TECHNOLOGY OVERVIEW

POTENTIAL FOR IMPACT

Problem Being Solved:
UAT is creating a sensor network for electrical wiring that is designed to reduce weight, improve safety, and simplify maintenance through the use of Augmented Reality and Artificial Intelligence. The aviation industry has focused on modernizing their fleets both in the military and commercial sectors. Aging aircraft wiring is a predominant problem for aviation. The issues illustrated in Figure 1, are the problems UAT has focused on solving by replacing the metal clamps used today for the Smart Interconnecting Clamp for aircraft wiring management.

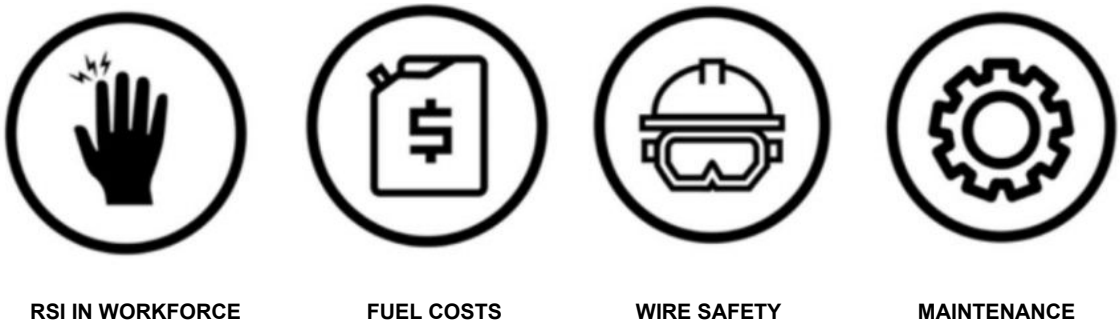

Figure 1. UAT has focused on solving today's most relevant problems in aircraft maintenance.

Problem Alignment:
The proposed solution aligns with the future of aircraft maintenance. A sensor network that can analyze, monitor, map warn and learn from the data gathered with this technology without the use of batteries.

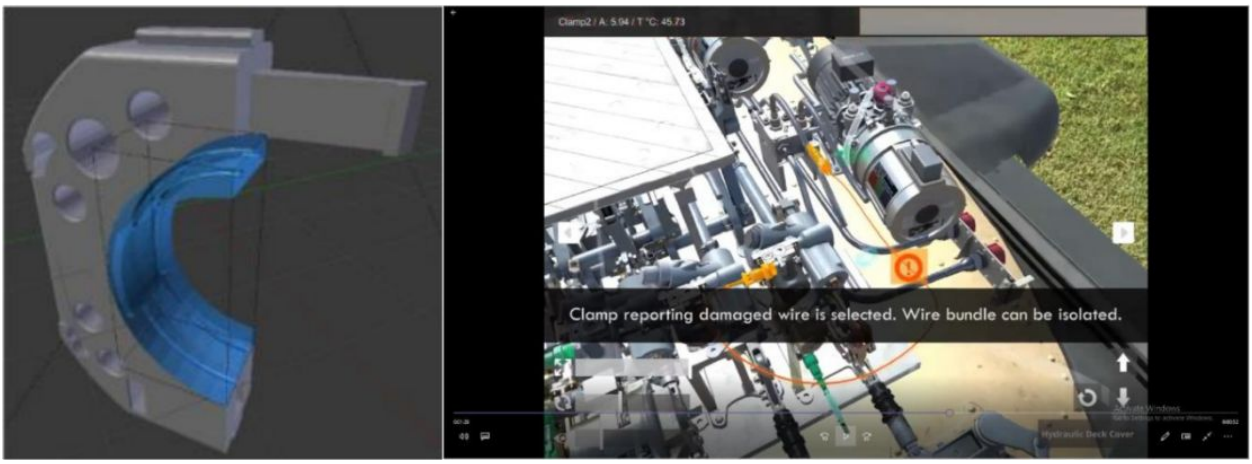

Figure 2. Smart Interconnecting Clamp with sensing technology (left). Smart Interconnecting Clamp Sensor Network for Isolating Faults (right).

This technology supports the network, hardware, and software modernization priorities for the US. military. For example, a smart wire harness clamping sensor can detect acoustic emissions generated from an external source or a malicious attack that may affect the density of a fiber optic core. Fiber cables are immune to electromagnetic interference. Nevertheless, when the acoustic emission signal acts on the fiber cable, it transmits in the form of sound pressure that can change the optical path length of the fiber, and thus the phase of light propagating in the fiber. In addition, the chemical bonds forming the optical fiber core can be disrupted by the impinging high energy resulting from radiation (directed-energy weapons) in the appearance of new electronic transition states giving rise to additional absorption in the wavelength regions. A Smart clamp with radiation sensing technology can detect ionizing radiation, such as deep ultraviolet, x-ray or gamma radiation in the wiring harnesses in real time without the need for disconnection.

Problem Magnitude:
Aircraft operating at speeds with vibrating aerodynamic forces in high temperature environments require visual inspections to verify aging and chafing of electrical wiring or contact with fuel lines, hydraulic lines and oxygen lines. It has been noted that on fuel systems, intermittent electrical faults have led technicians to find an Adel clamp cutting into an electrical harness causing unwanted fuel migrations, or low fuel pressure. In hydraulic lines, electrical wiring clamp bands (MS21919) have been found rubbing through hydraulic system lines resulting in a loss of hydraulic quantity. Visual inspection of these clamps is inefficient because mechanics need to remove all the clamps that are installed on an aircraft or vehicle. A large rotary craft may have up to 2,000 of these clamps and a commercial aircraft may have up to 15,000 of these clamps. The time required by mechanics to visually inspect every single clamp for chafing against the wires is tedious and extreme. UAT is aware of these problems and is currently developing a user-centered sensor network design integrated into an Augmented Reality Monitoring System for monitoring aircraft wiring integrity.

Solution's Uniqueness:
The proposed system is novel in that no electrical wiring clamp that combines 3D video and smart sensing monitoring technology exists for wiring maintenance and training. Successful execution of the proposed research will create a smart sensor network visualization system that promises to provide maintenance crews greater confidence, minimize complexity, shorten procedure times, reduce time loss, and help expand the utilization of Augmented Reality to beyond all electrical wiring maintenance. The anticipated benefits will apply equally to aircraft weight savings and reduction of Repetitive Strain Injuries (RSI) among the workforce.

Operational Impact:
The performance of electrical systems would be greatly enhanced by the availability of real-time on-board sensor data on amperage leaks, electromagnetic interference, radiation, sonar weapons, temperature, humidity, pressure, etc.

With the use of this novel technology, maintenance crews will be provided with an ability to isolate electrical wiring threats. Maintenance operations will be assisted by data collected from a variety of sensors which are part of the Smart Interconnecting Clamp sensing devices for wiring harnesses. Data from these devices is processed and interpreted locally over an ask-and-response portable system, Figure 3.

Figure 3. Sensor Network embedded in Smart Interconnecting clamps (SICC) creates the novel augmented reality visualization of the fault in the wiring system.

Impact Scale Potential:
UAT is targeting the aviation industry, specifically the military rotorcraft market as their point of entry expanding through Lockheed Martin and Boeing into commercial fixed wing aircraft, Figure 4. UAT was named an awardee of Sikorsky Innovations securing an agreement that leads into the testing of the technology and pilots.

Warfighter Demand:
The number of crashes involving American military aircraft, including fixed-wing fighters, bombers, cargo haulers, and rotary-wing attack and supply helicopters, is up 40 percent over a four-year period, according to a Military Times analysis of such incidents from 2013 to 2017. The development of this technology for the future of aircraft maintenance will deliver more reach, enable lighter weight, more payload, and protection for the US military's modernization efforts. Aircraft readiness and overall mission capability for the aging fleets is a priority. On a Chinook helicopter, this technology can save 200 lbs. UAT provides a solution to the struggle with aging aircraft by providing a system for the Army's air power to continue exerting dominance in the skies above battlefields worldwide.

Figure 4. Scale potential.

SCIENTIFIC AND ENGINEERING VIABILITY

Scientific Feasibility:
Although this technology is initially focused on rotary aircraft, this system could be used in fixed wing, spacecraft, ships and boats of all sizes, ground vehicles, etc. UAT is collaborating with BAE Systems, Lockheed Martin, Penn State and i3 Corps to engage in research, analysis, and manufacturing of the sensing network technology for the Smart Interconnecting Clamp. UAT has implemented the AR platform and is currently in the product development stage conducting Design for Manufacturing and Assembly (DFMA) activities. The system is powered by harvesting energy, for example, from the aircraft vibrations. This will increase preventive maintenance, reduce repair time, and minimize preventable injuries to maintainers. All the maintenance information would be gathered and stored every time a scan is done. This increases the knowledge database, allowing artificial intelligence and machine learning to build a more predictive maintenance process. The continued data collection of an entire program of recorded data would enable predictive failures, preventing unnecessary down time, and increasing equipment readiness.

Enabling Technologies:
UAT is in the process of conducting Finite Element Analysis through SimuTech (ANSYS) and will be creating injection molding samples for MIL-SPECS certification.

Alternative Technical Approaches:
Specific physical damage tends to be more difficult to find and repair on a single wire within a wiring bundle, and this damage tends to be more critical to repair due to the complexity of the electrical systems. Skilled technicians understand that the replacement of electrical wiring

clamps is not trivial. On December 29, 2000, for example, a Delta Airlines aircraft flight 219 (L1011) had an electrical fire due to electrical arcing of the windshield heat wire bundle. The cause of the electrical arcing was an Adel clamp damaging wires in and a 30-wire bundle. Twenty of the 30 wires were observed burned. The repair costs of the many systems these clamps support can be enormous. Figure 5 shows the advantage of the smart clamp over the competition on a Boeing 737 model.

Figure 5. Competitive advantage.

Tech Maturation Plan:
UAT is manufacturing the base model outsourcing to Sinicon Plastics in Dalton, MA and Plastek in Erie, PA. UAT has focused their efforts in having their products military specification certified. Currently, the company is more than halfway through the certification process. Thanks to UAT's impact and efforts in the aviation industry, the company has gained support and endorsement from Lockheed Martin, BAE Systems, I3 Corps, and Sikorsky. UAT is also establishing a CRADA with DEVCOM's Chemical Biological Center to develop a sensor for the smart clamp that is capable of detecting radiation where detecting and characterizing spectral activity is necessary to isolate a distortion in fiber optic cables.

Time to Fielded Solution:
UAT is expecting to finish with the timeline illustrated in Figure 6 by the spring of 2020. This will position the team to begin commercializing after the Sikorsky pilot program. Currently, UAT is focused on finalizing the engineering for manufacturing, so the product can be sent for final military specification testing.

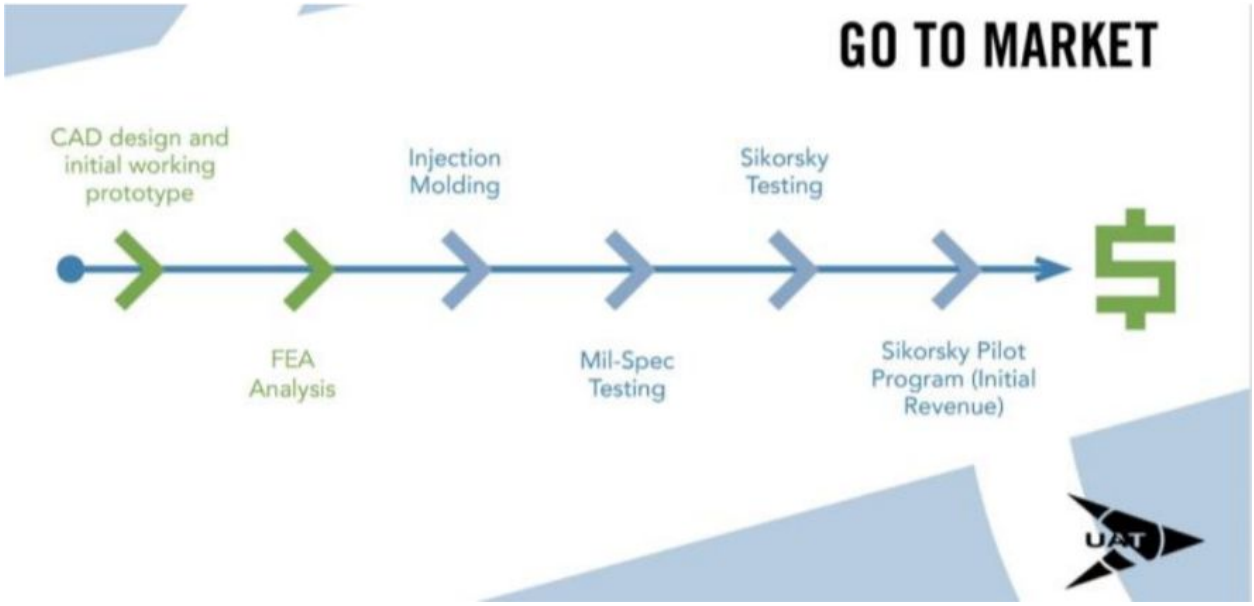

Figure 6. Timeline.

Dual Use:
UAT is commercializing AFRL dual use technology in the Smart Interconnecting Clamp sensor network that provides real-time data to an aircraft, vessel, or a vehicle's wiring system. UAT is supported by the Chairman of the SAE Wiring System Installation Subcommittee (AE-8A). Furthermore, UAT has gained the interest of EMBRAER (recently acquired by BOEING). UAT is currently in conversations to deliver the basic clamp to their fixed wing platforms as soon as it meets MIL-SPECS.

Future Civilian-Sourced R&D Funding:
UAT has raised $100K in equity funding and $90K in manufacturing grants. UAT has received an incentive package from the city of Pittsfield, MA, for $300K to support the development of this technology at their new Berkshire Manufacturing Innovation building. UAT is also the winner of $200K from IDEA-NY through an AFRL Commercialization Program.

Company Profile:
United Aircraft Technologies of Troy, NY is a veteran and minority owned small business that was established in 2017. UAT currently employs 5 people in its facilities in Troy, New York, and has two other employees in the Mohawk Region and Beaumont Texas.