The following abstracts are the 6 finalists that were chosen to display on-site at DoD

Collective Mind

Early Warnings of Systematic Failures of Equipment

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Fleets of equipment are managed through carefully controlled supply chain processes. When any of the planning assumptions fail, for example due to a new mission, a batch of out-of-spec parts or an ill-conceived maintenance procedure, an unexpected demand on maintenance and supply can develop, leading to increases in operating costs and reductions of equipment availability. Isolation of early warning signals of the onset of such crises is critical to dealing with them proactively. Complexities of the underlying processes make it difficult for managers to recognize emerging patterns failures before they escalate. Often, only when availability is significantly affected, will attention be paid.

Systematic failures in man-made equipment appear analogous to outbreaks of disease spreading among humans. Introducing faulty spare parts to circulation resembles the effects of a new virus entering a community. Often, healthcare providers remain unaware of the system-wide nature of a problem until relatively late in its progression. Fortunately, data mining and machine learning technology has been demonstrated to reliably generate early warnings of the advent of human epidemics by observing the operation of the health care system over time.

This Great Idea presents evidence that similar approach brings value in alerting about unusual patterns when monitoring health of fleets of equipment. It involves new data-driven analytics to notify managers about emergence of one or more of a huge variety of possible problems substantially earlier than before, and to enable pragmatic prioritization of investigative efforts according to the statistical significance of the detections.

A team of Carnegie Mellon University, University of Massachusetts Amherst, the F-16 Weapon System Supply Chain Management (USAF AFMC 500 ACSS/CL) and the F-16 Engineering and Supply and Demand Planner Requirements office (USAF AFMC 416 SCMS) have developed and tested the concept in the F-16 aircraft fleet. Comprehensive statistical searches for fleet-wide patterns of escalated maintenance activity yielded 10-20% improvement in accuracy of monthly watch lists of potentially problematic components while mitigating the "we do not know what we do not know" challenge. Similar approaches help identify unexpected failure patterns in individual "bad actor" components and in individual aircraft. Early detection of emergence of systematic failures reveals avoidable replacements of parts. Resulting value of these avoided exchanges across the F-16 fleet is estimated at $18 million per annum.

To realize the "doing more without more" paradigm, Collective Mind software relies only on routinely collected data and integrates seamlessly into existing fleet management processes. The toolkit has a web interface and leverages smart data structures to execute fast massive scale searches for patterns in very large sets of multidimensional data, and to enable interactive visualization of results. Slicing-and-dicing and source data lookup functions further boost situation awareness and understanding of the processes that produce alerts.

Collective Mind transitioned smoothly to other fleets within the Air Force (setup for the USAF A-10 and T-38 fleets took less than one man-day each) and to the NAVAIR environment (incorporating the V-22 fleet required two man-months of effort).

FRITA: Fastener Removal Improvement Technology Adoption

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Abstract

Launched in July 2012, the Fastener Removal Improvement Technology Adoption (FRITA) project is a collaborative effort between Perfect Point Inc., NCMS, and several aircraft maintenance Depots across the DoD. The project introduces a new technology for the optimization of aircraft fastener removal procedures, and presents a plan to streamline the adoption of this technology into DoD Sustainment operations.

The current approach to aircraft fastener removal is extremely labor intensive and has traditionally resulted in high damage rates, requiring the use of standard twist drills to separate the fastener head and body. The commonly accepted side effects of the existing method include low productivity, structure damage, noise, repetitive motion and eye injuries, and the FOD hazard to equipment and personnel resulting from thousands of drill shards.

In 2009, a new technology known as the E-drill was developed by Perfect Point EDM (PPEDM) of Huntington Beach, CA to address and mitigate the disadvantages associated with fastener removal using conventional methods. A handheld implementation of EDM (Electro-Discharge Machining) technology, the E-drill uses spark erosion to cut a circular groove into the head of a fastener to a depth corresponding to the head thickness. After cutting, a thin fillet of material is left between the fastener head and shank; this fillet is easily fractured when the cut fastener is struck with a hammer and punch. The cutting process produces fine particulate debris that is flushed away and captured by a closed-loop fluid handling system, resulting in a fast clean cut whose only remnants are the fastener head and body. The effectiveness and cost savings attributable to E-drill implementation have been conservatively estimated at better than 50% reduction in labor cost and 75% reduction in damage rate and the costs associated with disposition and repair.

While a limited number of military locations have put the E-drill into service, the DoD has yet to realize the benefits of the system on an extensive scale. Currently, the engineering analysis and training development required for narrow local approvals have been largely inconsistent and have required redundant efforts. The objective of the FRITA project is to address these issues by coordinating the efforts of multiple locations to develop a common set of Engineering, Process and Training specifications pertaining to E-drill deployment that will be applicable across multiple facilities and Services within the DoD. In order to accomplish this, we propose to deploy an E-drill system at each of seven primary DoD Depot facilities: (3) US Navy Fleet Readiness Centers (FRCs), (3) US Air Force Air Logistics Centers (ALCs), and (1) US Army Depot. The intent is to create a collaborative environment in

which to share results and develop common specifications for expanded deployment of the technology across DoD. The anticipated project deliverables will also include a comprehensive cost-benefit analysis for each participating location, based on documented and quantified improvements observed during the course of the project.

IFDIS – Expanding Role within the DoD Maintenance Enterprise

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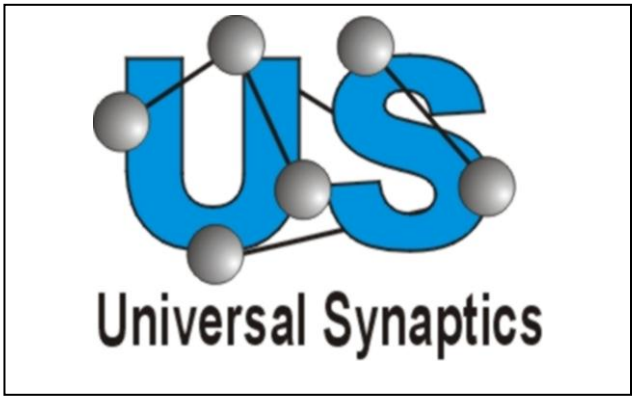

Abstract (300-500 Words Only)

There is a growing problem that continues to threaten the airworthiness, mission readiness, ownership cost and safety of aircraft. However, recent technical developments have made possible a new inspection method that greatly mitigates this threat, and now multiple case studies are validating the effectiveness of this new capability. The growing problem is intermittent faults in new and aging aircraft electronic boxes. The recent development is the Intermittent Fault Detection and Isolation System (IFDIS), and the case studies and expanding role within the Department of Defense maintenance enterprise that are validating the effectiveness of the IFDIS thus far involve the F-16, the F/A-18, and the EA-6B.

Maintenance personnel well know the challenge they face when the pilot reports that a system malfunctioned during flight, but the subsequent ground test of that system shows “No Fault Found” (NFF). It is apparent that there is an intermittent problem somewhere in the system, but the frustrated maintenance crew simply lacks the equipment needed to enable them to detect and isolate the problem. Repairing the intermittent circuit is seldom difficult; the difficult task is detecting and isolating which circuit within the box is intermittent. An intermittent fault, or momentary “open,” can be due to a number of different conditions including a cracked solder joint, a corroded contact, a sprung connector receptacle, a loose crimp connection, a hairline crack in a printed circuit trace, a loose wire wrap, a broken wire, or various other conditions. As the electronic boxes are pulled from the errant system for bench test, they often all test NFF. No repair is performed, because no problem can be detected.

Conventional test equipment is simply not designed to detect intermittent circuits. Rather, conventional equipment is designed to test the electronic box for nominal

operation, and it usually “averages out,” and hence hides, any short term anomalous events. The IFDIS is a tester that was specifically designed to detect and isolate intermittent circuits in aircraft electronic box chassis. Hence, the IFDIS very effectively compliments conventional testers. The conventional testers test for nominal equipment operation, while the IFDIS detects and isolates intermittent circuits. Because intermittent faults often only occur during the vibration and/or temperature extremes experienced in an operational environment, the IFDIS includes an environmental chamber and vibration platform that subjects the box to simulated operational conditions, substantially enhancing the probability an intermittent circuit will manifest itself.

At the heart of the IFDIS is state of the art intermittent fault detection circuitry which continuously and simultaneously monitors every single electrical path in the chassis under test, while the box is exposed to the simulated operational environment. The intermittent fault detection analog neural network circuitry will detect when an intermittent event, even as short as 50 nanoseconds (0.00000005 seconds), occurs in any chassis circuit, and it identifies in which circuit the intermittent event occurred.

One IFDIS project alone has produced over a $50 million dollar return (22 times ROI) while tripling the Mean Time Between Repair (MTBR). Previously undetectable problems are being rapidly identified and repair shop troubleshooting time is being substantially reduced. More importantly, the IFDIS is significantly enhancing aircraft reliability, aircraft availability, mission readiness and safety.

IMPROVING THE BENEFITS OF MAINTENANCE EFFECTIVENESS REVIEWS

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Abstract (300-500 Words Only)

A Maintenance Effectiveness Review (MER), in which maintenance programs are periodically reviewed for effectiveness, is a continuous improvement program that provides the opportunity to evaluate and enhance the use of Condition Based Maintenance. MERs are important because there is often a variance between the anticipated performance of a complex system and actual performance in an operational environment. Often tools used during the system design process to plan logistics and sustainment reflect the system "as designed" but do not provide the ability to update the characteristics of the system (FMECA, RCM analysis) using actual results from the field, compare them to expected performance and make adjustments to improve availability and/or reduce cost of operations.

The Maintenance Aware Design environment (MADe) provides the capability to continuously improve the supportability of new and legacy DoD platforms based on a consistent GUI based workflow that is based on the RCM and MER methodologies. The MADe toolset enables the rapid integration of parameters extracted from operational data and those from projected design changes into a system model that can be used to perform the analysis required for an effective MER. MADe provides the capability to identify potential improvements in the support profile for a platform based on identification of the key system degraders and analyze them using the MER workflow.

When used in conjunctions with an existing RCM program, MADe provides the design and maintenance support personnel with the following capabilities:

- **Using the system design, identify and isolate the critical functions of the system. This process can be based on the original RCM analysis and updated in response to changing requirements or functionality.**
- **Using maintenance and other records, collect the functional failures actually experienced during use of the system.**
- **Compare actual failure modes, effects and impact to those projected in the original RCM analysis.**
- **Determine if the appropriate sensors and data sources are in place to provide early detection and identification of a potential failure.**
- **Identify and model methods for early warning of the failure mode and for reducing the impact of the failure should it occur.**

- **Evaluate different alternatives with respect to functionality, cost and risk**

MADe is a model-based tool that provides the information required to perform an effective MER process including mapping actual performance to the current RCM analysis with the objective of ensuring that in place processes are optimized based on actual performance of the system. The tool provides the basis for an on-going MER process by ensuring consistency of the analysis process based on consistent nomenclatures and data definitions. It ensures that the goal of continuous improvement is achieved in an orderly but rigorous manner.

Abstract-Light Guide Systems by OPS Solutions

Companies that employ team members to perform manual processes face a number of challenges, such as:

- - Optimizing Return on Investment (ROI)
- Meeting stringent quality standards
- Increasing productivity
- Minimizing operational and capital costs
- Maximizing operational flexibility and scaleability to meet changing demand
- Training new and existing team members on manual processes involving increasing complexity and variation

Our company, OPS Solutions LLC, is based in Northville, MI. Light Guide System™ (LGS) is patented through both product and method claims under Patent #7,515,981 and is designed specifically to be an innovative work instruction solution for manual process problems in order to drive higher levels of quality, productivity, and training efficiency. The unique LGS value proposition solves these problems with a breakthrough system that projects Visual Display Features (VDF's) as work instructions directly onto a product and workstation thereby providing a replacement for hardcopy work instructions, distracting computer screens, or an employee's memory. Since these VDF's are paperless and wireless, employees remain focused on the task at hand as they are guided through complex manual processes by simply "following the lights" while discrete cycle times are measured to improve productivity.
The unique ability of LGS to project manual instructions and guide team member actions throughout critical manual processes can enhance productivity and dramatically reduce errors for both simple and complex manual processes. LGS accurately projects color coded and animated lighted work instructions in the form of text, symbols, graphics, blueprints, video as well as audio prompts anywhere on the work station surface and product.

By sequentially guiding the team member or trainee with easy-to-follow illuminated work instructions throughout their entire manual process, LGS can increase ROI by allowing companies to design increasing product variation into existing assembly lines and other assets, which today increases ROI but often decreases quality due to the increased complexity of manual processes. The ability to recognize and adapt to work cell product variations, and automatically record production times, results in increased efficiency and quality with both new and existing employees. Since LGS is sold as a kit involving an industrial strength projector, CPU, touch screen HMI and proprietary software, volumes can be scaled up very quickly to meet demand. LGS is a factory-tested package that can run 24/7 and provides the companies worldwide with innovative technology and an impressive new mistake-proofing solution. A list of common manufacturing applications is highlighted in the table below as well as a picture showing how the system is guiding an operator through both part selection and a critical torque sequence for an electric vehicle charge coupler assembly process.:

To date, customers have included world class manufacturers such as General Motors, Chrysler, John Deere, Case New Holland, and Detroit Diesel.

Miniature Vacuum for Fluid and Debris Removal

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Company Logo

Fluids and Debris Removal using a Miniature Vacuum coupled to a High Definition Remote Videoscope

Water entrapment due to water intrusion in airframes has long been a source for electrolytes in a corrosion cell on DoD weapon systems. Inaccessible areas of these airframes complexes the removal of these fluids and leads to corrosion attack until the weapon system can be dismantled for depot level maintenance. AACL has engineered and designed tooling that allows a maintenance technician to remotely access the once inaccessible areas of these airframes to remove corrosion causing fluid contaminants and debris.

AACL has employed the use of formable guide tubing coupled to a high resolution videoscope equipment to locate and remove liquids and debris. A small diameter insertion tube coupled to small diameter high resolution videoscope can be inserted and snaked through areas such as drain holes, structure lightening holes, and other access points to remotely navigate to entrapped liquids and/or debris. Upon locating the entrapped contaminants the miniature vacuum with collection vessel is pneumatically enabled to remove the liquid or small solid material debris mitigating the destructive potential of the contaminants. After performing extraction of the contaminants the fluids and debris can be analyzed to determine point of entry and/or origin of debris so the source can be eliminated. The miniature vacuum system coupled with the high definition videoscope has also been used on multiple occasions to perform removal of foreign objects that could have possibly been the source of potential damage or equipment failure. Through the use and employment of the miniature vacuum equipment the DoD has saved countless dollars in corrosion damage repair and in the replacement of primary and secondary structures.

The equipment and the techniques employed for liquid and debris removal have been repeatedly tested in-house and also used and validated in the field on active DoD weapon system airframes during aircraft

condition inspection inspections performed by AACL under contract from the U.S. Air Force Air Logistics Center in Ogden Utah. The remote miniature vacuuming equipment is an integral part of the AACL inspection technician's kit carried to each inspection site and used on every aircraft inspected when liquid contaminants or debris is detected. Adopting the Miniature Vacuum liquid and debris removal equipment and techniques for use DoD wide can prove to be endless savings.