develop on the hulls of U.S Navy ships. With 100-200 overboard discharges per ship, this causes a significant amount of hull staining. Metal scuppers can be welded or bolted to the hull to push the water away from the hull but these require costly hot work for installation and are subject to corrosion and damage by tug boats. Hull maintenance by ship's personnel and shipyards is time consuming and requires specialty equipment such as a boom lift or paint skiff to access the hull and additional personnel protective equipment for surface preparation and recoating the hull with the required materials. 	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> 3D printed scuppers when attached to the hull will reduce the ship hull staining and the need for difficult ship's hull maintenance by ship's force or shipyards. Models can be easily developed for a variety of different configurations as needed to accommodate different pipe sizes and scupper lip lengths depending on the profile of the ship hull. Files for 3D printing can be easily provided to additive manufacturing facilities throughout the world ashore and afloat to be able to 3D print scuppers as required. Flexible thermoplastic polyurethane can be used to print impact tolerant scuppers to minimize tug hits. 												
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> 3D printed polymer scuppers can be easily attached to the hull surface using very high bond strength foam tape with a sealant applied around the bond line. Models for the 3D printed scuppers can be easily changed to accommodate different sizes and shapes depending on the ship overboard discharge pipe configuration. Scuppers can be printed using rigid or flexible material that provides additional impact resistance to tug hits. Models can be easily used by 3D printing facilities around the world, ashore and afloat, to make new scuppers as needed on demand. 	<table border="0"> <tr> <td style="text-align: center;">Before Flanged</td> <td style="text-align: center;">After Scupper</td> <td style="text-align: center;">Before Eye Brow</td> <td style="text-align: center;">After Scupper</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td colspan="2"></td> <td colspan="2"></td> </tr> </table>	Before Flanged	After Scupper	Before Eye Brow	After Scupper								
Before Flanged	After Scupper	Before Eye Brow	After Scupper										
													
													

STAR 4D PAINT SIMULATOR

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Problem Statement: Learning how to accurately apply aerospace paint to an aircraft is a tricky proposition. Over-spraying can create thick patches of heavy paint that cause weight problems and increased drag, while under-spraying leads to accelerated corrosion and wear on the air frame. Both extremes translate to cost, quality, and schedule issues that CCAD customers find undesirable.

Description: The STAR 4D Virtual Paint Simulator provides CCAD with the ideal tool to realistically train artisans without consuming costly paint and PPE. The equipment utilizes replica paint nozzles used in real-world applications in a safe, simulated environment. STAR 4D helps artisans with transfer efficiency, which reduces the variability in speed and distance patterns to provide a smooth, even paint application on each airframe and component, thus maximizing the aerospace coating efficiency. The result? Aircraft now leave CCAD with single-run applications of paint that preserve the aircraft while remaining within weight limits and total Mil-thickness tolerances. STAR 4D also improves the qualifications

required to create and sustain skilled Aviation Painters. It has become the required certification tool for CCAD aviation painters.

Current Development Status: CCAD is currently leasing the equipment from the original equipment manufacturer (OEM) with the option to purchase. The simulator was recently upgraded and currently provides real environments needed to maintain aircraft painter certifications.

Test/Simulation Data (Supporting Claims of Benefits): Prior to STAR 4D acquisition, aircraft painters were using 7 to 8 gallons of paint per aircraft. However, recent data reveals that CCAD paint artisans are now using approximately 4 to 5 gallons per aircraft, a reduction of 3+ gallons per aircraft. Less waste occurs at the end of the value stream when fewer waste barrels are used, which improves the Depot's Environmental Management System performance. Every gallon of paint saved results in a corresponding 15 to 20 lbs. of weight reduction on the airframe, meaning less drag, increased fuel efficiency, and longer endurance times for air crews. Since STAR

4D arrived, quality metrics have improved by more than 50% and, as a result, rework hours have been reduced by close to 75%. The STAR 4D virtual trainer also translates to reduced training costs in terms of paint and PPE usage.

Next Steps/Potential Benefits: In addition to the above benefits, STAR 4D also has the capabilities to simulate Plastic Media Blast (PMB) cleaning, with the added potential of another viable certification path using this tool. No data currently exists for PMB, but the outlook is promising. CCAD intends to purchase the system within the next year (2024) when the lease period ends.

PROBLEM STATEMENT

- Learning how to accurately apply aerospace paint to an aircraft and its components is a tricky proposition. Over-spraying can create thick patches of heavy paint that cause weight problems and increased drag, while under-spraying leads to accelerated corrosion, wear and tear. Both extremes translate to cost, quality and schedule issues that CCAD customers find undesirable.

BENEFITS

- Reduced paint waste stream by approximately 45%
- Reduced weight on aircraft up to 300lbs (9 Gallons down to 5 Gallons)
- Reduced Cycle Time from 5 to 3 Days
- Reduced cost (paint, defects, man hours, PPE)
- Improved quality of training: Virtual Environment means accurate coverage and digital feedback to learner

TECHNOLOGY SOLUTION

- STAR 4D Virtual Paint provides employees the tools to realistically train artisans without consuming paint and PPE. The equipment utilizes the actual paint nozzles used in real-world applications in a safe, simulated environment. STAR 4D helps artisans reduce the variability in speed and distance patterns to provide a smooth, even paint application on the airframe. The result? Aircraft now leave CCAD with mostly single-run applications of paint that preserve the aircraft while staying within weight limits. STAR 4D improves the qualifications required to create skilled Aviation Painters. It has become a required certification program for CCAD aviation painters.

VIRTUAL TRAINING IN A PRISTINE ENVIRONMENT



LASER PHOTONICS: DEFENSETECH CLEANING LASERS

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Corrosion damages over \$20 billion of military assets annually. Maintenance practices within the military and defense sectors have struggled with the challenges of efficiently cleaning intricate and sensitive equipment critical to mission success. Traditional cleaning methods often fall short, leading to increased downtime, costly repairs, and potential mission delays. Laser Photonics' DefenseTech Cleaning Lasers aims to revolutionize maintenance by offering an innovative solution to these challenges.

DefenseTech lasers are an innovative technology designed to meet the cleaning needs of various equipment and components for military and defense. These lasers utilize high-intensity, precisely controlled laser beams to remove contaminants, coatings, and unwanted deposits from a wide range of surfaces without damage to the underlying materials. The system is highly adaptable, allowing it to be customized for specific applications, from optics and electronics to mechanical components.

This technology has progressed from concept and prototype to a successful market launch. We have conducted

extensive testing, demonstrating the efficacy and safety of DefenseTech lasers when used on a wide range of military equipment and substrates. Initial results indicate remarkable improvements in efficiency and reduced downtime.


Our lasers consistently achieved excellent removal times for various contaminants, including oil, paint, rust, corrosion, and coatings, in an extensive range of environments. These results have been corroborated through testing in multiple maintenance depots and military facilities, demonstrating the technology's reliability and suitability for real-world maintenance scenarios.

The next step in the development of these Cleaning Lasers involves refining the technology to meet the specific needs of various military branches and the Defense Logistics Agency (DLA).

Our lasers create a safer work environment for maintenance personnel, eliminating hazardous chemical cleaning agents. DefenseTech lasers also significantly enhance maintenance efficiency by reducing

cleaning time and manpower requirements, improving operational readiness, and cutting costs. Another benefit of this technology is that it extends the lifespan of critical equipment components by minimizing damage and reducing the need for replacements. These lasers' cross-service applicability ensures a unified solution to maintenance challenges across military branches. This innovative technology is well-positioned to seamlessly integrate into military maintenance practices, aligning with the evolving needs of specific DoD programs and readiness levels.

The technology's proven health benefits, cost-effectiveness, versatility, and readiness for implementation make it a viable candidate for addressing critical maintenance challenges and improving operational readiness within the DoD.

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none"> Corrosion costs the Department of Defense over \$20B in military assets every year. Amid growing environmental concerns, the DoD is under pressure to adopt sustainable supply chain practices, including eco-friendly cleaning products and waste reduction. Traditional methods like sandblasting and chemical cleaning expose personnel to hazardous chemicals and pollutants and involve costly consumables that are facing increased environmental and workplace health and safety regulations. 	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> DefenseTech Laser Cleaning Systems provide a non-contact, environmentally friendly process that removes rust, corrosion, and coatings from various surfaces without damaging the underlying substrate, ensuring prolonged equipment life and operational readiness. No Chemicals No Hazardous Fumes No Complex Cleaning Procedures
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> Laser surface treatment can be used to remove rust and corrosion on missiles, munitions, and other equipment with accuracy, enhancing the lifespan and performance of critical equipment. Non-abrasive and non-contact cleaning method which minimizes harm to the environment while prioritizing the safety of personnel involved in maintenance operations. Its portable, handheld design ensures mobile performance, allowing military and defense personnel to maintain readiness anywhere, anytime. 	<p style="text-align: center;">GRAPHIC</p> 

GREY GECKO REAL-TIME INSPECTION TOOL (GRIT)

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Problem Statement: The aerospace industry grapples with costs and challenges due to corrosion, costing the Department of Defense nearly \$20B annually. Traditional inspection methods are labor-intensive, inconsistent, and often miss defects, endangering aircraft safety and emphasizing the need for an easy-to-use, easy-to-train, deployable inspection tools.

Description of the Technology: In 2016, Grey Gecko launched the Grey Gecko Real-Time Inspection Tool (GRIT), enabling maintenance technicians to perform cursory corrosion inspections without removing aircraft from service or involving NDI technicians. Since then, in concert with DoD and OEM feedback, we've refined the GRIT in size, weight, and power. The GRIT 125v2.5 is a significant innovation, providing non-destructive inspection to detect corrosion and material defects beneath coatings up to 20mils thick. It's versatile, working on aluminum, steel, titanium, and composite substrates. Additionally, it's compatible with the Smart Tools infrastructure, capturing high-quality images and inspection data. GRIT solves the industry-wide problem of inspection

area size by implementing a stitching algorithm that allows multiple images to be stitched together. The onboard "Gecko Vision" software turns these findings into comprehensive, actionable reports, ensuring meticulous tracking of defects across fleets.

Achievements and Partnerships: Grey Gecko won AFWERX Flightline of the Future, highlighting the GRIT's potential. Our ongoing partnership with the U.S. Coast Guard, which recently mandated the GRIT for all HC-144 Ocean Sentry aircraft inspections, showcases the system's credibility and necessity in real-world applications.

Current Development Status: GRIT is a fully developed and available system tailored for the aerospace sector.

Test/Simulation Data: On Gen 3/4 aircraft, strategic lift, bomber, executive transport, and C4ISR platforms, the GRIT has a seven-month ROI. Focusing inspections on suspect areas, the GRIT reduces corrosion downtime by 25% and personnel needs by over 50%.

Next Steps/Potential Benefits: We aim for pilot unit testing and fleetwide adoption.

No positive/negative pressure hangar is required. No solvents or chemicals. No EPA disposal. No PPE requirements. Does not interfere with existing operational PPE. No PMEL calibrations. Future GRITs will integrate variable focus, machine-learning corrosion detection, and autonomous and robotic automation. With the GRIT's rapidly deployable footprint, it not only promises financial savings but also operational risk reduction and airframe life extension. As GRIT's technology becomes more integrated, its role in bolstering the confidence of aircrew and payloads and significantly reducing maintenance costs cannot be overstated.

PROBLEM STATEMENT

Aerospace's Crippling \$2.5T Corrosion Crises

- The aerospace industry spends \$2.5T / U.S. military aviation spends \$20B annually and has no early detection capabilities.
- Current inspection methods are manual, non-targeted, inconsistent, and limited, often missing critical defects.
- Inspections require specialized training, are time-consuming, and reduce sortie generation rates, which presents a barrier to regular/routine inspections.
- Extending the airframe life-cycle is imperative in fiscally constrained environments—early detection and mitigation save airframes, and most importantly, it saves aircrew lives.
- Reactive by Nature: Current inspections are driven by accident and overhaul data. Entrenched philosophies discourage the addition of predictive solutions.

BENEFITS

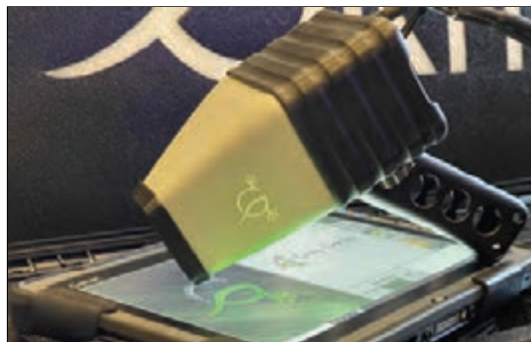
GRIT: A step change in aerospace corrosion detection

- **Ease of Operation:** Designed for use by both traditional maintenance and NDI personnel. Trained in as little as 4-hrs.
- **Rapid Inspection:** Rugged, ready-to-use, and immediately deployable, pushing more lines faster and safer.
- **Proven Production:** Fully developed and optimized for the aerospace sector.
- **Collaboration:** Designed in concert with maintainers and OEM's, the GRIT is a USCG mandatory item and is endorsed by Lockheed Martin for use on their aircraft. Made by maintainers, for maintainers.
- **Early Detection & Extended Lifecycle:** The GRIT enables "early finds" and focuses existing NDI inspections on known problem areas, eliminating needless downtime and optimizing manpower.

TECHNOLOGY SOLUTION

GRIT Technology: Superior Real-Time Inspection, Optimized for SWaP-C (Size, Weight, Power, and Cost)

- **Versatile Application:** Optimized for traditional coatings found in 3/4 Gen Fighters, Heavy Lift, Bomber, Executive Transport, and C4ISR platforms. ITAR compliant. No PMEL calibrations needed.
- **Material Agnostic:** Operates seamlessly on all substrate materials, including aluminum, steel, titanium, and composites.
- **Real-Time Detection:** Easily identify corrosion, cracks, and deformities beneath surface coatings up to 20mils thick.
- **Portable and Deployable:** Handheld and battery operated with at least 8 hours of scanning on each battery. Two batt. Included.
- **Worldwide Deployable:** With an operating temperature of 4-120f / -15.6-49c and global voltage compatibility, GRIT can go anywhere.



ADVANCED DEPLOYABLE AIRCRAFT MAINTENANCE STRUCTURE (ADAMS)

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The Advanced Deployable Aircraft Maintenance Structure (ADAMS), designed and built by Trac9, is a large volume, modular structure specifically designed to fill the Air Force's need for a deployable aircraft maintenance structure. This need originated from INDOPACOM's desire for low observable coating maintenance facilities that could withstand the extreme and varied climates of their operational environments.

The ADAMS is composed of rigid Kevlar composite panels with a patented folding design that allows it to be set up and torn down quickly with no additional tools required. The panels offer ballistic protection and sound dampening. The ADAMS is an ideal capability to store and utilize potentially hazardous maintenance equipment. Engineered to withstand winds of up to 120 mph and temperatures between -60- and 120-degrees Fahrenheit, the ADAMS is ready to support units in any climate.

Once erected, the single ADAMS provides approx. 1,450 sq ft of floor space, enough space for 15 Airmen to comfortably work or live in. The modularity of the design allows the ADAMS to be infinitely reconfigured as


additional structures can be added on in 120 sq ft increments. The ADAMS is able to be shaped to meet a variety of use cases, including medical complex, dormitory, testing facility, storage area, security facility and maintenance structure. The ADAMS has passed extensive testing at Hurlburt AFB and Cannon AFB, including as a paint/LO coatings booth.

The ADAMS is ready for integration into current cargo transportation systems. The base structure can easily be broken down and stored in one ISU-90 for redeployment.

The ADAMS is currently at TRL 7. To take it to the next level of readiness, additional testing will take place at Hurlburt Field, FL to challenge its resilience against ballistic and environmental effects. The ADAMS development pathway also investigates opportunities to optimize weight and cost.

The ADAMS is a rapidly deployable, modular structure capable of meeting any unit need or mission requirement in rapid and austere environments. The ADAMS directly supports Operational Imperative #5 for Resilient Forward Basing by greatly reducing the

manpower and time constraints imposed by similar structures and is ready to fulfill the many logistical needs of the Air Force.

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • The Agile Combat Employment CONEMPS require rapid operational bed down and maneuver within threat timelines • Soft-skinned tents currently used for many mission needs lack the modularity and protective shielding necessary for proper multifunctional use • Need for rapidly deployable structures that can stand up to a wide range of climates and operational scenarios 	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> • Configurable to meet any mission requirements in one easily deployable package • Reduces risk from using or storing hazardous maintenance equipment • Increased force protection through ballistic and environmental shielding • No additional support equipment required to assemble
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • ADAMS is large volume, modular structure configurable to any mission (Trac9) • Force protection built in via Kevlar composite panels • Allows safe storage of harmful chemicals and critical equipment required for aircraft maintenance • Fits within the confines of ISU-90 for seamless integration into current transportation system • Flexibility to infinitely attach additional structures as needed • TRL 7; tested at Hurlburt AFB, FL and Hickam AFB, HI 	

COATING AND CORROSION PREVENTION

3-IN-1 PORTABLE SURFACE PREPARATION SYSTEM

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Maintenance and sustainment of DoD combat systems is an annual multi-billion-dollar expense and reduces the readiness rates of critical military combat systems. Removing combat systems for extended periods limits the readiness of all DoD services and compromises the readiness of the warfighter. Combat systems that require precision coating removal around compromised structures require a precision tool that does not impact the structure leading to failure. Removal of any metal or damage to surfaces must be avoided in these scenarios, which disqualifies highly abrasive removal methods such as blast cleaning, needle-gunning, or other mechanical techniques.

In large-scale construction and manufacturing industries, such as marine and aerospace, coating removal is an essential but time-consuming process required for constructing and maintaining combat systems and other structures. Today's techniques (wire-brushes, needle-guns, wet chemicals, lasers) are often used for surface preparation, and each comes with their own drawbacks such as hazards to operator health, slow removal

rate, specialized containment requirements, and damage to substrates. For all DoD services, there is a significant need for an easy to use, mobile tool that will accelerate small scale coating removal operations without negatively impacting the health of the operator or the underlying substrate.

The PlasmaBlast technology requires no media, generates no waste streams beyond the removed coating, allows for debris capture, presents no undue occupational or environmental hazards to the operators, and can remove partial or whole coating layers across a wide variety of platforms. The complete elimination of media to remove coatings reduces the de-painting waste stream by more than 95% which provides environmental benefits, increases efficiency, and lowers costs. The PlasmaBlast system sets up quickly, with only electricity and compressed air as inputs (no media or chemicals) and is quickly deployed to forward operating locations. Localized repair, which can require hours of surface preparation just to perform inspections on critical areas, can be reduced to minutes using the PlasmaBlast system. For example,

PlasmaBlast has been field-demonstrated to significantly reduce NDI/NDT of critical welded systems from hours to minutes. Due to the mobility of the technology, the system can be brought to the work piece for field repairs, eliminating the need for lengthy downtimes.

The PlasmaBlast system significantly reduces the maintenance man-hours, improve equipment readiness, and prevent corrosion. Combat operations benefit with cost savings, reduction in resources (manhours), and quick turnaround enabling combat systems to return to field operation faster. It has been deployed and utilized across the depth and breadth of the DOD including Public and Private Naval Yards, Army Depots and Arsenals, National Guard Camps, and forward operating maintenance facilities.

PROBLEM STATEMENT

Maintenance and sustainment of DoD combat systems is an annual multi-billion-dollar expense and reduces the readiness rates of critical military combat systems. Today's techniques (wire-brushes, needle-guns, wet chemicals, lasers) are often used for surface preparation, and each comes with their own drawbacks such as hazards to operator health, slow removal rate, and damage to substrates. For all DoD services, there is a significant need for an easy to use, mobile tool that will accelerate surface preparation operations without negatively impacting the health of the operator or the underlying substrate.

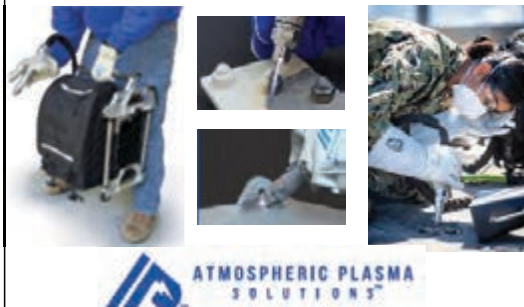
BENEFITS

- ✓ Removes coatings, cleans surfaces, promotes adhesion
- ✓ Profile is maintained, no damage to the substrate
- ✓ Requires only compressed air and electricity to operate
- ✓ Media and chemical free
- ✓ Safer for the operator, environmentally friendly, requires minimal containment and clean-up
- ✓ Significant job cost reductions
- ✓ Fast to train, simple to operate, low maintenance requirements
- ✓ Lightweight, 5-minute set-up
- ✓ All in one system

PORTABLE PRECISE POWERFUL

TECHNOLOGY SOLUTION

The PlasmaBlast technology requires no media, generates no waste streams beyond the removed coating, presents no undue occupational or environmental hazards to the operators, and can remove partial or whole coating layers across a wide variety of platforms. The complete elimination of media to remove coatings reduces the waste stream by more than 95% which provides environmental benefits, increases efficiency, and lowers costs. PlasmaBlast is easy to operate, < 5 minute set-up, portable single person carry, and provides precise coating removal and cleaning without damaging the substrate.



SPRAY-ABLE BUSHING FOR AIRCRAFT WHEELS

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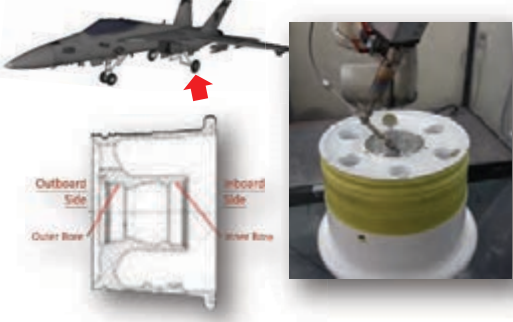
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This submission summarizes development of the F/A-18E/F Super Hornet and EA-18G Growler Main Landing Gear (MLG) wheel bore repair using Low Pressure Cold Spray (LPCS) technology. The equipment used for this repair development is Inovati's Kinetic Metallization™ system, also known as LPCS. A majority of the testing conducted was made possible through NAVAIR SBIR Topic N07-122, Contract Number N68335-16-C-0376. The Aircraft Equipment Reliability and Maintainability Improvement Program (AERMIP) funded FRC-SW Materials Engineering at North Island for support of this SBIR topic.

A qualification test plan was made based on the Original Equipment Manufacturer (OEM) requirements for a new Super Hornet wheel. F/A-18 Fleet Support Team (FST) Landing Gear cognizant engineering approved the test requirements. The qualification test plan included both static and dynamic load testing of fully assembled wheels. Repaired wheels had both the inner and outer bores machined to a minimum thickness then cold sprayed to restore original dimensions. The LPCS coating is a metal matrix composite consisting of an aluminum alloy and nickel.

The qualification requirements were initially designed for a newly manufactured wheel to complete, not a repaired wheel.

After review of the SBIR testing results the risk from a Materials Engineering standpoint appears to be low in the worst case. Additionally, the LPCS process reduces parent material removal (i.e., strength conserved). The LPCS bore repair is now beginning to be implemented at FRC-SW and other platforms such as F-16 and F-35 are considering this repair process.

<p>PROBLEM STATEMENT</p> <p>Aircraft wheel bore damage causes an unacceptable premature scrap rate. Aircraft carrier deck landings and operational tempo demands are factors particular for naval aircraft, although other aircraft platforms also suffer bore damage. In 2015, NAVAIR Fleet Readiness Center Southwest investigated scrap rates of F/A-18E/F wheels. Over \$1 million dollars worth of wheels were scrapped for bore tolerance issues. Aircraft wheels are Critical Safety Items (CSI) which can be challenging to procure for ageing aircraft platforms. The current cost to procure the same amount of wheels scrapped in 2015 is now over \$7 million dollars. A bushing repair is standard practice for reestablishing bore tolerance. However, standard bushings are a challenging, time intensive, and one-time repair that remove the maximum amount of parent material from the wheel.</p>	<p>BENEFITS</p> <ul style="list-style-type: none"> ✓ Wheel strength conserved: The only wheel material removed is the damaged area and within structural repair limitations. Low Pressure Cold Spray can be applied as thin as 0.005 inch thickness. ✓ Increased repair opportunity: Wheels that have been Cold Sprayed and are further damaged in-service can be restored multiple times, if within structural limits. This is not possible with standard bushings. ✓ Low cost: Low pressure Cold Spray is uniquely efficient in its use of consumable materials. Repair cost is less than standard bushing repair. ✓ Fast turn around time: Low Pressure Cold Spray takes less than half the time than a standard bushing.
<p>TECHNOLOGY SOLUTION</p> <p>Low Pressure Cold Spray technology, a proven metal spray process, was used to demonstrate a bore repair with properties equivalent to a one-time bushing repair. In 2018 an SBIR Phase II.5 was leveraged to conduct full scale testing of F/A-18E/F Main Landing Gear Wheels according to the OEM qualification requirements. The Air Force Landing Gear Test Facility conducted static and dynamic loads according to Boeing wheel procurement specifications. As of 2023, the spray-able bushing repair is being implemented for F/A-18E/F wheels and being considered for F-35 and F-16 wheels.</p>	

COATING AND CORROSION PREVENTION

COMPLETE SPOT REPAIR UAS FOR ELEVATED STEEL STRUCTURES

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Large steel structures often develop small areas of premature paint failure or corrosion requiring some level of repair, even though 99% of the structure retains a fully intact protective coating. A repair may require the entire asset to be shut down to install scaffolding or position cranes to allow workers to repair the failed protective coating. The repair will frequently involve cleaning, light blasting, then coating the small repair area. Over the lifetime of the coating, the cost of multiple minor repairs may exceed the price of the entire coating, with the bulk of the expense relating to asset downtime and the cost of worker access to the elevated area.


Apellix is developing a system to allow the repair of small, elevated areas based on our patented software-controlled Spray-Painting drone. Using an autonomous unmanned aircraft system (UAS), this system performs cleaning, removal (blasting) of paint and corrosion to an ISO 8501 Sa1 brush-off abrasive blast standard (i.e., NACE No.4/SSPC SP7), and application of primer/base-coat/top-coat or protective rust inhibitor such as Corrocoat. The Apellix computer-controlled unmanned aerial

vehicle (UAV) platform performs all tasks. This technology can reduce project time and expense by over 95% while keeping the asset in service.

The Apellix system can currently control the precision flight of a heavy-lift (140lb thrust) industrial UAV to within a few centimeters, allowing the accurate application of a 3000-psi pressure washing, a blast system, and the application of protective coating. Apellix has commercialized a pressure washing drone using 3,000 psi ground-based pumps and 230vac power (connected via tether). Apellix has developed (through pilot stage) a UAV for making contact with elevated structures to obtain steel wall thickness (ultrasonic) or paint thickness measurements under complete computer control (e.g., autonomous flight). In conjunction with AkzoNobel, Apellix has developed (but not commercialized) the ability to apply coatings with its computer-controlled UAV with a precision exceeding traditional painters.

The requisite technology is already in commercial use or at pilot-stage with the US Army, Saudi Aramco, and AkzoNobel.

Integrating a blasting component will allow complete repairs while eliminating asset downtime and keeping workers safely on the ground.

<p style="text-align: center;">PROBLEM STATEMENT</p> <p>Minor defects in the protective coatings protecting large steel structures (including vessels) are common and must be repaired to retain asset integrity and avoid more serious structural failure. The repairs are dangerous to workers and expensive in terms of the required time and number of personnel. More critically, the repairs often require total asset downtime to allow scaffolding, crane positioning, or rigging for rope access and the actual work.</p>	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none">• Revolutionary increase in maintenance efficiency• Eliminate downtime and lower overall cost.• Increase safety with all workers safely on the ground• Reduced reliance on staffing• Increased readiness, faster cycle time• Integration of existing technology already in various stages of commercialization• Applicable across-service to all branches, easy to transition for use by the DOD• Creates a complete, auditable digital data record
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <p>The Apellix Spot Repair UAV provides an easy-to-operate, fully portable computer-controlled drone platform where complete surface preparation and application of the remedial protective coating can occur with a single UAV. The easy-to-transport drone can be configured for different coatings, blasting compounds, and levels of surface preparation. The system is designed to operate in GPS-compromised outdoor environments. Autonomous flights can be configured based on individual repair requirements.</p>	

ADVANCED COATINGS ON MISSILE LAUNCHER RAIL COMPONENTS TO REDUCE LIFE LIMITING WEAR


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Missile Launchers LAU-128/129 used on F-15 and F-16 aircraft had a life limiting wear condition due to the use of legacy anodizing coating that resulted in the launchers to fail. The failed rail bodies had to be replaced every 3 to 5 years, costing the USAF roughly \$10M per year. These launchers carry and fire, AIM-9M, AIM-9X (Sidewinder), and AIM-120 (AMRAAM) including their captive carry variants.

It is now standard for all new LAU-128 and 129 launchers to be coated with PEO and DLC coatings for enhanced wear resistance. This technology has lowered maintenance costs, lowered the new production needed to alleviate DMSMS issues and eliminated the need for Solid Film Lubricant, as the combination of PEO and DLC has less friction.

In an effort to mitigate the high cost of replacing the rail bodies and the difficulty in manufacturing, the Armament Sustainment Division has worked with IBC Materials & Technologies, LLC, to develop novel coatings for the 7075 AL rail body and the steel missile hangers that increase hardness, wear and corrosion resistance. These coatings coupled with a more robust design of Launcher Dampeners has significantly mitigated the life limiting wear condition in the LAU-128 and LAU-129 launchers. After 9 years of testing in flight, rail bodies coated with IBC's PEO (Plasma Electrolytic Oxidation) coating partnered with missile hangers coated in IBC's DLC (Diamond Like Carbon) coating have no measurable wear detected and continue in service.

<p style="text-align: center;">PROBLEM STATEMENT</p> <p>Problem: Accelerated wear of LAU-12X (AMRAAM/Sidewinder) Missile Launcher Rails</p> <ul style="list-style-type: none"> • typical wear-out in 3-5 years • \$10M annual replacement cost + supply shortages • Drives extra maintenance: <ul style="list-style-type: none"> • Checking for wear • Apply SFL to body • Repair nose erosion • Legacy anodize coatings unable to withstand modern ops tempo 	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> • Environmentally friendly process – no acids or harsh chemicals. • Corrosion resistance outperforms all Anodization Types. • Eliminates application of Solid Film Lube (SFL) in field. • Cost savings from reduced frequency of inspection. • Cost savings from reduced component replacement rate. • PEO coating technology solution demonstrated successfully on defense and commercial applications.
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <p>Plasma Electrolytic Oxidation (PEO) and Diamond Like Carbon (DLC) coatings</p> <ul style="list-style-type: none"> • Applied to LAU-12X rail and associated components • PEO and DLC processes fully qualified and matured to TRL 9 / MRL 9 • Operational testing began 2014, full production began 2019 • PEO & DLC coatings applied on over 1800 Missile Rails • Zero measured wear on PEO coated rails over 9 years • PEO & DLC Coating is saving \$8M+ annually for USAF fighter fleets 	<p style="text-align: center;">GRAPHIC</p>  <p style="text-align: center;">PEO & DLC Coated Missile Launcher Rail & Components</p>

COATING AND CORROSION PREVENTION

TOUGHGUARD NANO HYBRID POLYURETHANE (NHP) – THE END OF CORROSION

DANIEL REID

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NHP® is the only industrial coating in the global marketplace to enhance, restore, and extend the service life of freshly coated and oxidized painted surfaces by 10 years. NHP® sets new benchmarks by extending the potential service lifetime of assets and reducing the costs associated with maintaining assets in a state of repair, thus improving the ROI associated with their operation. NHP® Coatings are a long-term solution designed to reduce surface cleaning of painted assets by 50%.

Unlike conventional coatings which are subject to scratching & chipping, water absorption, chemical attack, UV degradation, NHP® Coatings penetrate deep into the pores of newly painted or highly oxidized paints to dramatically improve corrosion resistance, scratch & chipping resistance, chemical and long-term UV resistance.

NHP® Coatings are designed to be applied “over” conventional paints, are impervious to water and oxygen and protect painted metal surfaces using a proprietary, 3D nano-structured, high cross-link density polymer coating.





NHP® reduces maintenance frequency, recoating cycles, chemical costs (mixing, repair, cleaning), the length & frequency of repair & maintenance downtime, the volume of coating material shipped/ stored/applied to project surfaces and, thus, reduces expenses. Customized “first-to-market” functional additives have also been developed that enhance the multi-functional attributes of NHP to record setting levels of performance.

ToughGuard NHP is manufactured using proprietary 3D nano-structured polymers producing extreme crosslink density. NHP® is a one-component (1K), humidity cured, polyurethane / polyurea hybrid nano-coating that penetrates deep into the pores and voids of new or highly oxidized paint systems to form a hard, protective, clear, topcoat surface.

NHP® protects against corrosion, restores existing color and gloss, and provides strong resistance to UV degradation, extreme weathering, and chemical attack, as well as abrasion, chipping, marring, gouging, impact, and scratching. NHP® also features repellency properties for

oil & dirt, water & ice, brake dust, algae, and other environmental and biological contaminants. NHP is a flexible, solvent based solution with low VOC values.

NHP® is a reliable, long-term, eco-responsible, industrial solution that extends the surface life of an asset’s coating system and is backed by an industry leading 10 Year Warranty.

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • The annual cost of corrosion to our US Military is estimated at \$25 billion. • Continual corrosion maintenance keeps high value assets out of operational service. • At a time of leaner military budgets cupelled with every increasing potential adversarial interaction, the US military would benefit to find ways reduce the out-of-service time of its high value assets to have at the ready to be deployed when and where needed. 	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> • The use of NHP® Coatings will significantly reduce the ever-increasing monetary cost to the US Military. • The use of NHP® Coatings will increase the number of critically important military assets ready for deployment or deployed where they need to be rather than in maintenance facilities. • The use of NHP® Coatings will have a positive health impact on maintenance personnel due to the reduction of re-paints and all of the health issues that arise from the removal and stripping of old paints and the reapplication of new paints.
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • The innovation of NHP® Coatings are designed to tackle these issues head on by significantly preventing the problems of corrosion and by reducing the costs associated with ongoing maintenance programs. • NHP® Coatings work with existing coating systems • NHP® Coatings reduces the amount of paint coatings needed thereby reducing costs and weights associated with paint • NHP® Coatings dramatically increases the service life of paint coatings thereby reducing maintenance cycles due to corrosion 	<div style="display: flex; flex-wrap: wrap;"> <div style="width: 50%; text-align: center;">  <p>1 gallon container of NHP</p> </div> <div style="width: 50%; text-align: center;">  <p>Ship drydock repair</p> </div> <div style="width: 50%; text-align: center;">  <p>Chemical resistant NHP</p> </div> <div style="width: 50%; text-align: center;">  <p>Abrasion resistant NHP</p> </div> </div>

ON- SITE AEROSOLIZATION OF ALL CHEMICALLY, BIOLOGICALLY, OR RADIOLOGICALLY CONTAMINATED WATER OR ALGAE

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Abstract: My proven TRL8 IP based system and method eliminates any type of chemically, biologically, or radiologically contaminated water or algae in place, without treatment and not requiring a “discharge permit” from federal, state or local regulators. DoD is already the worlds’ expert on all safety and controllability aspects of “aerosolization” and this medically understood science (CBRNE would be the SME’s) can now be used to “de-water in place” any type of contaminated water all naturally, quickly, effectively, and very cheaply.


Problem: Presently @\$33B is spent, annually and across DoD, in trying to effectively and according to statutes deal with contaminated water on its installations. Legacy contaminated water technologies are: complex, labor intensive, extremely capital and operational costs expensive, prone to continuous litigation, and known environmental and human performance impacts are tremendously destructive when installations have any sort of “discharge”.

Solution: On-site “aerosolization” of any type of water: immediately, all naturally, in very high volumes, as an overlay to existing

infrastructure and operations, and very cheaply concentrates and encapsulates any contaminants while liberating a vast percentage of the water component as now cleaned water vapor. Adding and automating known CBRNE safety and operational protocols for equipment maintenance, remote monitoring and compliance reporting would greatly reduce DoD’s overall maintenance burden and free up tremendous amounts of labor hours for more mission focused efforts.

Benefits: Adding the operational and maintenance capability of drastically reducing the total volumes of contaminated water on each of DoD’s installations at will would: cut existing capital and operational costs by 85+% once fully deployed and automated. DoD’s installations can now: alter/improve/reduce/eliminate their required operational and construction footprints, environmental compliance requirements, relationship with federal, state and local regulatory bodies, many legacy technologies, logistical considerations and costs, “off-base discharges”, and will make the newly DoD approved “Atmospheric Water Generators-AWG’s” exponentially more efficient in making drinking water from the air with

colossal amounts of local and controllable clean humidity. Of course, the local, state, federal and international (overseas bases) environmental water quality will also tremendously and measurably improve.

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • Presently @\$33B is spent across DoD in trying to effectively, legally and cost effectively deal with contaminated water on its installations. Legacy water technologies are: complex, labor intensive, extremely expensive, continually prone to tremendous litigation and well known for detrimental environmental and human performance impacts. • Legacy contaminated water technologies were created to seek to deal with specific contaminants, were more fixed in operations and have fought various innovations for many decades. • For some reason, DoD’s own SME’s for CBRNE and the medical profession have, in the past, not worked closely with the environmental or maintenance professions and the low hanging fruit of installation maintenance innovation, environmental compliance and overall cost savings have not been delivered, to date. 	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> • @85+% savings from legacy technologies, once fully automated and deployed into a mobile, scalable and self reporting system. • Eliminates/modifies many DoD personnel, construction, regulatory and permitting requirements. • Overlays existing DoD infrastructure, maintenance and operations and is immediately available. • Reduces existing and possible environmental litigation. • Reduces installation footprint and base operational considerations. • Provides DoD an immediate “Zero Liquid Discharge--ZLD” capability. • All natural • Makes the newly DoD approved “Atmospheric Water Generators--AWG’s” exponentially more efficient at making drinking water from the air at the point of need when we work together.
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • A safe and proven TRL8 IP based “on-site aerosolization” capability would deliver “de-watering in place” and concentrated and encapsulated contaminants ready for ease of final and appropriate disposal at the will of installation commanders and do so easily and as a mobile platform that can be scaled, as needed. • All aspects of the medically understood science of “aerosolization” are very well known across DoD as the contaminants are “oxidized and clumped to “salt out of solution” and back into the pond from which they came as “electro-statically clumped fall out”. • As a “dual use” technology, both the public and private sector will quickly be able to: domestically mine, protect the supply chain and confidently deliver DoD contracted requirements, as each has a tremendous “contaminated water” tail. 	<p style="text-align: center;">Graphic or Image</p> 

ENHANCING DOD'S SUSTAINMENT CAPABILITIES WITH US-MADE ULTRA LOW TEMPERATURE LITHIUM-ION BATTERIES

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In conjunction with Purdue University, Valgotech is developing ultra-low temperature lithium-ion battery technology that addresses the challenges of operating batteries in extreme temperatures by optimizing the electrolyte, separator, and cathode components for high-performing extreme temperature cells. The technology employs a system-based approach to optimize the key components of the battery, namely the electrolyte, separator, and cathode. The innovation lies in the integration of a newly developed high salt concentration electrolyte (HSCE) and an advanced modified separator with a high-performance electrode to achieve high-performing extreme temperature cells.

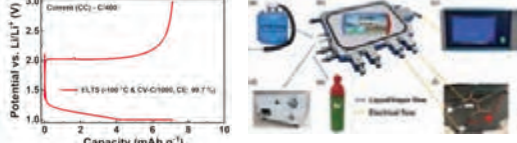
The HSCE is compatible with various commercially obtained electrodes and has excellent electrochemical performance at extreme temperatures. Test data shows that the HSCE outperforms conventional electrolytes at sub-zero temperatures, with over 80% capacity retention at -20°C and over 40% capacity retention at -40°C. The modified separator, which is a proprietary tri-layer polypropylene separator deposited with polydopamine

and graphene-carboxymethyl cellulose, improves electrolyte wettability, electrical conductivity, and regulates Li-ion flux, resulting in increased cycle stability and Coulombic efficiency.

The optimized electrode, NbWO, has shown promising sub-zero temperature performance under high current rates, with over 95% capacity retention at -20°C. The technology has been demonstrated in various cell configurations, including high-voltage NCM/graphite full cells, LTO half-cells, and sub-zero pouch cells. The sub-zero pouch cell demonstration showed that the HSCE electrolyte can be successfully implemented in high energy density and extreme temperature space missions.

The technology is currently in the development stage and has been tested extensively through various test configurations. The next steps for development include scaling up the technology and optimizing it for specific applications. The technology has potential applications in various industries, including transportation, energy storage, and

defense. The Department of Defense can benefit greatly from the technology's extreme temperature capabilities and high performance, allowing for greater flexibility in battery design and application.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> Operating batteries in extreme temperatures is challenging Low-capacity retention, decreased cycle stability, and decreased Coulombic efficiency are common issues These limitations hinder the application of batteries in space, military, and other industries where extreme temperatures are common 	<p>BENEFITS</p> <ul style="list-style-type: none"> Test data: Technology outperforms conventional batteries. Achieves over 80% capacity retention at -20°C and over 40% capacity retention at -40°C. Modified separator improves cycle stability, Coulombic efficiency, and electrolyte wettability. Optimized electrode shows promising sub-zero temperature performance under high current rates. Potential application industries: transportation, energy storage, and defense. Benefits to Department of Defense's CTMA project: allow for greater flexibility in battery design and application, including extreme temperature environment.
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> In conjunction with Purdue University, Valgotech is developing ultra-low temperature lithium-ion battery technology that optimizes the electrolyte, separator, and cathode components for high-performing extreme temperature cells. The technology uses a high salt concentration electrolyte (HSCE) and an advanced modified separator with a high-performance electrode. The HSCE electrolyte is compatible with various commercially obtained electrodes and has excellent electrochemical performance at extreme temperatures. 	 <p>A demonstration of the Voltage profiles of Li4Ti5O12 (LTO) - cyclopentyl methyl ether (CPME) in our ELTS setup, tested at -100 °C.</p> <p>Lithium-ion Batteries with Temperature Range of -100 °C to 45 °C</p>

CONFINED SPACE MONITORING SYSTEM (CSMS)

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The main goal of the CSMS is to monitor the health and safety of shipyard workers. This is accomplished by instrumenting mechanics with several sensors (e.g., physiological, location, and atmospheric) and other supporting hardware, which collect data from both the entrant and the environment. All sensors and portable hardware within the CSMS will be managed devices configured with specific device management policies that comply with required government security standards and operational constraints.

The sensor data is processed and analyzed in near-real-time to generate estimates of health status and alerts for notable events or behavior. In addition to monitoring workers, the CSMS also streamlines several processes such as submitting and approving entry forms, signaling confined space entry/exit, and locating personnel during an emergency.

In May 2022 initial shipboard testing was successfully completed with minor findings/changes. Software updates are underway to meet local intranet requirements. Further hardware testing will determine if fewer components can be used to produce the

same results, saving costs and bandwidth. Final shipboard testing and final deliverable are scheduled to occur in Q3-Q4 of FY23.

<p style="text-align: center;">PROBLEM STATEMENT</p> <p>Most submarine overhauls require work to be performed in a confined space. The space must be tested for air quality and deemed safe for personnel to inhabit. Depending on the type and size of the space the clearance will expire after a certain amount of time. In that time, the air quality and the health of its inhabitants is largely assumed to be satisfactory. The CSMS provides real-time atmospheric monitoring of the space and the health of its inhabitants.</p>	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> • CSMS is a proven system that will immediately reduce availability mandays. • Resources can be reallocated to other critical path jobs to further increase avail. efficiency. • Improved understanding of entrants' health status via continuous physiological monitoring. • Improved understanding of environmental conditions via continuous atmospheric monitoring. • Faster response to changes in entrants' health status and requests for help/assistance. • Faster response and increased awareness for first responders in emergency situations.
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <p>The CSMS will support prevention, detection, and intervention of health and safety hazards while reducing the time and costs required by current practices. Key benefits include the ability to remotely monitor the environmental conditions of each confined space, the physical status and location of the mechanics in these spaces, and a communication link between remote monitors and the mechanics. Mitigating risks in confined spaces through more efficient and reliable monitoring will increase the safety of our personnel.</p>	<p style="text-align: center;">Graphic</p> 

ENHANCED INSPECTION

IDENTIFYING AIRCRAFT PRESSURIZATION LEAKS USING ACOUSTIC IMAGING

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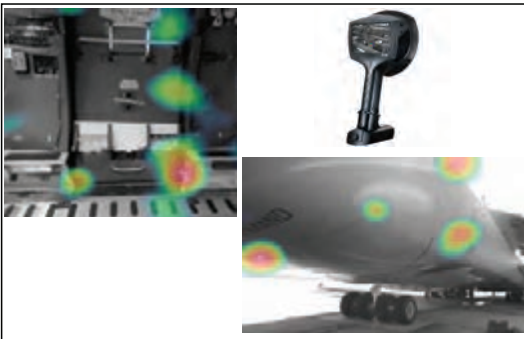
Achieving acceptable pressurization levels on aging airframes is an increasing challenge, requiring more manhours and increased fuel costs. The traditional methods of feeling for leaks with hands and using bags to identify leaks are no longer adequate. These methods may help technicians discover some leaks but are increasingly insufficient at identifying enough of the leaking areas to achieve required pressurization levels, especially with our aging fleets. These methods are time consuming, cannot be used in confined areas, and are overall less than effective. Relying on these inefficient methods increases maintenance downtime, reduces aircraft availability, increases manhours, and significantly increases fuel costs. For example, C-5M aircraft use 40,000 pounds of fuel per pressurization run, costing approximately \$23,000.

We can overcome these problems with innovative off-the-shelf technology. Acoustic imaging cameras very accurately pinpoint pressure leaks and overlay this information on a camera image. Utilizing an array of microphones tuned to the ultrasonic frequency of pressure leaks these cameras

can triangulate the location of leaks from up to 20 feet away. On-aircraft testing demonstrated their operational effectiveness in the loud flightline environment, easily distinguishing the sound of leaks from the background noise. These cameras also provide technicians with the ability to peer into confined spaces typically inaccessible during pressurization runs due to personnel safety concerns. The technology quickly verified leaks found using traditional methods and easily identified many more leaks that traditional methods could not find. The ability to save the camera images for reference reduced repair times and the need for rework. In addition, the cameras have applications both on-and-off aircraft and can be used to identify leaks in any compressed gas system. We recommend purchase of three cameras per maintenance unit to ensure active use capability of two cameras at any one time. Average cost of this technology ranges from \$15-20K per unit.

Use of this innovative technology will increase overall aircraft availability across the majority of MDSs by reducing maintenance downtime. The ability to identify pressurization leaks quickly and more

accurately will eliminate rework, reducing both manhours and fuel costs. These cameras are adaptable across all airframes and can be easily implemented for use in the field, ISO/Phase docks, and Depot locations. For Regional ISO docks which are kept to a tight schedule, such as the C-5 Minor RISO at Westover ARB, the time and cost savings would enhance ISO flow reliability, prevent excess downtime and late returns of aircraft to home station. In summary, this technology is a cost-effective tool that can be implemented today for returns on investment that will last long into the future.

<p>PROBLEM STATEMENT</p> <p>Passing aircraft pressurization checks during Isochronal Inspections has become increasingly difficult</p> <ul style="list-style-type: none">Traditional methods used to find leaks are time consuming and less than effective<ul style="list-style-type: none">Rely on feeling for leaks with hands or using paper towels & trash bags to detect leaksAccess restrictions & safety concerns make it difficult/impossible to find leaks in confined areas on aircraft during pressurization checksAging airframes leak significantly more and from previous unknown locations <p>Negative Impacts</p> <ul style="list-style-type: none">Increased inspection flow, negatively affecting aircraft availability (typically 2-3 days per C-5M aircraft)Increased fuel costs associated with need for additional pressurization engine runs (40,000 lbs. per run for C-5M)Increased manhours required to achieve passing pressure<ul style="list-style-type: none">Rework required to identify and repair previous missed leaksManhours required to re-accomplish pressurization runsTies up limited personnel needed for other maintenance tasks	<p>BENEFITS</p> <p>Increased Aircraft Availability & Reduced Inspection Time</p> <ul style="list-style-type: none">Improved leak detection eliminates the need for multiple pressurization runsReduces rework and disruption to RISO inspection flowPressurization rework within RISO adds 2-3 days of NMC time <p>Reduced Manhours & Labor Cost</p> <ul style="list-style-type: none">12 hours per pressurization run (4 personnel for 3 hours)\$40.66 per hour for WG-10 (\$488 per pressurization run) <p>Fuel Savings</p> <ul style="list-style-type: none">C-5M burns 40,000 lbs. of fuel per pressurization run on averageReduced fuel cost = \$23,165 per pressurization run (C-5M) <p>Adaptable Across DOD</p> <ul style="list-style-type: none">Can be used in the field, ISO/Phase Docks, and PDMTechnology can be used on all MDS that experience pressurization leaksCamera can also be used to identify leaks in any compressed gas system (on or off aircraft)
<p>TECHNOLOGY SOLUTION</p> <p>FLIR Si124-LD Acoustic Imaging Camera</p> <ul style="list-style-type: none">Off the shelf technology124 microphones listens for "ultrasonic" sound of pressure leaksPinpoints leaks and displays location on screenCan store images of leaks for reference when making repairsWorks at distance & can look into confined areas personnel cannot safely goCan be used on all MDS to identify pressurization leaksCan also be used to identify leaks compressed gas systems (GOX, LOX, LN2, bleed air systems, Industrial shop air) <p>UNIT COST \$17,502</p>	

DIGITAL THREAD TOOLS FOR NONDESTRUCTIVE INSPECTION APPLICATIONS

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What problem does your solution aim to solve?

Nondestructive inspection (NDI) is a critical aspect of any aircraft structural integrity program and one primary requirement driving depot maintenance. Current USAF data collection processes are largely manual, performed by a well-trained technician using a handheld tool. There is currently no method for automating the data capture and transfer of the critical inspection data to maintenance information systems. This leads to opportunities for missing data, lack of quality, non-standard reporting, and any overall lack of visibility to critical data that is required to effectively manage structural integrity. Lack of data often leads to conservative planning translating into reduced efficiency and increased maintenance costs. Even with the latest methods for data capture utilized by weapon system program offices, it was reported by the USAF that “current [NDI] challenges include an automated method for digital procedural compliance and record retention, importing digital NDI equipment outputs, end item processing data, meta-data, photos, etc., interfacing with legacy maintenance

(Mx) processing systems (i.e., NDI), and trending capabilities.” [Steffes, ASIP 2020].

The Air Force Life Cycle Management Center (AFLCMC) has indicated a national defense-related mission need in the area of digital integration of depot tools with USAF systems.

What is your solution?

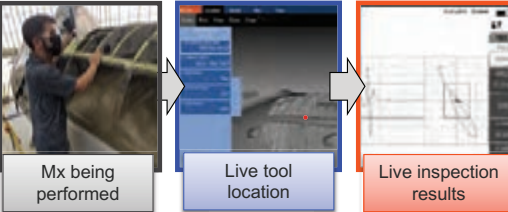
The use of tools and methodologies for capturing the digital thread generated during on-aircraft maintenance actions continue to be a key focus area for improved aircraft structural integrity. Hill Engineering has developed the Integrated Maintenance System+ (IMx+) as an advanced maintenance technology that:

1. Integrates shop floor tools with automated data collection and spatial position tracking for NDI activities
2. Establishes the digital thread to better support flight-line personnel
3. Bridges the gap between maintenance tools and standard data repositories thru built-in analytical tools within the USAF network.

IMx+ has already been deployed for A-10 in one location with several more in-work for USAF A-10, USAF B-1B, Lockheed Martin, The Boeing Company, and others.

Benefits of the solution

The application of the IMx+ technology will contribute to solving a mission need in the area of digital integration of depot tools within USAF systems. By integrating spatial tracking with maintenance tools, automated data capture can be achieved and is directly imported into NIPRNET databases and readily available to expedite repair dispositions. With annual DoD depot maintenance costs expected to exceed \$38B in fiscal year 2024, every avenue to increase efficiencies can result in significant cost savings. Ultimately, integrated tools are necessary to automate the collection of NDI data and ensure the correct maintenance was accomplished, sewing the digital thread for NDI, and reducing the overall costs for aircraft depot maintenance.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • Nondestructive Inspection (NDI) is a critical aspect of any aircraft structural integrity program and a primary factor driving USAF depot maintenance • Current NDI processes are largely manual, performed by a well-trained technician using a handheld tool • <i>“Current challenges include an automated method for digital procedural compliance and record retention, importing digital NDI equipment outputs, [and] interfacing with legacy maintenance processing systems (i.e., NDI).”</i> - USAF Lt. Col. Gary Steffes in 2020 	<p>BENEFITS</p> <ul style="list-style-type: none"> • Contributes to solving a defense mission need in the area of digital integration of depot tools within USAF systems • With annual DoD depot maintenance costs expected to exceed \$30B in FY2024, increased efficiencies can result in significant cost savings • For many USAF aircraft, fastener holes are primary driver for structural inspections, accounting for ~70-90% of fatigue critical locations • Estimated 20% reduction in inspection time through real time feedback and ~50% reduction in time to document inspection results • Addressing and mitigating this technical risk directly impacts operational safety while reducing maintenance costs
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • The Integrated Maintenance System (IMx+) automatically integrates critical NDI data with associated spatial position to expedite maintenance actions, decreasing inspector time to capture and document NDI results • Has Authority to Operate (ATO) on USAF NIPRNET • IMx+ has already been deployed for A-10 in one location with several more in-work for USAF A-10, USAF B-1B, Lockheed Martin, The Boeing Company, and others • Assists maintainer to identify maintenance location with real-time position feedback • Full digital thread capture of NDI data • Simplifies entire maintenance, inspection & reporting process 	 <p>Mx being performed → Live tool location → Live inspection results</p>

ENHANCED INSPECTION

ACCELERATING ELECTRICAL MAINTENANCE USING DIGITAL TWIN TECHNOLOGY AUTOMATING THE ELECTRICAL PAPER TRAIL

DAVID COATES

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Problem Statement: The complexity of modern electrical systems has dramatically increased over the last decade. Maintenance experts often need to manage hundreds of advanced processing units and miles of wiring harnesses when they repair or upgrade complex systems. However, this renaissance in complex electronic systems has not spread to the tools and methods being used for system maintenance. Engineers and technicians must often wade through 100s of pages of paper schematic diagrams. Tracking intricate issues through a maze of hard-to-read, irrelevant, and often out-of-date electrical schematics requires hours of wasted effort, which translates to delayed service schedules and poor service department performance.

Description of Technology: Altair Engineering Inc. has applied its advanced visualization technology used in the semiconductor industry to the public sector. This has resulted in an online, system and wire harness debug and visualization tool called EEVision (<https://altair.com/eevision>) that incorporates Google-style search and multiple functions for rapid issue resolution.

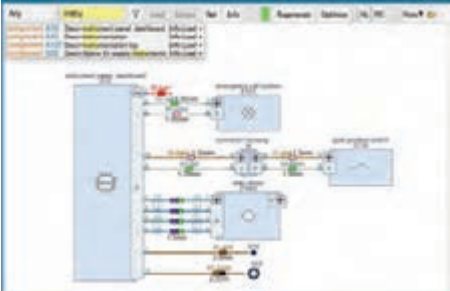
This innovative approach interactively uses key details as input and presents just the component of interest, together with surrounding wiring and connected parts. Irrelevant clutter is eliminated. The visual appearance is crisp and clear, highlighting key detail and making effective use of space and color. Additional information may be brought up on the schematic, such as part detail and numbers, descriptions, key attributes, etc. A key aspect of any visualization and debug system is search speed. Google has shown us the power of successful searches based on incomplete input, and the same approach works here. For example, type in "instru" and receive a list of the places in the entire system database where such a character sequence is used. Click on one and be immediately taken to just that component or wire, and its surrounding connections. From there the automated connectivity search allows quick tracing through the wiring and components, ignoring irrelevant connections to track down the problem sources rapidly. Finding problem source that used to take hours and days can now be traced in seconds. All service schematics are automatically

generated from a digital twin database, eliminating any error-prone manual drawing of diagrams for manuals. The enterprise is automatically kept 100% up to date so as system revisions, configurations and alterations are made, the documentation throughout the entire organization is revised, ensuring schematics are always up-to-date, accessible, and relevant.

Development Status: EEVision is commercially available and used in both the public and private sectors.

Data Supporting Performance Claims: See the NASA-JPL case study defining performance benefits. (https://concept.de/press_nasa.html). Other case studies can be found at the above product webpage.

Benefits: See above NASA-JPL case study for typical EEVision benefits.

<p>PROBLEM STATEMENT</p> <p>The complexity of modern electrical systems has dramatically increased over the last decade. Maintenance experts often need to manage hundreds of advanced processing units and miles of wiring harnesses when they repair or upgrade complex systems. However, this renaissance in complex electronic systems has not spread to the tools and methods being used for system maintenance. Engineers and technicians must often wade through 100s of pages of paper schematic diagrams. Tracking intricate issues through a maze of hard-to-read, irrelevant, and often out-of-date electrical schematics requires hours of wasted effort, which translates to delayed service schedules and poor service department performance.</p>	<p>BENEFITS</p> <ul style="list-style-type: none">➤ Faster service and repair, for increased operational readiness of combat systems.➤ Provide DoD with accurate and up-to-date electrical service schematics.➤ Save cost for document creation and deployment.➤ Help DoD to manage complex electrical systems.➤ Sustainable mission readiness.
<p>TECHNOLOGY SOLUTION - EEVision</p> <ul style="list-style-type: none">➤ Smart service and repair platform using digital twins (DT).➤ Automatic document generation from digital twins.➤ Easily explore and repair even the most complex electrical systems.➤ Auto-generated compact schematic diagrams allow to quickly understand electrical functions, harnesses structures, and system behavior.➤ EEVision runs as PCs applications or as a cloud app (On-Prem or Off-Prem).➤ For engineers who maintain, repair or refurbish electrical systems.➤ For engineers who manufacture or upgrade electrical systems.➤ For engineers who develop electrical systems.	<p>Graphic or Image</p> 

BLUE LIGHT SCANNER

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Problem Statement: Inspection of aircraft components can range from a simple visual inspection to calculating a percentage of surface damage over a complex area. Conventional hand tool inspection measurements can be questionable, especially when damage tolerance can be as low as 0.002". Any lack of confidence in the condition of a Flight Safety Part results is the discarding of the part.

Description: Blue Light Scanning (BLS) provides mechanics with an alternative automated inspection tool for performing component overhaul inspection procedures. This technology helps with reducing inspection times, complex surface comparison, component handling and executes sequence of events for performing examination. Reports are tailored to meet technical requirements in an electronic format. Data captured during scanning is saved by part number and serial number and is stored for future analysis.


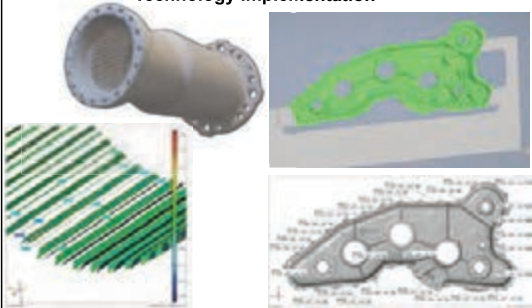
Current Development Status: Modernize overhaul inspection procedures for aircraft components by introducing automated inspection systems which enable

repeatable detailed inspections. CCAD is currently deploying BLS technology for the inspection of aircraft transmission components. Holding fixtures were developed to ensure repeatability and part alignment between samples. Robotic programs along with fixtures guarantee all surfaces of interest to be inspected per applicable technical requirements.

Test/Simulation Data (Supporting Claims of Benefits): CCAD's legacy inspection methods for transmission components range from half an hour to four hours and require constant manipulation of the inspection specimen. Time studies comparing legacy inspection methods and BLS demonstrate reduction of inspection times by a 30% with minimal handling of the part. By combining an automated system with the appropriate fixture, the inspection sequence and steps is guaranteed. The implementation of this technology translates to cycle time reduction and increases mechanic efficiency.

Next Steps/Potential Benefits: Maximize automated scanner capacity by utilizing all three scanning bays of existing equipment with appropriate fixtures and programs. Then

deploy additional BLS scanners to other component inspection activities to both decrease inspection times and decrease component fallouts.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> Inspection of aircraft components can range from a simple visual inspection to calculating a percentage of surface damage over a complex area. Conventional hand tool inspection measurements can be questionable, especially when damage tolerance can be as low as 0.002". Any lack of confidence in the condition of a Flight Safety Part results is the discarding of the part. 	<p>BENEFITS</p> <ul style="list-style-type: none"> Reduced component fallouts due to low confidence in inspection measurements – UH-60 Shafts 60-70% Reduced inspection times for transmissions overhaul of 30% - AH-64 Main Xmsn 3D data is saved for historical analysis Derived Benefits: 3D pdf for NDT instructions, reverse engineering of samples & CAD models for CMM inspections CAD created can be used to derive repairs using advanced manufacturing methods
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> Modernize overhaul inspection procedures for aircraft components by introducing automated inspection systems which enable repeatable detailed inspections. The introduction of Blue Light Scanning (BLS) in an automated environment has proven to increase mechanics inspection confidence. 	<p>Technology Implementation</p> 

SENSITIZATION DETECTION OF ALUMINUM ALLOY PLATES BASED ON ULTRASOUND FABRY-PÉROT RESONATOR

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Al-Mg alloys, renowned for their weldability, corrosion resistance, lightweight, etc. are widely used in industries like aerospace, petroleum, and shipbuilding. However, prolonged exposure to temperatures above 50° C causes sensitization in Al-Mg alloys due to their high Mg content. This microstructural material damage makes Al-Mg alloys susceptible to intergranular corrosion, exfoliation, and stress corrosion cracking, thus impacting the maintenance regime and life-cycle of structures built with these materials.

Detecting sensitization is a challenge; the standard method, nitric-acid mass loss test, is a destructive test, involves a 24-hour nitric acid immersion and measuring the resultant mass loss to calculate the degree of sensitization (DoS). Other non-destructive tests include RF probes, eddy current tests, and ultrasonic methods. RF probes fail to produce accurate sensitization quantification. Eddy current tests are impacted by surface oxidation. Conventional ultrasonic techniques require direct contact. And the correlation between time-domain attenuation and DoS is quite weak due to large error margins (about 20%).

Our study introduces the ultrasound Fabry-Pérot resonator (UFPR) concept for non-destructive, non-contact detection of sensitization. We heat-treated alloy samples to induce sensitization and employed a pulsed laser to generate ultrasonic longitudinal waves. The impulse responses of the plates with progressively increase DoS were acquired by a two-wave mixing interferometer. A digital signal processing algorithm, based on UFPR fringe analysis, was developed to extract attenuation parameters.

Initially, we utilized time-frequency analysis to investigate the frequency-dependent behavior of attenuation parameters within time-domain impulse responses. This analysis showed a clear frequency range, within which the longitudinal ultrasound attenuation increases with sensitization. Hence, the fringe spectrum, derived from impulse responses through the first fast Fourier transform (FFT), was selected within this range. After converting the selected frequency spectrum to a fringe frequency using a second FFT, we calculated attenuation parameters from the fringe frequencies and statistically analyzed them

to account for location variability. Thus, these fringe frequency attenuation parameters, correlating strongly with DoS, can serve as indicators for sensitization with enhanced sensitivity and reduced uncertainty.

In sum, this non-destructive and non-contact technique establishes a direct correlation between fringe frequency attenuation and DoS, presenting a valuable metric for maintenance and ensuring the prolonged durability and performance of Al-Mg alloy structures. The technique will be extended with flexural ultrasound to increase attenuation sensitivity and capability of larger structure detection. This work lays the theoretical foundation for real-time and in-situ sensitization progress tracking in future.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> Al-Mg alloy is widely used in industries like aerospace, petroleum, and shipbuilding Al-Mg alloy will be sensitized once prolonged exposure to temperatures above 50° C due to its high Mg content Sensitized alloy is susceptible to corrosion, thus impacting the maintenance regime and life-cycle Detecting sensitization is a challenge <ul style="list-style-type: none"> Standard nitric-acid immersion method: destructive Surface eddy current test: surface oxidation Conventional ultrasound: large error margin (~20%) 	<p>BENEFITS</p> <ul style="list-style-type: none"> Presenting a valuable metric for maintenance and ensuring the prolonged durability and performance of Al-Mg alloy structures Establishing theoretical foundation for UFPR-based attenuation measurement Establishing a direct correlation between fringe frequency attenuation and DoS Tracking progress of sensitization in real-time and in-situ Detecting sensitization with enhanced sensitivity and accuracy compared to eddy current test and conventional ultrasound test
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> Ultrasonic longitudinal guided waves generated by high-power pulse lasers Impulse responses were acquired by an adaptive two-wave mixing interferometer Effective frequency range for attenuation shift due to sensitization was revealed by time-frequency analysis Fringe frequency within effective frequency range was converted from acquired impulse response by two FFTs Attenuation for fringe frequency was calculated and correlated to the degree of sensitization (DoS) Sensitization can be determined by the increase of fringe frequency attenuation 	

AIRCRAFT BATTLE-DAMAGE REPAIR INSPECTION AND LOGISTICS IN CONTESTED ENVIRONMENTS

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Problem Statement: The increasing complexities of Aircraft Battle-Damage Repair logistics in contested environments necessitate an agile and accurate approach to damage assessment, repair procedures, and associated replenishment logistics. This challenge becomes particularly daunting considering the urgent need to maintain the highest levels of aircraft readiness while ensuring efficient and rapid damage mitigation.

Description of Technology: The nFlux assembly manufacturing operations Procedure Monitoring and Assistance (PMA) system leverages state-of-the-art AI/ML technologies to perform video analysis for monitoring and understanding intricate human-executed procedures. Initially designed to detect errors in manufacturing operations in real time, the PMA system provides instant operator operations procedure guidance and verifies product fabrication quality in multifaceted, unconstrained manufacturing settings.


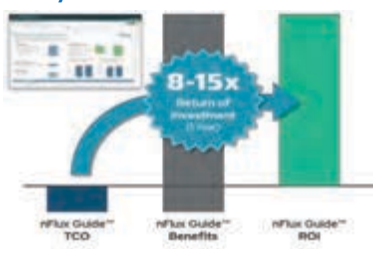
Current Development Status: nFlux's PMA is fully operational at Technology Readiness Level (TRL) 9 and Manufacturing Readiness

Level (MRL) 9, with successful deployment in diverse industrial environments across the globe, confirming its versatility and adaptability in handling a wide spectrum of operational scenarios.

Test/Simulation Data: In its current application in manufacturing operations, the PMA system has tangibly decreased operator errors (34% defect avoidance), improved product quality (15% reword reduction), and augmented training effectiveness (-52% training time reduction). This has translated to an impressive reduction in the Cost of Quality and resulted in sizable Return-On-Investment (ROI) of 8 to 15 for nFlux's industrial clientele. Given its proven track record, this system has the potential to deliver similar impactful results in the DoD domain.

Next Steps/Potential Benefits: nFlux envisions the evolution of the current PMA tailored to the Aircraft Battle-Damage Repair domain, to provide non-invasive inspection methods and swift battle-damage and repair analysis. This integration will facilitate real-time data access, potentially revolutionizing logistics and supply chain

processes for repair and maintenance activities. Adopting its successful commercial manufacturing deployment strategy, nFlux expects to initiate development/adaptation at MRL 8, with transition to full production MRL 9 is within a 6–12-month timeframe in the DoD context, underpinned by nFlux's rapid prototyping AI/ML video analysis and learning mechanism. This technology offers a significant leap in agility, efficiency, and effectiveness of maintenance and sustainment in contested naval environments.

<p>Overview</p> <p>nFlux has deployed AI/ML technology in concert with video analysis and annotation in complex, real-time, large throughput manufacturing operations. Current installations have proven to lower operator errors, improve training effectiveness, and reduce the cost of quality assurance. Government applications include our initial customer, NASA, for whom we created an AI agent for assisting astronauts in deep-space missions on which real-time support from Mission Control is not feasible, and DOD in AF flight line maintenance and training.</p>	<p>BENEFITS</p> <p>nFlux tools have quantified impact on efficiency nFlux Guide™ and Acuity™ suite of tools have demonstrated increases in quality and productivity.</p>  <p>nFlux Guide conveniently provides guidance to workers using a wide range of UX mechanisms ranging from a head-up display to sound alarms or visual indicators.</p>
<p>TECHNOLOGY SOLUTION</p> <p>nFlux's Procedure Monitoring Assistance (PMA) tools, Guide™ and Acuity™, transform how assembly is conducted and managed</p> <p>Integrating AI/ML and Computer Vision, nFlux has developed solutions that supervise, analyze, and advise on operations in industrial manufacturing environments. The PMAs provide workers real-time feedback on product status, enabling high quality performance metrics and immediate employee training to drive continuous improvement.</p>	<p>nFlux's PMA tools are TRL 9 and MRL 9, are deployed commercially, and have completed feasibility studies with NASA and USAF.</p> 

NOSE ARRAY ROBOTIC MACHINING AND INSPECTION PROCESS

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Problem Statement: A capability gap exists to perform pre- and post-potting machining operations to successfully refurbish torpedo nose array polyurethane over-molding to drawing tolerances.

Description: The robot work cell consists of a 6-axis robot, industrial machining spindle, control stand, end of arm tooling, and cable management. Additionally, the inspection was performed with a blue structured light non-contact metrology system. This robotic system also had a custom human machine interface (HMI) for operations. Although the robot, machining spindle, and inspection hardware were all commercial off the shelf (COTS) components, significant design was required in development of the system. This required integration of pneumatics (oiled and non-oiled), cooling lines, electrical communications, programmable logic controller (PLC) programming, robot program development and, as previously stated, HMI development.

Development Status: The system development and fabrication was completed in FY23. Soon after completion, the operational demonstration on a scrap asset

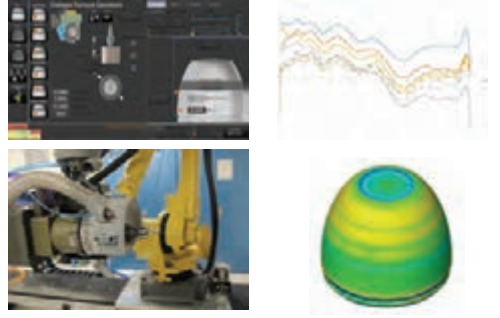
was performed. This consisted of removal of (1) existing urethane, (2) removal of corrosion on the bare aluminum, (3) re-potting, (4) profiling, and (5) finishing/polishing to final dimensions. An integral part of this process was integrating metrology throughout final profiling and finishing to verify concentricity, profile, parallelism, and length.

Test/Simulations Data: The final profile was measured using both the blue-structured light system and a coordinate measurement machine (CMM). The results were compared and found to be nearly identical, except that the CMM had a deviation of profiles along one axis of the array. This was likely due to a known lobing of the connection area that serves as one of the primary reference datums. The CMM can only calculate the datum from the probed points, whereas the blue-structured light system generates a mesh of the surface to perform calculations on. If the CMM data was adjusted by the estimated lobing, then both measurement systems showed that the full profile was within drawing tolerance.

Next Step/Potential Benefits: The profile of this hardware is critical and has been the

most challenging aspect of manufacturing and refurbishment. This system was shown to produce the best profile of any measurements seen in refurbishment or new construction. The success of the system has led to Program office interest in pursuing a Technology Transfer partnership to install a complete system at the OEM manufacturing facility.

The demonstration system is slated to support production refurbishments until the permanent system can be built and installed. The first production asset has gone through the pre-potting machining operation.

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none"> A capability gap exists to perform pre- and post-potting machining operations to successfully refurbish torpedo nose array polyurethane over-molding to drawing tolerances. 	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> The profile tolerances of this hardware is critical and has been the most challenging aspect of manufacturing and refurbishment. Integrating a robotics sanding with structured light inspection process has shown to produce the best profile of any measurements seen in refurbishment or new construction. Enabling Production Restart refurbishment of torpedo hardware Program office interested in pursuing a Technology Transfer partnership to install a complete system at the OEM manufacturing facility.
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> Developed an integrated robotic work cell to perform polyurethane removal, profiling, and inspection processes Integration of robot, industrial machine spindle, control stand, end of arm tooling, cable management, debris capture, pneumatics, and communications Custom Human Machine Interface (HMI) for operations Programmable Logic Controller (PLC), HMI, and Robotic programming were used for systems integration and hardware operation Use of non-contact metrology in the machining workspace throughout final profiling process enabled robot program adjustments to be made with each tool pass 	

6TH GENERATION OPERATIONS, MAINTENANCE, AND LOGISTICS MANAGEMENT SYSTEM

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Problem Statement: The digital transformation of both public and private industries necessitates a comprehensive interconnection of various data systems, covering maintenance, engineering, operations, scheduling, and supply chain management. Moreover, standardized reporting via automated data collection is essential. Currently, end-users lack a Class-6 IETM that can (1) swiftly access ALL technical data, (2) amalgamate electronic wiring, illustrated parts catalogs, checklists, job guides, and fault isolation manuals, and (3) standardize data reporting.

Description of the Technology: MDDV™, under ADS' 6th Generation Operations, Maintenance, and Logistics Management system, serves as the industry's only Class-6 Interactive Electronic Technical Manual (IETM). With its intuitive UI and features, MDDV streamlines research and repair tasks, ensuring they are swift, efficient, and precise. This technology supports virtually all data formats interchangeably, integrates vast data including wiring and part catalogs, and boasts a secure digital communication system. Its Automated AI & ML integration facilitates advanced

maintenance analysis, predictive scheduling, and spares forecasting.

Current Development Status: MDDV™ has been implemented, showing a considerable decrease in MX costs and a substantial increase in readiness. The USAF research indicates potential savings of over 30% on maintenance tasks, leading to a remarkable reduction of 11K flow days of scheduled maintenance downtime and annual savings of \$34M throughout the program's lifecycle.

Test/Simulation Data: The technology has demonstrated its merit through:

- Seamless data format support, including but not limited to SIOOD, SGML, PDF, and CATIA.
- Elimination of 11K flow days of scheduled maintenance downtime.
- Projected \$34M annual savings.


Additional significant data comes from our various collaborations and engagements:

- Northrop Grumman (NGC) Partnership: Collaboratively, we've positioned MDDV as a key component across NGC's

programs, with NGC AADA Strike Program endorsing MDDV as the standard IETM/P for future NGC endeavors.

- USAF & USMC MQ-9 Reaper: MDDV IETM/P is supporting over 3,700 users in 36 global locations, having adeptly converted and maintained the MQ-9A library, addressing functionalities ranging from maintenance to flight manuals.
- Awards and Recognitions: Our innovative achievements have been spotlighted through awards such as the AFWerx Mx Challenge, CTMA, and the Defense TechConnect Innovation Award.
- Advanced R&D Collaborations: Our partnerships with Advanced Aircraft Directorate & AFRL Tangram Flex place us in advanced R&D spheres.
- Other Engagements: Our involvement spans across platforms like the US Air Force & US Space Force SBIR Phase 1, AFNWC & Army ERDC SBIR, and the AFLCMC Phase 1 CBM+ programs.
- HH-60G PaveHawk Collaboration: We've executed a thorough S1000D conversion for the HH-60G, complemented by a lifetime license and rigorous training.

Next Steps/Potential Benefits: MDDV offers unmatched capabilities, enhancing readiness by markedly reducing maintenance downtime. ADS will further customize MDDV for diverse operations, emphasizing its digital transformative potential. By incorporating OEM source data into MDDV's Class-6 IETM and leveraging AI/ML, we anticipate an uplift in user experience and overall process efficiency. With accurate and timely data being paramount for weapon system readiness and effective maintenance planning, MDDV is poised to revolutionize maintenance systems, offering agility, efficiency, and affordability.

<p align="center">PROBLEM STATEMENT</p> <p>Digital transformation of public and private industries require:</p> <ul style="list-style-type: none"> • Interconnection of data systems/lakes that link maintenance, engineering, operations, scheduling, and supply chain managers • Standardized reporting through automated data collection <p>End-users lack a Class-6 IETM capable of (1) rapidly accessing ALL technical data, (2) integrating electronic wiring, illustrated parts catalogs, checklists, job guides, and fault isolation manuals, and (3) standardizing data reporting, and automating it (saving significant amount of users' time).</p> <p>MDDV™ - 6th Generation Maintenance System As part of ADS' 6th Generation Operations, Maintenance, and Logistics Management system, MDDV includes the industry's only Class-6 Interactive Electronic Technical Manual (IETM), offering intuitive user interface (UI) and functionality that makes research and repair tasks fast, efficient, and accurate. MDDV is certified for NIPR/SBIR).</p>	<p align="center">BENEFITS</p> <p>MDDV uniquely delivers these essential capabilities that boost readiness by significantly reducing maintenance downtime. ADS inducts existing OEM source data into MDDV's Class-6 IETM</p> <ul style="list-style-type: none"> • With Authority to Operate (ATO), MDDV automates reporting of failure, repair, and part usage data to information systems • MDDV leverages AI/ML to continuously improve user experience and end-user and process effectiveness <p>Accurate and timely data is critical to weapon system readiness, supply chain resilience, and effective predictive and preventative maintenance scheduling.</p> <ul style="list-style-type: none"> • Cross-service applicability – MDDV is potentially applicable to all military service branches, and DLA <p align="center">Significant Decrease in MX costs... Significant Increase in Readiness...</p> <ul style="list-style-type: none"> • USAF research projects savings of 30+% on maintenance • Eliminates 11K flow days of scheduled maintenance downtime • \$34M annual savings throughout the life of the program
<p align="center">TECHNOLOGY SOLUTION</p> <p>No other IETMs on the market provide end-users:</p> <ul style="list-style-type: none"> • Support for nearly all data formats interchangeably & and seamlessly • Full Integration of IETM with wiring, part catalogs, repair, and fault isolation manuals • Connection with major software engineering platforms (e.g., CATIA) to support rapid technical data changes and publishing (Supports 3D Model-Based Systems Engineering (MBSE)) <ul style="list-style-type: none"> ○ Supports rapid sustainment (re)engineering • Streamline processes like part ordering and data reporting <ul style="list-style-type: none"> • Hardware, OS, & Cloud Agnostic – Use any device, anywhere • Zero Footprint! No plug-ins or extensions • Zero-Wait State tech – near ZERO latency regardless of file size • Secure digital audio/video calling and social networking • Automated collection of failure & repair data uses AI & ML to: <ul style="list-style-type: none"> ○ Enable Condition Based Maintenance Plus (CBM+) analysis ○ Improve analysis for preventative maintenance scheduling ○ Improve spares forecasting & repair cycle management 	<ul style="list-style-type: none"> • MDDV automatically logs user activities and accumulates the data (user, aircraft, squadron, base, time-to-perform, replaced items, and more) • Generates a live & interactive dashboard (average time for maintenance activity, outstanding times, units' comparison, and more) • Real-Time Alerts for outstanding maintenance issues 

ENHANCED INSPECTION

MIXED REALITY EXPERT GUIDANCE (MREG)

MARK SMITHERS

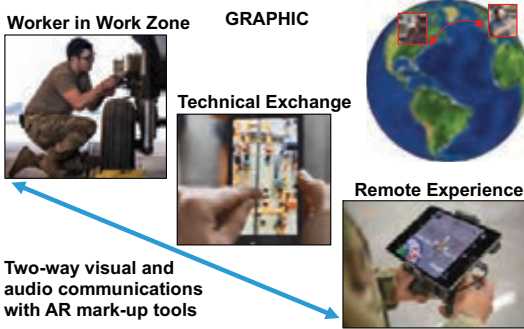
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Mixed Reality Expert Guidance (MREG) is an augmented reality (AR) enhanced secure remote video support tool connecting experienced workers with nascent workers. The platform is built using open architecture and supports multiple operating systems. The capability was purposely developed to operate on premise disconnected from cloud infrastructure but will work in a cloud instance when needed. The dual operational mode between cloud and non-cloud allows collaborations when cloud infrastructure is disabled (for whatever reason) and then resynching once the cloud connectivity returns.

MREG increases worker efficiency by significantly reducing work execution time by providing guidance by experienced workers on demand and avoiding workers leaving work sites to resolve issues. The initial proof-of-principle prototype was completed in collaboration with Portsmouth Naval Shipyard (PNSY) and NAVSEA. The capability was demonstrated at Port Hueneme as part of the REPTX event organized by NCMS. Successful demonstration leveraged a portable 5G communications capability

enabling ship to shore operation and sufficient bandwidth to support video, audio, and AR mark-up exchange.

The Technology Readiness Level (TRL) is 6/7 but with funding pledged for capability enhancement and preparation for deployment. There are many enhancements planned on the technology roadmap. MREG can be provided on Boston Engineering computing platforms or installed on government systems and equipment.

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • Maintenance and sustainment of our weapons systems is being challenged by shrinking experienced workforce and increases in our national retirement rate. • Nascent workers require training and mentoring before achieving the proficiency of highly skilled workers • Nascent workers often experience work package execution issues and must leave the work site to seek advice or help with decisions enabling continued work execution • Many maintenance requirements are discovered only after a weapon system reaches its destination. Knowledge gathering in route to the shipyard is not captured well today. 	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> • Provides experienced guidance to workers in work areas from experienced remotely located high skill or experienced workers and supervisors. • MREG can record or actively share work assessments in the field in advance of shipyard stationing providing planners advanced information, resulting in reduced schedule. • Connects nascent workers with retired workers who can work from home or part-time and continue sharing experience. • Open architecture enables capability advancement contributions by multiple people and organizations in industry, academia, and DoD R&D Centers. Achieved TRL 7 demo
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> •Mixed Reality Expert Guidance (MREG) is an Augmented Reality (AR) enhanced secure video remote assistance tool connecting experienced workforce to nascent workforce. •MREG operates on premise, on cloud infrastructure, or in hybrid or mixed connected and unconnected configurations. •The capability is built using open architecture, open standards, and software licensing to operate not required. •MREG has been demonstrated on portable 5G communications ship-to-shore in port providing the necessary bandwidth to support video communications. •MREG is device agnostic. 	<p style="text-align: center;">Worker in Work Zone GRAPHIC</p>  <p style="text-align: center;">Two-way visual and audio communications with AR mark-up tools</p>

INTELLIGENT DETECTION REPORTING APPLICATION (IDRA)

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Aircraft maintenance squadrons place a strong emphasis on Foreign Object Debris (FOD) prevention and removal as an essential part of their daily routines, as it ensures the safety, reliability, and airworthiness of aircraft. FOD mitigation requires data, and data can only be generated through FOD reports which Airmen should fill. This is sometimes, unfortunately, unattainable due to the inefficiency of filling out reports manually. This approach is labor-intensive and susceptible to human error. Manual reporting methods can also result in delays between the detection of FOD and its reporting. Moreover, human observations might not always provide accurate or detailed descriptions of FOD and inaccurate or incomplete reports might cause a challenge to address the root source of FOD. Finally, without robust data analytics, maintenance squadrons may miss opportunities to identify trends, track the effectiveness of preventive measures and continuously improve FOD safety measures.


IDRA is an Artificial Intelligence (AI) and Augmented Reality (AR) driven application offering an on-the-spot Foreign Object Debris (FOD) digital reporting mechanism

for an airbase's maintenance, operations, and airfield management squadrons. Every airman, through a mobile phone, will have the ability to report the presence of any FOD by solely taking a picture of the debris. A brief report will be auto-generated through the AI built within the application, saving time for the personnel. The report does not require any sort of internet connection to be generated instantaneously. IDRA functions on airplane mode, digitizes and automates FOD reporting as it reduces reporting time from 10 minutes to 30 seconds.

The report includes all relevant information such as size, location, type, color, and potential source of the FOD. IDRA also has a security feature that limits the capture of images to the ones only containing FOD as the camera will be automatically disabled if the phone is tilted upwards.

The application also generates data analytics with patterns and trends identified to further help in developing preventive measures and reduce the likelihood of future FOD occurrences.

IDRA was developed in collaboration with the U.S. Navy's NAWCAD (Naval Air Warfare Center Aircraft Division) and the DIU (Defense Innovation Unit) of the U.S. Department of Defense. IDRA is deployed with Nellis Air Force Base and is currently in use by the Thunderbirds demonstration squadron and the application will also be deployed with a number of Naval Air Stations of the U.S. Navy and Marine Corps Air Station of the U.S. Marines.

<p>PROBLEM STATEMENT</p> <p>Foreign Object Debris (FOD) is one of the largest threats to aircraft safety causing costly damages, accidents and, operational disruptions of \$23B dollars of losses annually. FOD mitigation requires data, and data can only be generated through FOD reports which Airmen fill manually. This approach is labor-intensive and susceptible to human error. Manual reporting methods can also result in delays between the detection of FOD and its reporting. Moreover, human observations might not always provide accurate or detailed descriptions of FOD and inaccurate or incomplete reports might cause a challenge to address the root source of FOD. Finally, without robust data analytics, maintenance teams may miss opportunities to identify trends, track the effectiveness of preventive measures, and continuously improve FOD safety measures.</p>	<p>BENEFITS</p> <p>Enhanced Operational Efficiency: auto-detection and recognition of debris allow for a faster and more accurate reporting process</p> <p>Insights & Analytics: automation and digitization of reports allow for access to insightful information, customizable graphs, and diagrams.</p> <p>Data Integrity & Security: operating on airplane mode/on the edge allows for cyber-secure reports</p> <p>Scalability: download-and-use application allow for cross-service applicability and fast deployment</p>
<p>TECHNOLOGY SOLUTION</p> <p>IDRA is an Artificial Intelligence (AI) and Augmented Reality (AR) driven application offering an on-the-spot (FOD) reporting mechanism. Through a mobile phone, personnel will have the ability to report the presence of any FOD by solely taking a picture of the debris. A brief report will be auto-generated instantaneously through AI, saving time for the personnel. The app digitizes and automates FOD reporting as it reduces reporting time from 10 minutes to 30 seconds. IDRA functions on airplane mode without the need for internet connection. The report includes the size, location, type, color and potential source of the FOD. IDRA generates data analytics with patterns and trends identified to further help in developing preventive measures and reduce the likelihood of future FOD occurrences. IDRA is deployed with Nellis AFB and is currently in use by the Thunderbirds demonstration squadron.</p>	 <p>You access the application, take a picture of the FOD and, automatically a report with FOD size, location, type, and color will be generated.</p>

ENHANCED INSPECTION

WELDSCOUT™: INTELLIGENT WELDING INSPECTIONS FOR CRITICAL INFRASTRUCTURE

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WeldScout™ is an image recognition technology that ensures quality for welding by using artificial intelligence (AI) to rapidly identify defects in weld inspection scans. Its primary purpose is inspecting weld integrity for the structural and piping connections that compose the world's most vital industrial infrastructure, including aerospace, shipbuilding, bridges, data centers, refineries, railroads, sewage systems, and more.

The system uses a trained algorithm to evaluate Phased Array Ultrasonic Testing (PAUT) scans of welding and identify potential defects. PAUT is rapidly replacing radiography as the preferred method to inspect welds, and a shortage of certified PAUT inspectors often causes significant delays on projects. WeldScout™ improves the speed and accuracy of welding inspectors by flagging potential defects and prioritizing those for closer study. It also enables scans to be reviewed by certified inspectors anywhere in the world, not just those at the facility.



WeldScout™ has been piloted on multiple projects, proving its effectiveness in

real-world environments. During a pilot on a large project in South Korea, WeldScout™ was found to make inspections five times faster, increasing welding inspector productivity from 5 meters/hour to 27 meters/hour. Overall, it decreases inspection and data processing time by over 50%.

This technology is especially relevant for maintenance purposes, because proactively detecting potential welding defects before accidents occur is the most cost-effective and sustainable approach. Industries including energy, manufacturing, fabrication, and pharmaceuticals all perform welding during regular maintenance activities, which must be inspected to ensure quality, safety, and strength, and must meet all governing regulations and specifications.

Multiple applications also exist for the military, DLA, and DOD. For example, it could be used in U.S. Navy shipyards on vessel maintenance, Allied Trade Specialists in the Army, or ensuring that DOD welds meet Unified Facilities Guide Specifications (UFGS).

WeldScout™ is currently in prototype form. Cumulus plans to complete development for the first commercial release later this year, and then expand the platform to include many other types of inspection data. This will provide maintenance teams with a greater amount of flexibility to scale usage at projects globally, improving welding quality and productivity at facilities around the world.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none">Inspecting weld integrity is a critical maintenance function, yet a shortage of certified inspectors is causing significant delaysThis is causing a backlog of maintenance projects that contributes to major safety and sustainability issuesA system to augment human inspectors and increase their bandwidth is needed in order to ensure the continued quality of the world's most vital infrastructure	<p>BENEFITS</p> <ul style="list-style-type: none">During a pilot on a large project in South Korea, WeldScout™ was found to make inspections five times faster, increasing welding inspector productivity from 5 meters/hour to 27 meters/hour.Overall, it has been found to decrease inspection and data processing time by over 50%.Analyzes inspection data to ensure quality, safety, and strength, and that welds meet all governing regulations and specifications.
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none">WeldScout™ uses a trained AI algorithm to evaluate Phased Array Ultrasonic Testing (PAUT) scans of welding and identify potential defectsThis improves the speed and accuracy of welding inspectors by flagging potential defects and prioritizing those for closer study.It also enables scans to be reviewed by certified inspectors anywhere in the world, not just those at the facility	 <p>Inspector using WeldScout™</p>  <p>Screenshot of WeldScout™ evaluating welding data</p>

ROBOTICS AND SUPEROXALLOY ABRASIVES TECHNOLOGY FOR TRANSFORMATIONAL SAFETY AND EFFICIENCY IN SURFACE PREPARATION OF CONFINED SPACES

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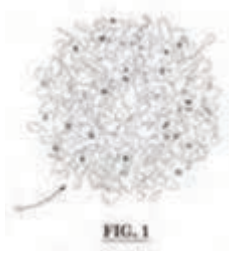
Confined Space Robotics, Inc. (CSR) and 10X Engineered Materials, LLC (10X) are combining autonomous robotics and superoxalloy abrasives as a synergistic and transformational technology for safer and far more efficient surface renewal using abrasive blasting in confined spaces. CSR brings proven robotic solutions to complete jobs quickly with minimal exposure of humans to exhausting and unsafe work conditions inside confined spaces. 10X superoxalloy abrasives technology brings environmentally sustainable, verifiably safe, non-magnetic, and durable particles that efficiently remove difficult coatings, leave a clean surface, delay rust formation, and require only one blasting pass before recoating. Both CSR and superoxalloy abrasives technologies are commercially available and are being applied in a wide variety of applications, including tanks in the oil and gas industry, rail tank cars, and Naval vessels.

Among the overarching maintenance challenges for the Department of Defense is returning fleets of ships, aircraft, vehicles, and other critical assets back into service in a timely manner. The U.S. Navy reports

that as few as 40% of Naval availabilities are returned to service on schedule. Abrasive blasting to renew surfaces for recoating is a significant driver of overall maintenance schedules. Many blasting jobs must be completed inside the confined spaces of tanks and compartments in a wide variety of defense assets, notably storage tanks, ballast tanks, and other critical enclosures.

The safety of workers is paramount in the many innovation and modernization initiatives underway in the DoD services to improve the readiness of our defense assets. Surface restoration in confined spaces is an exhausting, time-consuming, and unsafe task performed by humans. Workers must withstand the forces of high-pressure abrasive nozzles in unergonomic positions for extended periods of time. Dust accumulation from pulverized materials reduces visibility to nearly zero. Efficiency is compromised from repeated work stoppages due to exhaustion, to vacuum the work area, or to restore visibility. Robotic blasting using durable and efficient abrasive technology eliminates these safety hazards and provides new levels of quality and productivity that

can greatly reduce out-of-service time of defense assets.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • Returning critical defense assets to service from maintenance in a timely manner is a critical objective across DOD services. • Surface renewal for recoating is a critical-path task in maintenance schedules. • Abrasive blasting in confined spaces is slow, unsafe for workers, and ripe for technology innovation. • Work stoppages from exhaustion, abrasive vacuuming, and clearance of dust to restore visibility compromise efficiency. • Surfaces must often be blasted more than once due to off-spec surface finish or rapid onset of corrosion after blasting. 	<p>BENEFITS</p> <ul style="list-style-type: none"> • Minimizes or eliminates human blasting in confined spaces. • Clean surface finish for maximum coating performance. • Operate continuously without work stoppages at least 2.5X faster than humans. • Significantly decrease time and cost of confined space surface prep tasks. • Clean, white metal finish in one pass. • Efficient removal of the most difficult coatings and corrosion. • Minimized abrasive usage, clean-up time, and waste disposal. • Reusability of the abrasive up to six times. • Delayed rust bloom minimizes or eliminates re-blasting.
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • Autonomous robot combined with superoxalloy abrasives. • 4-phase algorithm scans, plans, and executes blasting tasks in confined spaces. • Flexible 3D movement for complex tasks and obstacles. • Multiple robots can be positioned and operated with a single operator. • Lightweight (< 55 lb) and fits through 18-inch manways. • Tempered amorphous particles with high impact strength maximize robotic capabilities. • Unique & patented particle shapes for high surface area finish and maximum coating performance. • SSPC-AB 1 certified and approved under MIL-A-22262B. • Can be used on all metals. 	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p>CSR Robot operating in a tank</p> </div> <div style="text-align: center;">  <p>FIG. 1 Patented superoxalloy abrasives</p> </div> </div>

RELIABILITY IMPROVEMENT (HARDWARE)

ADVANCED TACTICAL SPHERE BRAKE KITS

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Problem: 3d Marine Logistics Group (3d MLG) has a two-part problem for ground motor transportation (MT) assets. On the average, these assets spend 60 days in shop for corrective maintenance (CM). Additionally, the preventative maintenance (PM) requirements of the fleet is \$1M and 15K man-hours.

Description: In 2018 we knew CBM+ was the solution to our maintenance problem. However, we were not clear how to proceed within the 3 facets of people, process, and technology. Out of the 2019 Maintenance Symposium we realized our epiphany moment when the keynote speaker made the following 2 statements: 1) Good technology overlaid on bad, unrefined, and unimproved processes results in bad technology. 2) Relying on the addition of manpower, funds, or structure is unsustainable. These two statements shape our CBM+ solution focusing on changing our processes and empower our people thereby ensuring the effectiveness of the forthcoming enterprise CBM+ technology solution. Applying these concepts to CM, we eliminated administrative non-value-added




business steps not directly contributing to the restoration of the asset. Moreover, a system of standardization of work centers, workspace ownership, quality assurance, and minimizing physical movement has been implemented to increase efficiency. In the area of PM, a side-by-side comparison between the owner/operator monthly service checks were found to be more in-depth compared to the annual PM. Strictly enforcing the owner/operator annual monthly service checks had enabled us to remove the redundant tasks found on the annual PM resulting in a reduction of man hours. Furthering the concept, interval and time-based PM material replacements were changed to condition-based replacement resulting in a reduction of material cost. The totality of the process changes have enabled no cost, immediate positive effects in the morale of the owner/operators/mechanics and improved tactical level equipment availability.

Current: As of this submission, we have fully implemented CM/PM process changes in ground motor transport assets. Additionally, we codified these changes in directives, maintenance standard operating procedures,

obtained a service level maintenance process waiver, developed, and delivered training to 600+ personnel, and perform formalized CBM+ compliance inspections.

Data: Our initial baseline data for CM of 60 days in shop compared to the improved CBM+ process data of 19 days in shop have indicated we have reduced the days in shop by 41 days, a 60% improvement. Similarly, our initial baseline data for PM \$1M and 15K man-hours, as required by the technical manuals has improved to \$200K (80% reduction in material cost) 1K man-hours (90% reduction time effort).

Next Steps: Expand to Engineer equipment including both Heavy and Utilities equipment, scale up to the service level component adopting the process changes into policy, and empower individuals to think about maintenance in a condition-based context.

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none"> Ground tactical vehicle brake systems are experiencing significant corrosion, wear, and performance degradation. Some ground tactical vehicles must replace brake pads every 500 miles under current mission profiles. It currently takes at least 15 tools, infrastructure, trained technicians, and at least 12 hours to change brake pads on all wheel-ends for one vehicle. This problem impacts safety, performance, operational availability, maintenance time, logistics delay time and money. What's needed is a scalable holistic solution to satisfy the needs of the maintenance technician, the program manager, the PEO, and the Warfighter. 	<p style="text-align: center;">BENEFITS</p> <p>Description of Capability: The SB Kit was designed to address the needs of the maintenance technician, the program manager, the PEO, and the Warfighter. It is holistic in the value it delivers to all stakeholders and holistic in the value it delivers in performance. SB Kits provide unprecedented reliability, maintainability, and safety to the Warfighter that existing brakes cannot match. The collective return of investment yields thousands of dollars of savings per mile.</p> <p>Value to Warfighter:</p> <ul style="list-style-type: none"> Brake pads can be replaced without removing wheels or tools = increased unit readiness and Warfighter safety. Increased brake pad and rotor service life = increased fleet readiness. Less unsprung mass at wheel-end = better stability = better mobility Less rotational mass at wheel-end = better rideability = better fuel efficiency
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> The Sphere Brake (SB) Kit uses hydraulic pressure to compress hemispherical brake pads against a spherical brake surface requiring a smaller brake effective diameter to generate the same force requirement. The SB Kit is designed to bolt-on to existing ground tactical vehicle wheel-ends integrating with Antilock Brake Systems (ABS) and Central Tire Inflation Systems (CTIS). The SB Kit has completed Federal Motor Vehicle Safety Standards (FMVSS) 121 track testing on the Stryker and FMTV. The system will be executing Reliability Qualification Testing on Marine Corps Amphibious Combat Vehicle in FY23 and early FY24. 	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p>SB Kits on FMTV 60 Slope Hill Hold</p> </div> <div style="text-align: center;">  <p>ACV SB Kit in Dyno Testing</p> </div> </div> <div style="text-align: center; margin-top: 10px;">  <p>SB Kits on Stryker at ATEF.</p> </div>

ARMAMENT FLIGHTLINE TEST INNOVATION YIELDS SIGNIFICANT TIME AND COST SAVINGS: A WEAPONS SECTION CHIEF'S PERSPECTIVE

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Problem: As a USAF Weapons Section Chief, my responsibilities encompass all aspects of alternate mission equipment (AME) and munitions handling and test, and one of the most daunting challenges I face is deploying the most effective flightline armament test solutions.

Today's armament maintainer must perform flightline test and maintenance with legacy test sets that limit the ability to quickly and efficiently verify system readiness, diagnose failures, and return the aircraft to full mission capable (FMC) status.

Technology: The MTS-3060A SmartCan™ Universal O-Level Armament Test Set is the most advanced test set available, capable of testing all AME and Aircraft Armament Equipment (AAE) including pylons, launchers, bomb racks, and pods.

COTS designated, it is the most cybersecure flightline test set available, replacing multiple currently deployed, large-footprint, test sets with a single rugged, hand-held solution weighing less than 5 lbs. Powered by 6 AA batteries, the complete kit includes self-test,

adapters, and cables, all weighing less than 50 lbs.

Development Status: The MTS-3060A is a TRL 9, deployed non-developmental item available for immediate purchase and use, and is applicable to all branches of the USA, FMS Armed Forces and DLA. It has received SERD certification (SERD #75A77), and declared a fully qualified and approved solution for the F-16, effective for testing armament systems including launchers, bomb racks, pylons, fuel tanks, and gun.

Test/Simulation Data: Deployment: Currently deployed supporting F-16, F-15, A-10, F-18, UAS, TA-50, FA-50, Hawk, and F-5 and in 2 System Integration Labs (SILs). Qualification data, F-16 SERD certification, and a cybersecurity ATO further validate its capabilities. Also, it is ready to support all 5th and 6th generation armed platforms.


Logistics: (1) MTS-3060A can replace (15) armament test sets currently supporting (9) armed USAF platforms.

Test and Setup Time: F-16 setup time is reduced 91% (45 to 4 minutes), test time for a

MIL-STD-1760 pylon is reduced 85% (20 to 3 minutes), and reduced 89% (35 to 4 minutes) for a LAU-129. Similar time reductions have been realized for all armed platforms; further savings will be seen through test set consolidation, simplified logistics, and standardized training.

Next Steps/Potential Benefits: The MTS-3060A significantly improves hardware readiness while reducing maintenance costs. Sustainment savings for the USAF are projected to be between \$7.5M - \$10M annually per MDS. When coupled with reduced training, savings are projected to approach \$12M annually. Savings are based on scheduled maintenance activities and do not reflect additional savings from unscheduled activities which could easily exceed \$20M annually.

The MTS-3060A also enables the USAF's ACE doctrine by supporting both legacy and smart weapon test on any DOD armed platform, and by reducing logistics and training requirements. It is a multi-capable Airmen enabler.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • Armament maintainers currently perform O-Level (flightline) test and maintenance with legacy test sets that greatly limit the ability to quickly and efficiently verify armament system readiness and diagnose failures. • Multiple legacy test sets are typically needed for a single aircraft, or only perform a single function on multiple aircraft, resulting in long test/repair times and increased training/logistics burden. • Ability to execute DOD initiatives, including the USAF's Agile Combat Employment (ACE) doctrine, are severely impacted by current test sets. • Returning aircraft to FMC (Full Mission Capable) status is significantly delayed due to the multitude of currently deployed / legacy test sets. 	<p>BENEFITS</p> <ul style="list-style-type: none"> • Overall summary: <ul style="list-style-type: none"> ▪ Reduced costs, fast test times, less training, test set consolidation, quicker FMC aircraft availability, rugged, handheld, cybersecure • A single, hand-held, test set conducting full functional armament test for all armed aircraft • Maintenance savings: <ul style="list-style-type: none"> ▪ ~\$8.5M annually per MDS, \$12M when coupled with reduced training • Test setup and execution savings (F-16 actual): <ul style="list-style-type: none"> ▪ Reduced 91% (setup – from 45 minutes to 4 minutes) ▪ Reduced 85% (execution – from 20 minutes to 3 minutes) • Test set consolidation / logistics savings (9 armed USAF aircraft): <ul style="list-style-type: none"> ▪ (1) MTS-3060A replaces (15) current armament test sets currently supporting (9) USAF platforms • Support for DOD initiatives: <ul style="list-style-type: none"> ▪ Enables USAF's ACE doctrine by conducting armament test for all weapons on all DOD armed aircraft; Multi-capable Airmen enabler
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • The MTS-3060A leverages innovative design and packaging techniques to replace multiple, currently deployed O-Level armament test sets with a single, rugged, hand-held COTS solution weighing less than 5 lbs. • Its pioneering design incorporates more than 35 measurement channels, squib measurements, active communications test interfaces, 3 arbitrary waveform generators, multiple electronic loads, discrete outputs, data logging, BIT, self-test, automated calibration, cable ID, and a sunlight-readable LCD display. • Innovative power management requires only 6-standard AA batteries for up to 40 hours of operation. Innovative 4-year calibration cycle. • USAF Cybersecurity ATO concluded that the MTS-3060A represents a Low / Very Low cyber risk 	<p>MTS-3060A SmartCan™ Universal O-Level Armament Test Set</p>  <p>Single case includes MTS-3060A, all cables, adapters, selftest</p>

SELF-ALIGNING NUT PLATE

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Problem: Aircraft access panels have multiple bolts attached to their rim with retaining rings that slide up and down axial grooves in the bolts. These rings can tilt, bind, and then break leading to FOD (foreign object debris). These bolts thread into a nut plate that is bonded or riveted to the inner surface of the substructure. Current nut plates use a nut element that can move radially to try to accommodate hole mismatch between the panel bolt and the nut plate. With curved aerospace structures, such as the leading and trailing wing edges, there can be radial and axial hole mismatch between the access panel bolt and the nut plate. None of the current nut plates have axial freedom of motion to allow for the nut element to “tilt” to accommodate a bolt that is off-axis to the nut plate. A frequent scenario is when a maintainer is attaching an access panel, and he has already inserted 50-60 out of 100 bolts. With the next bolt, however, there is hole mismatch resulting in cross-threading of the bolt. He then needs to untighten all of the bolts to remove the panel, have the offending nut plate removed and replaced, and then he starts the panel attachment process all over again.

Technology Solution: The self-aligning nut plate has an axially spring-loaded nut element, which has freedom of motion in both a radial and an axial direction. This allows the nut element to “tip” to engage a bolt that is off-axis to the nut element. The nut plate then self-aligns during tightening of the bolt. The axially spring-loaded nut element also allows for an axially fixed position panel bolt retaining ring. The panel bolt retaining ring utilized with this nut plate is a more robust conical ring which collapses during initial insertion of the bolt onto the panel. It then re-expands to capture the bolt to the panel.

Benefits: With multiple panel bolts being inserted into their individual nut plates, hole mismatch is accommodated even when a bolt is off-axis. When there is axial and radial hole mismatch, the nut plate’s nut element will tilt to engage the off-axis bolt, and then it will self-align during tightening. This greatly reduces the time to attach an access panel and improves flight maintenance time. Foreign object debris (FOD) is also reduced with a conical fixed position panel bolt retaining ring.

Status: A new National Aerospace Standard (NAS9938) has been established, and the self-aligning nut plate is commercially available. Applications include aircraft, spacecraft, and missiles. Through Air Force Contract #FA864922P0854, the self-aligning nut plates are being qualified as suitable subs on the B-1, B-2, and KC-135. Through Air Force Contract #FA864922P0810, a variant of this nut plate was developed, which is the only nut plate that mechanically locks the bolt. All other nut plates rely on thread friction, so this variant will provide for extreme vibration resistance, such as is needed in hypersonic applications.

PROBLEM STATEMENT

Aircraft access panels have multiple bolts attached to their rim with axially floating panel bolt retaining rings, but these rings can bind and break leading to FOD (foreign object debris). The bolts thread into nut plates that are attached to the substructure. With curved structures such as leading and trailing wing edge, hole mismatch can occur between the panel bolt and the nut plate. Current nut plates will not engage an off-axis bolt, so cross-threading occurs often halfway or more into the panel attachment. This results in the maintainer loosening all of the bolts to remove the panel, replacing the offending nut plate, and starting over with the panel attachment.

BENEFITS

With multiple panel bolts being inserted into their individual nut plates, hole mismatch is accommodated even when a bolt is off-axis. When there is axial and radial hole mismatch, the nut plate’s nut element will tilt to engage the off-axis bolt, and then it will self-align during tightening. This greatly reduces the time to attach an access panel and improves flight maintenance time. Foreign object debris (FOD) is also reduced with a conical fixed position panel bolt retaining ring.

TECHNOLOGY SOLUTION

The self-aligning nut plate has an axially spring-loaded nut element, which has freedom of motion in both a radial and an axial direction. This allows the nut element to “tip” to engage a bolt that is off-axis to the nut element. The nut plate then self-aligns during tightening of the bolt. The axially spring-loaded nut element also allows for an axially fixed position panel bolt retaining ring. The panel bolt retaining ring utilized with this nut plate is a more robust conical ring which collapses during initial insertion of the bolt onto the panel. It then re-expands to capture the bolt to the panel.

Graphic or Image



ELIMINATION OF SAFETY WIRE WITH MECHANICALLY LOCKING FASTENERS

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Problem: Although fasteners are often overlooked as commodity items, their reliability and attributes are essential not only to the warfighter but essential also in the reduction in the time and cost of maintenance for the Commands. For critical applications, safety wire is often used to try to prevent loosening of the fastener, but this is very labor intensive and therefore costly. On average, a maintainer can safety-wire 10-15 fasteners/hour. Castle nuts are often used on the landing gear of aircraft, but castle nuts have only 6 slots (gradations of torque). If a narrow range of installation torque is specified, the mechanic may torque to that range and find that the cotter pin cannot be inserted. He will then try another nut and repeat that trial-and-error process until he is successful. Permanently locking fasteners are also used, but these need to be cut out for maintenance, and they cannot be re-tensioned after initial installation.


Technology Solution: The Silver Lock fastener is a mechanically locking, high vibration resistant fastener. Once installed, it is permanently locked, but for maintenance it is easily reversible and reusable with a

standard hex socket. In vibration testing, it survived 10x the aerospace requirement. There are a minimum of 36 gradations of torque per revolution, and the fastener remains locked even with loss of preload (clamping force). It can withstand extreme temperatures, and materials include A286, 300 series, titanium, and Inconel 718. It is available in a locking bolt version and a locking nut version.

Benefits: In the same hour that 10-15 fasteners could be safety-wired, over 300 Silver Lock fasteners could be installed improving assembly and maintenance times. For replacement of castle nuts, it eliminates the trial-and-error process by offering many more gradations of torque per nut revolution. It remains locked even with loss of preload, which makes it ideal for extreme temperature environments including space, missiles, and engines, in addition to rotary and fixed wing aircraft. The use of the Silver Lock fastener in the suspension of ground vehicles would simplify maintenance by eliminating permanent fasteners that currently need to be cut out and replaced with specialized tools. Bolts used in tracked vehicles and

for armor attachment need periodic torque testing maintenance, which would not be required with these fasteners.

Status: New National Aerospace Standards (NAS9940 and NAS9942) have been established, and the fasteners are commercially available. Through Air Force Contract #FA864921P1435, the fasteners were miniaturized to No.4-10 for use in missiles and spacecraft. A robotic end effector was also developed for installation in space, and an Air Force TACFI was recently awarded for development of a magazine for storage. Through Air Force Contracts #FA864922P0854 and #FA864922P0897, the fasteners are being qualified as suitable subs on the B-1, B-2, KC-135, & aircraft ground support equipment.

<p align="center">PROBLEM STATEMENT</p> <p>Although fasteners are often overlooked as commodity items, their reliability and attributes are essential not only to the warfighter but essential also in the reduction in the time and cost of maintenance for the Commands. For critical applications, safety wire is often used to try to prevent loosening of the fastener, but this is very labor intensive and therefore costly. Castle nuts are sometimes used, but if a narrow range of torque is specified, the mechanic may torque to that range and find that the cotter pin cannot be inserted. He would then try another nut and repeat the process until successful. Permanently locking fasteners are used in ground vehicle suspensions and in high heat and high vibration applications, but these need to be cut out for maintenance.</p>	<p align="center">BENEFITS</p> <ul style="list-style-type: none"> • Installation of over 300 Enduralock fasteners vs 10-15 safety-wired fasteners per hour • 36 gradations of torque per revolution vs 6 gradations for castle nut with cotter pin, so trial and error eliminated for critical applications • Bolts remain locked, so periodic torque testing not required for tracked vehicles • Easy removal of ground vehicle suspension bolts with hex socket vs cutting of permanent bolts • Withstand extreme vibration and extreme temperature changes
<p align="center">TECHNOLOGY SOLUTION</p> <p>The Silver Lock fastener is a mechanically locking, high vibration resistant fastener. Once installed, it is permanently locked, but for maintenance it is easily reversible and reusable with a standard hex socket. In vibration testing, it survived 10x the aerospace requirement. There are a minimum of 36 gradations of torque per revolution (as opposed to 6 in a castle nut), and the fastener remains locked even with loss of preload (clamping force). It can withstand extreme temperatures, and materials include A286, 300 series, titanium, and Inconel 718. It is available in a locking bolt version and a locking nut version.</p>	<p align="center">Graphic or Image</p>  <p>NAS9940 NAS9942</p>

RELIABILITY IMPROVEMENT (HARDWARE)

COMPACT LOADING ADAPTER AND WINCH SYSTEM (CLAWS)

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In the face of dynamic environments and formidable peer adversaries, our ability to engage effectively and secure victory is constantly under threat unless we can swiftly reload armament systems and confront challenges head-on, even in remote and austere locations. The Compact Loading Adapter and Winch System, known as CLAWS, aligns seamlessly with the Air Force's future operational concept and "The Six Fights", particularly emphasizing "the fight to get into theater", "the fight to get airborne", and "the fight for air superiority".


Our current loading process presents a logistical nightmare, demanding six pallet positions worth of equipment for transport. This approach proves not only impractical but inefficient, especially for aircraft tasked with mission spanning vast areas of responsibility. In contrast, CLAWS introduces efficiency on a monumental scale, decreasing load times on an average of 50% and eliminating nearly all 9,000 pounds of support equipment. Developed based on the Navy's HLU-288 loading hoist, CLAWS aims to eliminate the need for 9,000

pounds of equipment currently required to reload a single AC-130 while significantly enhancing overall operational efficiency. Our existing loading operations involve complex maneuvers, necessitating ample space, an MHU-83 Bomb lift truck, and multiple locally manufactured pieces of equipment. CLAWS eliminates these complexities, replacing them with a single hoist capable of lowering and raising munitions directly under the wing. This not only eradicates the need for six pallets of equipment but also reduces the required support personnel.

CLAWS affords us two crucial advantages: first, its compact design enables internal carriage, ensuring that wherever the AC-130 lands, reloading capabilities accompany it. Second, CLAWS can be pre-staged, providing the agility to reload multiple combat-coded airframes swiftly. Without CLAWS we jeopardize our agility and rapid reload capability in austere locations, directly impinging on our ability to execute the ACE concept. Furthermore, as CLAWS is derived from existing Navy Loading Equipment used on their F-18 and F-35 Aircraft, a simple

adaptation of their adapter assemblies will enable cross-utilization on other Air Force airframes.

Over the past year CLAWS has undergone rigorous testing and continuous refinement. What remains is to showcase its operational prowess. This entails procuring an updated prototype, initiating development and operational testing, and ultimately deploying CLAWS across the AC-130 fleet. Beyond these initial objectives, we aspire to explore CLAWS' interoperability with other platforms, extending its utility across all airframes and broadening its transformative impact.

<p>PROBLEM STATEMENT</p> <p>Our ability to engage and fight effectively is under threat unless we can swiftly reload armament systems in remote and austere locations. Our current loading process presents logistical and operational challenges requiring a massive footprint for transport and substantial space for complex maneuvers.</p>	<p>BENEFITS</p> <ul style="list-style-type: none">▪ Compact: eliminates need for transport of 9,000lbs of equipment/6x pallet positions.▪ CLAWS is transported internally with the AC-130J.▪ Removes need for personnel required to transport and maintain current equipment.▪ Tests and demos show on average a time reduction of 50% for re-loading Hellfire missiles and SDBs.
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none">▪ CLAWS is an alternate loading system that uses hoists/pulleys to raise and lower munitions to wing pylons.▪ Modular design: system can adapt to other platforms easily.▪ Removes the need for the MHU-83 bomb lift truck and multiple locally manufactured adapters.	<p>GRAPHIC OR IMAGE</p> 

WEIGHT ON WHEELS TESTER

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The 27th Special Operations Maintenance Group's Air Force Repair Enhancement Program (AFREP) at Cannon AFB was presented a challenge by AFETS engineers and the Program Office. The V-22 Osprey main landing gear strut assembly has a proximity sensor, which acts as an aircraft weight on wheels switch. This switch has no official test routine, which can be completed by field level maintainers to validate and verify serviceability.

Currently, the standard process for a failing switch is to replace the main landing gear strut assembly. Mr. Justin Brett, the Lead 2M technician at Cannon's AFREP, accepted this challenge then developed and built a prototype test set. He procured some high visibility indicator lights, the necessary internal components, wire, and the corresponding connector plugs. He then 3d printed an appropriately sized project box as a housing and assembled the prototype. The test set was then presented to the AFETS engineers, who took it to the hydraulic back shop where a strut assembly was used to evaluate and test this new diagnostic tool.

This test adapter will allow field level maintainers to fault isolate failing weight on wheels switches. This enables field level maintainers to replace the switch instead of the whole assembly. This changes a 40+ man hour repair to approximately a four-man hour repair and from replacing a part valued at \$423k to replacing a component valued at \$5k for each associated repair. This also eliminates associated safety risks during the removal, replacement, and transportation of the strut assembly.

The end goal is for this test set to be produced at scale and made available to maintainers across the entire joint V-22 fleet at Organizational and Immediate levels. This success story also validates the reason for having an AFREP within your Wing/Base. Additionally, this demonstrates the advantage of the knowledge base and skillsets available and is within the core doctrine of accelerate change.

<p>PROBLEM STATEMENT</p> <p>V-22 Strut weight on wheels switch does not have official test procedures to isolate switch failure. Current ops is to replace entire main landing gear strut assembly (approximately 40+ man hours).</p>	<p>BENEFITS</p> <p>By enabling our force to test the weight on wheels switch on the V-22 strut, we allow for our maintainers to isolate and replace the defective switch. Each occurrence cuts expended man hours by 90% and maintenance cost by \$400K. Additionally, the logistics and protentional safety concerns of moving a large aircraft part.</p>
<p>TECHNOLOGY SOLUTION</p> <p>Developed handheld test set allowing for individual testing of weight on wheels switch from the strut. Prototype casing was 3D printed, and electronics was assembled. All in financial burden was less than \$100.</p>	<p>Graphic or Image</p> 

FLX BOT FOR MAINTENANCE AND SUSTAINMENT

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FLX Solutions creates robotic tools designed to reduce operational downtime in critical equipment and machinery while maximizing the efficiency and safety of technicians. Our flagship product, the FLX BOT, is a 1" diameter snake-like robot used by maintenance technicians to perform preventative maintenance in locations and equipment that have been previously inaccessible or require expensive and time-consuming disassembly. The FLX BOT was the recently announced winner of the 2023 ATI ManTech Advanced Manufacturing Challenge.

The status quo of inspection and repairs of critical equipment is manual labor using basic hand tools. This requires time-consuming disassembly, which leaves equipment disabled for extended periods of time. The FLX BOT solves this problem by autonomously maneuvering into hard-to-reach locations to perform rapid inspection and maintenance. It also helps to keep personnel safe and combat ready by minimizing common workplace dangers such as ladders, heights, and entry into confined spaces.


The FLX BOT is a patented 1" diameter, handheld, collaborative snake-like robot that a soldier can use with minimal training to maintain and inspect within confined spaces in critical equipment and machinery. It is modular, made up of identical, interchangeable links that each have a camera and sensors for autonomous obstacle avoidance. Interchangeable end effectors include 360°, thermal & 3D cameras, non-destructive testing (NDT) sensors, grippers, caulk dispensers, aerosolized sprayers, leak detectors, and more to help perform the maintenance required more efficiently, effectively, and safely.

The FLX BOT can be safely inserted into a critical machinery or equipment to investigate and inspect within. It can also be mounted on an extension pole to reach greater heights for investigating overhead areas without having to set up a lift or ladder, cutting down on setup/disassembly times and helping to keep key pieces of equipment ready for combat. Once the FLX BOT is inside a confined space the links will autonomously avoid obstacles and navigate

the cavity while relaying a live video feed back to the operator.

The FLX BOT has been identified as a tool that could benefit DoD techs on bases, ships, shipyards, or other areas with confined spaces. FLX Solutions received a paid demo with the U.S. Navy as one of ten finalists in the NSIN tank inspection competition. While onboard the USS Midway the FLX BOT was successfully used to 3D map a naval tank, inspect overhead HVAC areas as well as other confined spaces including within a jet engine. Other DoD departments have also expressed interest in demos, such as the Norfolk Naval Shipyard and large DoD Prime Contractors.

Next steps include additional FLX BOT pilots with interested parties along with ramping up manufacturing so it can be purchased through the GSA catalog. The inclusion in the catalog has been requested by personnel on the USS Midway and other agencies we are currently engaged with.

PROBLEM STATEMENT	BENEFITS
<ul style="list-style-type: none">Maintenance and Operations technicians within the DoD face a major challenge to quickly and efficiently inspect critical machinery and confined spaces on bases, ships, and within critical assetsThe status quo (manual labor using simple hand tools) usually requires costly dismantling/repair, significantly increases the time to complete projects and perform routine maintenance, and frequently puts maintenance technicians in precarious situationsCollaborative robots (cobots) are the clear solution, providing a safer, more effective way to inspect and make repairs in confined spaces as they minimize setup time and allow for rapid deployment in diverse environments	<ul style="list-style-type: none">Reduces operational downtime through increased preventative maintenance and faster failure recoveryAllows for maintenance in smaller facilities closer to the front linesAllows workers to remain safely on the ground while using the FLX BOT to inspect in elevated locationsCollects data using onboard and external sensors for predictive maintenance and better documentationLower costs for inspection, maintenance, and QA/QCFLX BOT is lighter, smaller, and provides more articulation than other robotic competitors that cost 10xCan be attached to an extension pole or other mobile systems to reach previously inaccessible places
TECHNOLOGY SOLUTION	
<ul style="list-style-type: none">The FLX BOT is a patented 1" diameter, handheld, snake-like robot that can be used with minimal training by technicians to access hard-to-reach areas to keep them safer and provide a more efficient method of maintaining key pieces of equipmentIt is modular, made up of identical, interchangeable links that each have a camera and sensors for autonomous obstacle avoidanceInterchangeable, customizable end effectors include 360°, thermal, and 3D cameras, grippers, leak detectors, NDT sensors, and moreLightweight and low-cost allowing for wide deploymentIntuitive user interface removes the need for training	

RELIABILITY IMPROVEMENT (HARDWARE)

MOTOR GENERATOR SHIPBOARD REPAIR SYSTEM

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Problem Statement: Motor Generator commutator resurfacing is a critical path maintenance item during Naval availabilities, this refurbishment is labor intensive, time-consuming, and oftentimes requires rework; lacking efficiency and optimization. Commutator environmental sensitivity to solvents, fumes, and contamination significantly limits or halts other production work in the equipment space. The legacy process requires complete disassembly of the end bell and bearing to access the commutator and installation of a temporary half end-bell to support the rotor and allow access for handwork.

Description: The Motor Generator Shipboard Repair System (MGSRS) is a comprehensive in-situ refurbishment system for motor generators (MG), commutators, and other electrical rotors such as slip rings. The system consists of notable subsystems including: a drive/brake system for spinning, stopping, and indexing a rotor; an industrialized robotic control system and user interface including hardware and software; a multi-axis internally mounted Computer Numerical Control (CNC) machining platform; and

a modular implementation designed for commercial transportation and use in space-constrained environments. The system performs multiple operations applicable to refurbishing large motors including: removing dielectric material between commutator bars (undercutting); bulk removal and refinishing of a commutator surface (stoning and polishing); chamfering and deburring commutator bars (chamfering); and inspecting commutator bar heights (inspection).

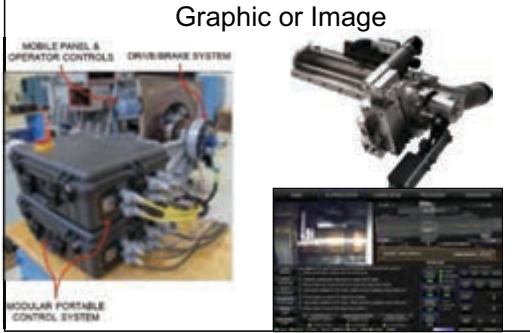
Development Status: The initial prototype has been designed, built, and tested on several functional platforms. Several Operational Demonstrations have occurred on both test and active platforms. The system is currently between development and production, in technology transition. Drawings are being updated for as-built changes. A user manual has been developed and is undergoing an update to account for minor process changes learned from shipboard usage and operator feedback.

Test/Simulations Data: To date, four active platform motor generators have been refurbished, retested, and brought

back to full functionality. Additionally, this equipment has supported four maintenance actions where it was used to spin the rotor to support maintenance unrelated to the intended use of the MGSRS equipment.

Next Step/Potential Benefits: There are many benefits to use of this system, the numeric controlled nature and touchscreen interface allows for a low barrier to entry for the next-generation workforce. Numeric control also reduces "end game" risk with high repeatability. The fly away kits enable maintenance to be performed at any location. This system shortened the critical path maintenance timeline by 80% and reduced expensive hardware replacement.

The team is pushing to build production kits for each of the maintenance centers, as well as provide a training suite within person training and refresher videos for tool operation.

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none">• Conventional Motor Generator (MG) Set commutator refurbishment is labor intensive, time-consuming, and oftentimes requires rework; lacking efficiency and optimization• Commutator environmental sensitivity to solvents, fumes, and contamination significantly limits or halts other production work in area during MG Set refurbishment• Public Shipyard Electrical Community of Practice leaned forward to champion a process improvement initiative by reaching out to NUWC Keyport	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none">• System shortened the critical path maintenance timeline by 80% and reduced expensive hardware replacement.• Numeric control also reduces "end game" risk with high repeatability.• Fly away kits enable maintenance to be performed at any location• Numeric controlled nature and touchscreen interface allows for a low barrier to entry for the next-generation workforce• Able to perform commutator refurbishment with end bell in place (no rigging support required)• Lowers barrier-to-entry for new personnel to perform task
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none">• NUWC Keyport provided waterfront engineering support, tool design & integration engineering, and operational demonstration assistance to transition this grassroots idea to a fully-supported industrial process.• This modular, robotic tool automates in-situ refurbishment capability for MG Set commutator undercutting, stoning and polishing, chamfering, and inspecting• Training plan/curriculum and refresher videos to aid in technician competency• Logistics sustainment plan for maintaining tool, engineering reach-back support, and expected technology refresh requirements	<p style="text-align: center;">Graphic or Image</p> 

RELIABILITY IMPROVEMENT (HARDWARE)

VACUUM CRAWLER ROBOTIC SYSTEM (VCRS)

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The Vacuum Crawler Robotic System (VCRS) is a modular, ruggedized work execution platform enabling workers a means to complete inspection and modification tasks from safe locations without requiring erection of scaffolding or other temporary infrastructure. The capability is developed from a commercial version and modified to provide open architecture and common robot operation system (ROS) software.

The VCRS is modular allowing reconfiguration and common interconnectivity interface to support multiple sensing and work execution payloads. Development activities began with additional scope added to a NAVSEA SBIR and currently is advancing under contract from NCMS in collaboration with Portsmouth Naval Shipyard (PNSY). Testing of the system is planned for PNSY in 2024. The above water variant design, technical data package for production, and shipyard certification will be completed in 2024. The modular nature of the technology sets the stage for establishing an underwater suction attached variant and dual configurations of the commercial version have been demonstrated at PNSY.

The Technology Readiness Level (TRL) is 6 for the ruggedized DoD version and will be TRL 7 once testing is completed in 2024. The Manufacturing Readiness Level (MRL) is 4 but is expected to be MRL 5 at the completion of the NCMS contract. The VCRS offers significant benefits in work execution efficiency and increased worker safety. A below water crawler (suction) is being developed under a recent Phase I award to being cavitating jetting to add in maintaining antifouling condition of sensors areas and the hull in general with requiring diver involvement.

<p>PROBLEM STATEMENT</p> <ul style="list-style-type: none"> Erect support structures, like scaffolding, or renting/using personnel lifts to enable work adds to time to maintenance schedules already under pressure. Maintenance and sustainment work time frames are too long, too inefficient, and requires too high a level of skill to achieve required quality for our weapons systems. Maintenance and sustainment of weapons systems can be dangerous, dull and dirty exposing workers to undesirable levels of risk or contaminant exposure. The workforce is declining with an increased retirement rate adding more stress manpower shortages, required skill levels and much needed experience or knowledge. 	<p>BENEFITS</p> <ul style="list-style-type: none"> Quick System setup. Allows rapid work start and eliminates the need to erect scaffolding. A modular TRL 7 design provides easier modifications to special configurations and new sensing and work attachments. Ruggedized system worthy of operating in DoD operational environments, such as Shipyards and Depots. Scalable platform providing versions sized for specific applications; e.g., smaller for Aircraft, larger for ships. Open architecture enables capability advancement contributions by multiple people/organizations in industry, academia and DoD R&D Centers.
<p>TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> The Vacuum Crawler Robotic System (VCRS) provides increased worker safety and reduces cost and time involved with erected infrastructure, rented equipment, or donning of safety gear required in high or confined spaces. VCRS "carries" work and inspection capabilities appropriate for the job, such as biofouling removal spray nozzles or SHT delamination inspection capabilities. VCRS provides a foundation for an underwater variant that allows underwater antifouling needed to maintain optimal performance of sensitive sensing systems. Both variants share significant componentry and common user interface. 	<p>GRAPHIC</p> <p><u>Leverage Existing Technology</u> <u>Reconfigurable Technology</u></p> <p>Commercial Defense Above Water Below Water</p> <p>System to Remove Biofouling</p> <p>Dual Configuration</p> <p>Robot 1 SHT Cutting Tool</p> <p>Robot 2 NAVSEA</p>

LATTICE FRAMEWORK FOR UNMANNED VESSELS

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The Lattice Framework (Patent Pending) is a system of embedded powered rails, tracks, and cables central to construction of the internal and external points of a manned or unmanned vessel (UV) (ground vehicle, military ground vehicles, ship, aircraft, spaceship, etc.) to which autonomous systems (robots) are attached to perform maintenance and other operations. The Lattice also contains electromagnetic grids for tracking and hull breach detection and a back-up system for operation when the vessel power is unavailable.

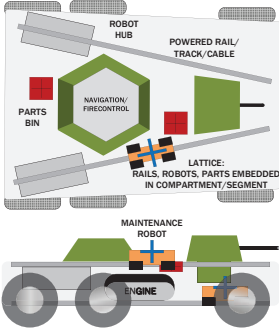
The Lattice Framework addresses the problem of making autonomous UVs as resilient and self-maintaining as possible. Current concepts rely on using multiple expensive and independently mobile robots capable of their own stability while requiring the ability to self-navigate through a UV. The Lattice eliminates the 3D movement requirement, supporting development of robots and capabilities focused on repair and sustainment. Our concept follows an assembly line/industrial robot philosophy. However instead of the parts moving on a line, robots move within a lattice of adjacent

track or rail systems. Vessel equipment and the racks are permanently affixed to the vehicle, and the robots move along the tracks as necessary to conduct operations. Spares bins are strategically located, just as they are in a factory or warehouse. Multiple robots can be on a track or a single robot with a multifunction arm can be employed so the combinations are endless.

This approach eliminates 3D mobility processing requirements for robots while still providing a high level of flexibility and scalability. The impact of vessel motion is mitigated as both robot and machinery are moving at the same time on the same plane. Track/rails or thick cables are straightforward parts that can be replaced organically. They also lend themselves to multiple materials and designs such as a single rail or cable for smaller compartments and double rails and cranes for larger pieces of equipment.

Catastrophic battle damage can be better addressed. Damage that severely impacts rails assigned to the propulsion system will have just as much impact on a set of autonomously mobile robots. If the rails remain intact movement

continues, while an autonomous robot will now have to successfully maneuver through a new landscape.

<p>PROBLEM STATEMENT</p> <p>The Lattice Framework addresses the problem of making autonomous unmanned vehicles (UV) as resilient and self-maintaining as possible. Current concepts rely on using multiple expensive and independently mobile robots capable of their own stability while requiring the ability to self-navigate through a UV. The Lattice eliminates the 3D movement requirement, supporting development of robots and repair capabilities focused on repair and sustainment.</p>	<p>BENEFITS</p> <ul style="list-style-type: none"> • Provides a new design, manufacturing, assembly, and maintenance framework that achieves high operational availability and resiliency for UVs • Maintenance robots are affixed to the Lattice in a manner that the robots do not move on the Lattice independently of the Lattice, regardless of vessel movement • Promotes current and near future robotic capability at reduced cost • Promotes true self sustainment design for autonomous vehicles, reducing the expense of accounting for unmanned AND manned support and access.
<p>TECHNOLOGY SOLUTION</p> <p>The Lattice Framework (Patent Pending) is a system of embedded powered rails, tracks, and cables central to construction of the internal and external points of a manned or unmanned vessel (UV) (ground vehicle, military ground vehicles, ship, aircraft, spaceship, etc) to which autonomous systems (robots) are attached to perform maintenance and other operations. The Lattice also contains electromagnetic grids for tracking and hull breach detection and a back-up system for operation when the vessel power is unavailable due to damage.</p>	<p>Notional Lattice UV</p> <ul style="list-style-type: none"> • Constructed with Lattice • Supported with Storage Hubs • Embedded Parts Bins • Robots/Robot Arms can be "off the shelf" • Scalable to larger vessels 

HUMANITY'S FIRST REACTIONLESS DRIVE

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A reactionless drive is a device that produces motion without the ejection of a propellant. Overall, a reactionless drive would be a major asset in contested logistics. It would allow for the rapid and unimpeded movement of supplies and personnel, and it would make it possible to operate in remote and hostile environments. This would make it easier to sustain military operations in a contested environment, and it would give military forces a major advantage over their adversaries.

A reactionless drive could solve the problems of contested logistics in a number of ways. First, it would allow for the rapid and unimpeded movement of supplies and personnel. This would be a major advantage in a contested environment, where enemy forces could easily disrupt traditional supply lines. Second, a reactionless drive would make it possible to operate in remote and hostile environments. This would allow for the delivery of supplies and personnel to areas that would otherwise be inaccessible. Finally, a reactionless drive would reduce the logistical footprint of military operations. This would make it easier to move forces

around and to sustain them in the field. A reactionless drive could be used for creating supply satellites which can be deorbited to anywhere on the surface whenever it is needed.

This would be a valuable asset for a number of reasons. A reactionless drive could improve tactical mobility and ground vehicles in a number of ways. First, it could allow vehicles to move much faster than is currently possible. This would give them a significant advantage in combat, as they would be able to outmaneuver their opponents. Second, a reactionless drive could allow vehicles to move over difficult terrain more easily. This would be especially useful in areas with rough terrain or obstacles, as it would allow vehicles to reach areas that are currently inaccessible. Third, a reactionless drive could allow vehicles to change direction more quickly. This would be useful in combat, as it would allow vehicles to avoid enemy fire and to take cover more easily.

PROBLEM STATEMENT

The reactionless drive could solve the problems of contested logistics in a number of ways. First, it would allow for the rapid and unimpeded movement of supplies and personnel. This would be a major advantage in a contested environment, where enemy forces could easily disrupt traditional supply lines. Second, a reactionless drive would make it possible to operate in remote and hostile environments. This would allow for the delivery of supplies and personnel to areas that would otherwise be inaccessible. Finally, a reactionless drive would reduce the logistical footprint of military operations. This would make it easier to move forces around and to sustain them in the field.

BENEFITS

- Rapid movement of supplies and personnel.
- Operation in remote and hostile environments.
- Reduced logistical footprint.
- Runs off electricity with about half the efficiency as a gas engine.
- Does not require friction.
- Can be added to existing platforms to add breaking efficiency and maneuvering efficiency without friction.
- A new technology which can provide logistical surprise.
- One (1) moving part

TECHNOLOGY SOLUTION

- Our current capability is a 2 kg thruster which makes 10 Newtons of reactionless thrust.
- Unlike other reactionless thrusters, these thrusters may be easily scaled up to provide larger thrusts for non-space applications.
- Simple basic revolutionary technology can be manufactured using the existing manufacturing base for power and transformer devices.
- Solution has a total of 4 major components and be rapidly adopted onto existing platforms.



PARKER QUICK FIT OIL CHANGE SYSTEM

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Maintaining military vehicles is critical to ensure maximum operating efficiency and long service life. Failing to perform maintenance can greatly reduce vehicle service life and can lead to failures. Military vehicles must be in service for decades and without proper oil changes the life of these vehicles will be reduced.

Working in cramped, hard to reach spaces with sharp edges and hot oil presents many safety concerns. During an oil change, there is the risk of spilling oil while removing and refilling, risk of exposing the engine to outside contaminants, and risk of not fully completing the oil change. These risks introduce hazards for servicemembers working around the maintenance shop by increasing the risk of burns, slips, trips, and falls.

Changing the oil on an armored ground vehicle can be a time consuming and difficult task which immobilizes the vehicle. To access the oil pan and drain the oil, heavy armored panels must be removed. After removing the armor and oil plug, the oil must be gravity drained adding as much as 20 minutes to the oil change process.

Upon completion, the armor must be reinstalled. The oil change process on a combat vehicle is time consuming and uses excess manpower.

Parker's quick change oil system benefits servicemembers by providing a faster and safer process through a simple three-step process that prevents oils spills and uses a single point connection for oil extraction and refill. The Quick Fit system utilizes a single connection point to purge, evacuate, and refill the oil for a complete oil change can be achieved in three easy steps: (1) purging the oil filter reduces oil in the filter before removal; (2) evacuating the oil from the pan to the waste containment via a suction pump; (3) refilling the engine through the filter. This also pre-pressurizes the system.

Parker Quick Fit increases safety and reduces maintenance time to perform oil changes on military assets by 50% so the assets deploy in theater more rapidly. The system is currently on test with GVSC and provides a critical solution for sustaining the Army's fleet and increasing safety.

PROBLEM STATEMENT

Properly maintaining military equipment is critical given the long life of the vehicles. However, with armor and other challenges added, performing maintenance oil changes are dangerous and burdensome to our military. Lack of oil changes can cause premature vehicle failure. Performing this maintenance in an austere environment can create safety issues for the maintainer, environmental spill concerns, and risk outside contaminants getting in the engine.

BENEFITS

- Decrease Maintenance time by up to 50%.
- Increase safety
- Minimize oil spills
- Reduce ergonomic risks for servicemembers
- Reduce servicemen exposure to oil
- Reduce risk of oil cross-contamination by consolidating multiple access points to a single point

TECHNOLOGY SOLUTION

The system uses a single connection point to purge, evacuate, and refill the oil for a complete oil change can be achieved in three easy steps: (1) purging the oil filter reduces oil in the filter before removal, minimizing oil spills; (2) evacuating the oil from the pan to the waste containment via a suction pump, reducing the evacuation time; (3) refilling the engine through the filter, reducing the risk of contamination entering the engine. This also pressurizes the system, reducing the need to idle the vehicle.



AUGMENTED & VIRTUAL REALITY END TO END REPAIR, TRAINING, & MAINTENANCE (AVEERT-M)

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Our military units may face multifaceted training, maintenance, and repair challenges depending on geography, equipment complexity, austere environments, and access to in-theatre maintenance contractors, requiring the DoD to keep up with technological advances to maintain superiority on the battlefield. Various technologies have offered piecemeal solutions, increasing system complexity, cost, and multiple systems to maintain.

Augmented and Virtual Reality End to End Repair, Training, and Maintenance (AVEERT-M) is an ARSOME-developed AR/VR/XR combined software solution to provide end-to-end support in maintenance training, maintenance operations and repair both in garrison and austere conditions.

AR/VR/XR reality can be used to create an end-to-end interactive environment where maintainers can train on every level of maintenance operations (including emergency operations) before accessing live equipment. AVEERT-M prevents unintended damage and provides training for operational equipment to be utilized in-theater, which

may be currently inaccessible. Holographic overlays using AR can provide detailed step-by-step maintenance and repair steps when overlaid over equipment. Supporting the maintenance of complex equipment or serving in support of junior maintenance personnel.

These systems can also be utilized in theater when contractors are unavailable or maintained by allied partners unfamiliar with the equipment. Geographically dispersed SME support can view maintenance operations in real-time to provide technical assistance as needed. Handheld scanners can be used by in-field assets to relay out-of-commission parts to repair depots or shipyards. In the event of unique pieces, dimensions of scanned items can be relayed to depot or shipyards for fabrication to reduce operational downtime. If combined with item unique identification (UID) and Decision Support Tool (DST), maintainers can quickly ascertain the availability of crucial parts for mission-critical repairs.

This capability is scalable across the DoD and can be used in various environments

and scenarios, from the recruit in boot camp who requires readiness training before their first duty station or schoolhouse to a reservist who needs re-training before falling in on equipment in a theater of operations, to maintainers who are in the field and require advance maintenance support in the absence of contractors, or allies who are provided US military hardware and also lack support from depot level maintenance or contractor support. The AVEERT-M combines prior disparate capabilities into one seamless end-to-end system.

Next Steps:

ARSOME Technology currently uses discrete pieces of this system in industry. The development of the all-encompassing AVEERT-M system is now in development. The immediate next step is to pilot with DoD hardware, IT integration, and SME support to align to individual unit/equipment requirements.

PROBLEM STATEMENT

Our military units may face multifaceted training, maintenance, & repair challenges depending on geography, equipment complexity, austere environments, & access to in-theatre maintenance contractors, requiring the DoD to keep up with technological advances to maintain superiority on the battlefield. Various technologies have offered piecemeal solutions, resulting in increased system complexity, cost, & multiple systems to support.

TECHNOLOGY SOLUTION

Augmented & Virtual reality End-to-End Repair, Training, & Maintenance (AVEERT-M) is an ARSOME software solution that combines several subsystems to support training, maintenance, & repair solutions that integrate pre-operations equipment maintenance training, holographic augmentation for step-by-step repair or maintenance directions, with live SME support, & ability to perform hand held scans of unique parts for fabrication by depot level maintenance facilities, shipyards, & / or CNC milling.

BENEFITS

Training & Simulation Solutions: Develop AR/VR training & simulation systems to identify components, conduct training, maintenance, & repair in low-risk, efficient, & cost-effective manner.

Maintenance & Repair: AR-based holographic capabilities allow maintainer(s) to overlay step-by-step maintenance & repair operations with field-deployed equipment. 3D field of view can be shared with off-site SMEs for real-time support.

Logistics & Supply Chain Management: Optimize logistics & supply chain operations, including AR-based inventory management systems, navigation tools, & digital content. Handheld scanners can take a 3D image of parts to share with depots & shipyards to reduce the time of fabrication, thus reducing operational downtime.



NAKAMIR AUGMENTED REALITY ASSISTANT (NARA)

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The US military has a very large number of assets that need to be maintained and cared for to be available for missions. However, the large variety of equipment requires a workforce with specialized maintenance skills and the necessary supplies. In the F-35 program alone, the backlog of parts requiring repair increased from 4,300 in 2019 to over 10,000 in 2023. This led to the F-35 fleet mission capable rate to just about 55 percent in March 2023, far below program goals.

We have created a solution, the Nakamir Augmented Reality Assistant (NARA) software to address the problem of workforce skill management. NARA records experts' video, audio, hands, heads, and gaze while they are interacting and maintaining complicated equipment. All recording is performed with sensors embedded in a hands-free AR headset that the expert can wear during the procedure. From these recordings, we then extract the relevant information to automatically create a virtual instructor that guides the worker step-by-step through the procedure. The virtual instructor is spatially attached to

the equipment, can point at, highlight, and explain important objects and the worker can view the instructor anytime anywhere they need them. In addition, workers can create virtual annotations and load 3D models to highlight areas and explain equipment in detail. Via an included depth camera, we can perform real-time 3D scans of equipment to create virtual 3D digital twins that can also be used for offline viewing and rehearsing of procedures.


NARA also allows the workers themselves to record their procedure, allowing them to easily document their interactions via voice and video recordings, providing a detailed list of performed maintenance procedures, how long the workers took for each procedure, or whether there were problems during a procedure.

The worker can automatically highlight objects and log their state via pictures for documentation of the procedure.

By processing the recorded audio data of the instructor and worker with AI, NARA can extract individual steps, compare which steps were performed by the instructor and

whether they were correctly followed by the worker and highlight steps where the AI could not detect agreement between instructor and worker action.

All data can be managed in a secure cloud environment where access can be restricted to specific users to limit authorized access.

<p>PROBLEM STATEMENT</p> <p>Predictive and corrective maintenance are crucial to ensure minimal downtime of equipment and avoid costly repairs and equipment loss. However, it is difficult to predict the most important maintenance scenarios. Maintenance procedures are furthermore difficult to perform and assess, requiring experienced maintenance workers that are familiar with the equipment.</p> <p>As one example, the F-35 fleet mission capable rate—the percentage of time the aircraft can perform one of its tasked missions—was about 55 percent in March 2023, far below program goals. Because of these difficulties, equipment often needs to be fixed by defense contractors instead of military engineers.</p>	<p>BENEFITS</p> <ul style="list-style-type: none"> <input type="checkbox"/> Decrease downtimes <input type="checkbox"/> Increase worker productivity <input type="checkbox"/> Decrease cost of documentation <input type="checkbox"/> Fastest existing instructional content creation using novel AR headset sensor-based approach <input type="checkbox"/> AI integration (computer vision, language models) to detect objects, document procedures and assess workers <input type="checkbox"/> Visualization of 3D instructions and IoT sensor data on AR headsets and annotated videos in smartphones and tablets <input type="checkbox"/> Versatile application that is agnostic to the equipment and can be used for a wide variety of applications <input type="checkbox"/> Simple integration with available Asset Management software like Maximo possible
<p>TECHNOLOGY SOLUTION</p> <p>The Nakamir Augmented Reality Assistant (NARA) is a software for AR headsets that allows experts to quickly create custom virtual instructions attached to the real world that can be viewed by maintenance workers anywhere anytime they need it. NARA allows visualization of virtual instructors, virtual annotations, 3D models, and IoT sensor data embedded into the real world. The worker can record the process to automatically document performed procedures. AI processing on the recordings can be used for automated assessment and summary of performed procedures.</p> <p>NARA has been tested for maintenance of machines in manufacturing, substations in the energy sector and facility management.</p>	

MAINTENANCE AUGMENTED REALITY SYSTEM (MARS)

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The Maintenance Augmented Reality System (MARS), designed and built by 3D Media, is the Rapid Sustainment Office's comprehensive, immersive work assistance tool. Designed to rapidly impart proficiency to maintainers for complex or infrequently performed tasks, MARS directly enables the creation of Multi-Capable Airmen, improving their capabilities for performing maintenance activities in an operational environment.

MARS consists of three components: BEAM API, Author Toolkit (ATK) web portal, and Manifest.


The BEAM API sends and receives API calls from various data sources. These interactions include procedural data extracted from Technical Orders and sent to the ATK. Additionally, BEAM API facilitates the synchronization of job completion percentage data between MARS and digital flightline management tools.

The ATK Web Portal serves as a management portal for authoring and verifying the accuracy of MARS modules. During the ATK authoring process, users can

attach amplifying content to individual steps within the extracted technical data such as photographs, instructional videos, 3D models, and more. Once authored, MARS modules are routed for approval to users such as QA team members or Program Office personnel.

The third component of MARS is Manifest. The BEAM API transmits approved amplifying content and associated module text from ATK to Manifest where it is ready to be assigned and used by maintainers. While being used to perform maintenance, MARS modules guide users through tasks via the amplifying content. MARS also provides users with the ability to record Faults or Evidence associated with the step they are working on when any issue is encountered simply by using the digital endpoint in their hands. This could include photos, videos, or text notes showing any issue that is encountered requiring either review by an expert maintainer or engineering support before proceeding. For issues that are too complex to be solved via evidence, MARS has the Connect feature for conducting remote tele-maintenance

sessions via immersive video streaming. Remote experts can guide users by creating digital holograms in the field of view of users, calling their attention issues or asset features. This also reduces the need for experts to be physically present to assist other maintainers. MARS is largely hardware agnostic, able to run on AR headsets, tablets, mobile devices, and laptops. Lastly, MARS is able to operate in a disconnected mode. Modules can be assigned and downloaded to an endpoint while connectivity is available, taken to point of need where connectivity is spare or nonexistent, and used for work assistance. Upon returning the endpoint to a connection zone, all data syncs and is logged automatically.

<p style="text-align: center;">PROBLEM STATEMENT</p> <ul style="list-style-type: none"> • Limited Subject Matter Expertise in the field, low-tenured workforce • Need for Multi-Capable Airmen, maximizing individual impact across operations • Limited assistance tools beyond flat, pdf type Tech Data/Orders 	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> • Decrease task accomplishment time, SME intervention, and mistakes • Increase speed from familiar to proficient and confidence • Maximize individual effectiveness with rarely performed or unfamiliar tasks
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • Augmented Reality offers intuitive interaction with user created content • Displays Tech Order work procedures and amplifying content such as pictures and videos, created by experts across the enterprise • Overlays real world referenced digital symbology in user's visual field – direction for less familiar systems and tasks • Tele-mx connects user at point of mx to SME (ex. 7 lvi, SPO EN) for assistance, troubleshooting, or fix validation • TRL 7; in T&E at Nellis, Charleston, and Wright-Patterson 	

MARITIME MAINTENANCE UNIVERSITY (MMU): ADVANCING COLLABORATION AND STANDARDIZATION IN COMPETENCY-BASED MAINTENANCE AND REPAIR TRAINING

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Problem Statement: The maritime maintenance industry faces challenges in achieving standardized competency-based training across various stakeholders, including the DoD, Department of the Navy (DoN), private industry, and academia. The lack of a unified training approach leads to inefficiencies, increased costs, and varying levels of expertise among maintenance personnel. There is a need for a centralized competency-based institution that fosters collaboration, standardization, and modernization of maritime maintenance and repair training.

Description of the Technology: MMU will serve as a centralized institution that brings together stakeholders from the DoD, DoN, private industry, and academia to establish standardized competency-based maintenance training programs. MMU will utilize a collaborative training approach, where military, government civilian, and private industry personnel train together in the same production shop and facility. This approach, inspired by a current US Navy maintenance and repair competency training program, promotes a culture of


affordability by reducing training time and focusing on the necessary competencies for achieving proficiency.

Current Development Status: The DoN competency training program is currently in effect and will be leveraged to include industry participation. The existing competency management system used by the DoN to monitor and record competency training can be expanded to support MMU and other competency-based programs across the DoD. A consortium of DoD, DoN, private industry, and academia stakeholders is ready and willing to move forward with the establishment of MMU. The next steps involve securing a primary DoD sponsor, further planning, and securing necessary resources to establish MMU as a shared resource for the DoD and industry.

Test/Simulation Data Supporting Performance Claims: Competency-based training has proven to be effective within the Navy, allowing individuals to gain valuable competencies in a matter of days rather than weeks of traditional instruction. The competency management system tracks and records individual competencies in real-time,

providing a readiness marker that aids in forecasting and scheduling maintenance and repair activities. This approach has shown promising results in increasing on-time completion of maintenance periods and improving overall readiness.

Next Steps/Potential Benefits: The establishment of the MMU consortium. Through collaboration and standardization, MMU will ensure that maintenance personnel across different stakeholders receive consistent and high-quality training. This will lead to improved competency, increased efficiency, and reduced costs in maintenance and repair operations. MMU will also serve as a sand box for sharing best practices, promoting innovation, and a test bed for addressing emerging challenges in maritime maintenance. Benefits include enhanced operational readiness, increased cost-effectiveness, and a more skilled /agile maintenance workforce.

<p>PROBLEM STATEMENT</p> <p>The maritime maintenance industry lacks standardized competency-based training, resulting in inefficiencies, increased costs, and varying levels of expertise among maintenance personnel. There is a need for a centralized institution that fosters collaboration, standardization, and modernization of maritime maintenance and repair training. With limited budgets, DoD and Industry cannot afford separate training programs with different competencies for the same equipment.</p>	<p>BENEFITS</p> <ol style="list-style-type: none"> 1. Increased Efficiency: Standardized training and collaboration lead to improved efficiency reducing equipment downtime. 2. Cost Reduction: Reduce multiple training development programs, shared training costs and promote a culture of affordability. 3. Improved Readiness: Ensures DoD and Industry maintenance personnel can execute. 5. Collaboration and Innovation: A sand box of innovation with real time DoD and Industry participation.
<p>TECHNOLOGY SOLUTION</p> <p>Maritime Maintenance University (MMU) is proposed as a centralized institution to manage and foster collaboration in maritime maintenance and repair training. MMU will establish standardized competency-based training programs that is shared with DoD and Industry. Military, government civilian, and private industry personnel will train / work together in the same production facility. DoD will provide real-world in-service equipment to MMU where we will create a rotatable pool of equipment for reinstallation.</p>	<p>We all need to Row Together</p> <p>Collaboration and standardization is necessary to sustain U.S. Maritime Dominance.</p> <ul style="list-style-type: none"> Private Industry, Shipyards and DoD must align competencies and training for the Maritime Maintenance workforce. 

VIRTUAL PAINT TRAINING SIMULATOR

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Government training resources have been extremely limited and unable to process approximately 360 WG-4102 painters within a 1-year time frame at Robins AFB. Under a Small Business Innovative Research (SBIR) contract, the Government developed a Virtual Reality Paint Trainer (VRPT) solution to provide these painters with basic skills to create airframe paint skill consistency across the board. This solution is currently available for all WG- 4102 AC painters within Robins AFB/WR-ALC, specifically in 402AMXG which has the largest group of WG-4102 painters. The solution will also be deployed at Hill AFB in Summer of 2023.


Prior to VRPT development, RAFB paint training occurred during one monthly class for 12 students, averaging 100 personnel a year trained on a very limited, antiquated system. With a 20% yearly turnover rate of 350 painters, to properly train personnel, the VRPT solution is needed train 8 students a week for 44 weeks a year.

The VRPT was developed in accordance with USAF Corrosion Prevention/Control and Coating Application/ Removal Technical Order requirements. It renders

realistic, full-sized C-5 Galaxy, Global Hawk, and F-16 aircraft, paint panels, paint carts, hangar, aircraft grounding points, air pressure sources/manifolds, manlifts, scaffolding, PPE, and fire extinguishers. The solution combines a uniquely designed core physics engine and COTS hardware to include a head mounted display, VR controllers with paint gun integration, and haptic feedback via air compressors to solidify learning of the specific techniques and muscle memory required to paint correctly. The VRPT displays real-time paint spray performance indicators and patterns/deficiencies and records for later assessment all user movement to include speed, proximity, trigger position, stroke duration, paint depth, angle of the paint gun, and active transfer efficiency.

During VRPT development, it was discovered that RAFB corrosion control for twenty-eight C-17s per year yielded paint-related issues (orange peel, runs/sagging, overspray, missing topcoat, etc.) for each aircraft, with rework costing nearly \$4.5M annually. These issues are specifically preventable via training with the VRPT.

This solution has been marketed to various agencies/installations to include Hill AFB and Naval Air Warfare Center Training Systems Division (NAWCTSD). There is promising traction for Phase III expansion to include de-paint training, F-15, C-17, and C-130 aircraft, small parts paint booth, and much more!

<p style="text-align: center;">PROBLEM STATEMENT</p> <p>The Air Force Maintenance Group's required a training program that would ensure consistently accurate and effective painting for the air platforms.</p> <p>The solution needed the following acute requirements:</p> <ul style="list-style-type: none"> • User-friendliness • Multiple users operating in the same environment • Render and simulate large and small aircraft • Accurately train painting and safety operations in DoD Tech Manuals and OSHA standards • Simulate and train on equipment/hardware currently utilized by the Air Force 	<p style="text-align: center;">BENEFITS</p> <ul style="list-style-type: none"> • The VRPT allows personnel to train in a safe, chemical and risk-free environment • Prevents material waste and ensures an effective baseline of skill that increases throughput of aircraft and parts. • Users are taught to DoD/OSHA standards • Supports learning retention of required tools, systems, techniques, and muscle-memory to paint correctly • Mitigate knowledge/skill loss due to the 20% yearly turnover of personnel • Consistently trains to DoD standards • Potential yearly savings of early \$5M in rework costs on C-17 alone. Saving across DoD would be \$50-70M/yr • Customizable/Scalable across all DoD
<p style="text-align: center;">TECHNOLOGY SOLUTION</p> <ul style="list-style-type: none"> • Realistic, full-scale simulation: C-5 Galaxy, Global Hawk, and F-16 aircraft, RAFB/HAFB Paint Hangars, Peripherals • Functional/Configurable paint guns, carts, support systems (stands, scaffolding, etc.) • Real-time paint spray performance indicators • Speed, proximity, trigger position, stroke duration, paint depth, angle of the paint gun, and active transfer efficiency • Paint deficiencies (wrinkling, sagging, etc.) • Individual and team-based training, with/without instructor • Learning Management System facilitates instruction of coursework and records all user activity and metrics to support grading and training improvements • Training Exercises, Tutorials • Utilizes COTS hardware/products 	



SUSTAINMENT

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE

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WASHINGTON, DC 20301-3500

MEMORANDUM FOR MAINTENANCE EXECUTIVE STEERING COMMITTEE JOINT GROUP ON DEPOT MAINTENANCE ORGANIC INDUSTRIAL BASE COMMANDERS

SUBJECT: 2023 Maintenance Innovation Challenge – Call for Submissions

I am pleased to announce the highly anticipated Maintenance Innovation Challenge (MIC) as part of the 2023 DoD Maintenance Symposium. Aligning with this year's Symposium theme "Cultivating Global Integrated Sustainment in a Contested Environment", innovative solutions are needed to improve and integrate sustainment operations in challenging operating conditions. The MIC provides an outstanding opportunity to identify, highlight and exploit promising innovations and technology within the sustainment community.

The MIC's objective is to elevate and expand sustainment innovation beyond new technology, to include value-added partnerships, resourcing strategies, business practices, processes, or any other transformative capabilities that make maintenance more agile, effective, and affordable. This annual competition raises awareness across our community to a myriad of new and promising technologies/innovative processes that potentially present the best opportunities to positively impact DoD sustainment.

From the field of submissions, six finalists will be selected, and the overall winner will be determined by a select group of senior DoD logisticians. The six finalists will present their new technologies, processes, or business practices to the symposium audience during a breakout session on Monday, December 18, 2023, at the 2023 DoD Maintenance Symposium in San Diego, CA. Continuing with tradition, attendees at the MIC breakout session will select the MIC People's Choice Award from the six finalists based on their live presentations. Winners will be announced and formally recognized during the Symposium's plenary on Tuesday, December 19, 2023. The six finalists will also be provided space to showcase their maintenance innovation on story boards in the co-located Defense Maintenance and Logistics Exhibition. Additionally, all qualifying abstracts and quad-chart submissions will be published in the annual MIC publication.

In an effort to recognize and uncover potential game changing innovations, I am challenging individuals and organizations to submit their innovative capabilities and forward-looking sustainment enablers for the 2023 MIC. As an added incentive, the National Center for Manufacturing Sciences (NCMS), has committed to support the demonstration of the winner's innovation and have offered to provide \$50,000 of in-kind support to both the MIC winner and the "People's Choice" winner. NCMS is referenced in this memorandum solely for informational purposes and does not serve as a DoD endorsement.

Please assist me in disseminating the call for Maintenance Innovation Challenge submissions and encouraging your communities to submit abstracts. The deadline for MIC submittals is Monday, October 6, 2023. Additional details are available at: www.sae.org/dod. My POC is Mr. Steve McKee, (571) 969-0662, stephen.e.mckee.civ@mail.mil.

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Vic S. Ramdass, Ph.D
Deputy Assistant Secretary of Defense
(Materiel Readiness)

