Small Business Success Stories

Version 1
June 2016

Introduction

The F-35 Lightning II Program is pleased to highlight our successful small business partnerships, in coordination with our industrial partners Lockheed Martin and Pratt & Whitney. In particular, the Small Business Innovative Research (SBIR) program has been of significant value, saving and/or avoiding well over $500M in lifecycle costs and providing performance and sustainment enhancements.

As highlighted by the Department of Defense (DoD) in "Better Buying Power" and reinforced by the Departments of the Navy and Air Force, small businesses have significant value to add to the DoD Acquisition process. The F-35 program will continue to look for opportunities to include small businesses as valued partners in the F-35 enterprise. We thank the small businesses included in this report for their contributions to the F-35 Program.

CHRISTOPHER C. BOGDAN
Lieutenant General, USAF
Program Executive Officer

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Production

F-35 SBIR Transition

Affordable Accurate Robotic Guidance (AARG)

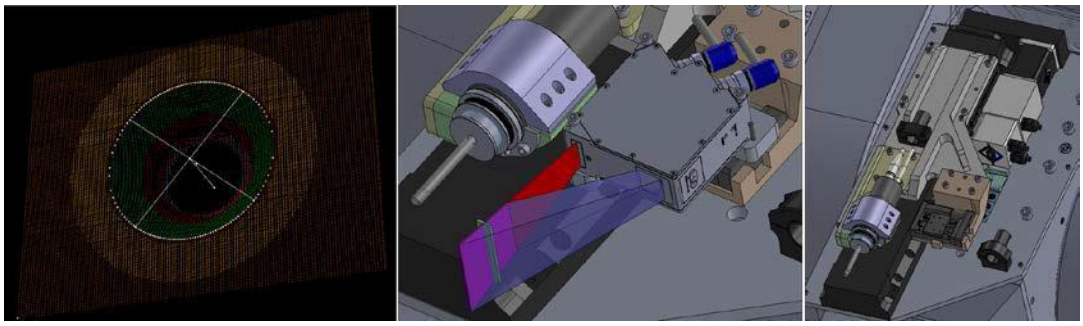
Title of SBIR/STTR Topic:
Affordable Accurate Robotic Guidance (TopicAF091C-001)

Company Name:
Variation Reduction Solutions, Inc. (VRSI)

Company Location:
Plymouth, Michigan

Company POC:
Deborah Lowis

JPO Associated IPT:
Production



COUNTERSINK SCAN ON RIGHT – FIVES BORE AND COUNTERSINK INSPECTION MODULE

SUCCESSFUL APPLICATION OF TECHNOLOGIES DEVELOPED FOR AARG

VSRI specifically addressed the anticipated floor space, ergonomic, and span time issues associated with manually drilling and inspecting the F-35 upper side Wing Overlap at the F-35 Production facility in Fort Worth, Texas. At the inception of the AARG topic, manual drilling and hand-gauging were the only acceptable processes. Lockheed Martin Aeronautics (LMA) ultimately included the automated countersink/bore/stack inspection developed by VRSI under the AARG contract into the FIVES commercial Wing Overlap auto drill statement of work (SOW).Three key system components were developed and demonstrated under the SBIR effort:

1. Drill end effector on-board enhanced measurement and inspection for countersink depth with integrated bore inspection for diameter and material stack thickness.
2. Guided X-Y micropositioning drill end effector spindle to wash out robot/system positional error before a hole is drilled.
3. A novel, closed-loop feedback laser beacon and target guidance system.

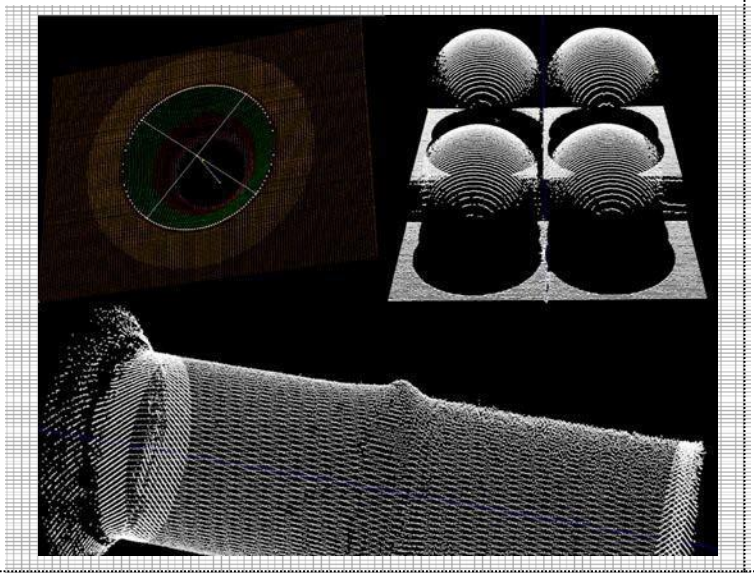
#1 has been integrated into several FIVES auto drills for F-35 assembly at Lockheed, Fort Worth; #2 has been integrated into a high-accuracy robotic hole transfer cell for Warner Robins- Air Logistics Center (ALC); #3 evolved into near real-time robot guidance using multiple commercial off the shelf (COTS) laser trackers working simultaneously.

F-35 Requirement:

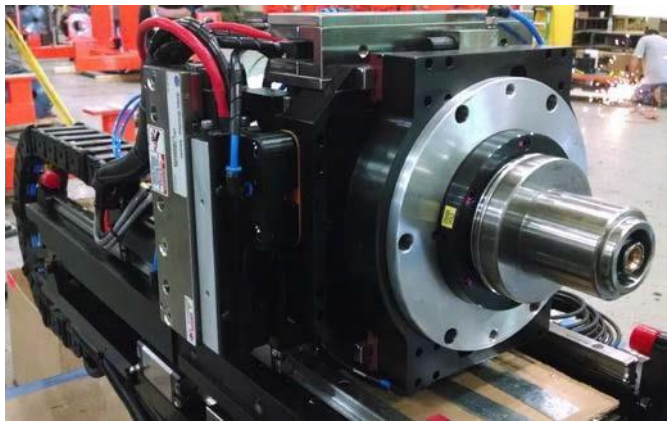
This project supported the Department of Defense's initiative to insert COTS articulated arm robot technology into aerospace manufacturing processes to realize the type of cost savings and efficiency increases demonstrated in industry, particularly in the automotive sector. The deployment of articulated arm robots guided by metrology devices in a closed-loop fashion in order to achieve precision tolerances was seen as one of the major milestones toward attaining this goal.

About the Technology:

Non-contact countersink measurement is superior to tactile Trulok gauges, as the vision algorithm measures the cone of the countersink to accurately provide the real countersink depth. The 2-D laser Scanner can automatically measure any type of countersink or tool ball array smaller than 1.0" diameter instead of using multiple Trulok gauges. The bore probe system enables automatic measurement of bore diameters, material stack thickness, grip length, exit burr, and liquid shim blow-out.



The X-Y micropositioners allow accurate closed-loop laser tracker measurement and correction of the cutter tip within 0.005" spherical radius or better of the commanded point before the hole is drilled. This is far more accurate than having the robot apply the corrective offsets.



LASER TRACKER GUIDED X-Y MICROPOSITIONING DRILL SPINDLE

F-35 Impact:

Robot end of arm inspection equipment supports 100% automatic inspection of all holes at the time of drilling as well as database archival for all hole and countersink data. Initial F-35 Affordability Team analyses had shown that the robotic cell would result in a cost savings of $122.9M to the F-35 Program over manual drilling.

Company Impact:

- Multiple bore and countersink inspection modules integrated into the FIVES auto drills purchased by LMA instead of the AARG robotic systems.
- Multiple X-Y micropositioning drills for high-accuracy robotic hole transfer at Warner Robins ALC.
- Commercial robot guidance systems each with (4) laser trackers working in unison to robotically assemble the Boeing 777.

Delivering the F-35 to the Warfighter

F-35 LIGHTNING II JOINT PROGRAM OFFICE

200 12TH Street South, Suite 600

Arlington, Virginia 22202

F-35 SBIR Transition Cryogenic Machining

Title of SBIR/STTR Topic:
Inserting Cryogenic Machining into the F-35 Supplier Base (Topic AF06-103)

Company Name:
Creare LLC

Company Location:
Hanover, New Hampshire

Company POC:
Dr. Jay C. Rozzi
Principal Engineer

JPO Associated IPT:
Production

The Cryogenic Machining System

Project Objective

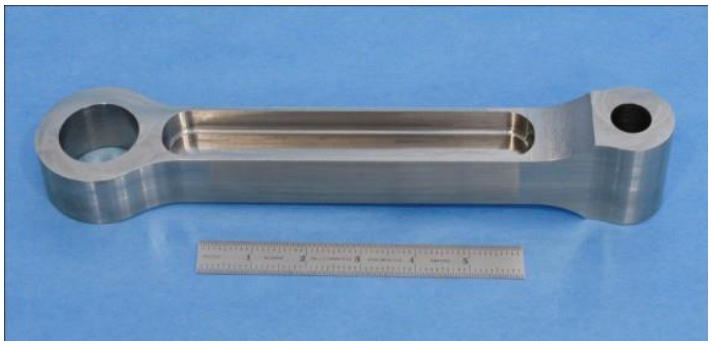
Titanium aerospace components are notoriously expensive and difficult to machine at high speeds, driving up per-part costs and limiting application of this material where it could be of substantial benefit to the warfighter. Creare's innovative Cryogenic Machining approach addresses this need by dramatically increasing processing speed and tool life, and eliminating lubricant capture and recycling systems. This program focused on achieving a direct cost/performance comparison between traditional and cryogenic machining for specific F-35 parts. A quantitative, direct comparison of this technology's value enables broader adoption across the supply chain by clearly establishing the business case for the technology. Such detailed cost savings data places Lockheed Martin (LM) in a more empowered position to negotiate agreements with F-35 titanium part suppliers and encourage more widespread use of the technology.

F-35 Requirement:

Titanium's relatively small specific heat and low thermal conductivity result in a significant temperature rise at the cutting edge. This fact, compounded with titanium's high strength, results in premature cutting tool failure and poor surface quality. At elevated temperatures, titanium also has a strong chemical reactivity with most cutting tool materials. For titanium, reducing the temperature at the cutting edge is the key element to increasing tool life and processing speed, with the concomitant decrease in processing cost.

About the Technology:

Creare's Cryogenic Machining approach directs cooling where it is needed most for the High Performance Machining (HPM) of titanium—the cutting edge. In doing so, our novel system substantially reduces the temperature of the tool, without unnecessarily cooling the titanium part being machined. The net result is a dramatic improvement in processing speed, which significantly decreases processing costs.



Representative F-35 Part Machined 2X Faster with Cryogenic Machining

We also anticipate that residual stresses within the machined part will be drastically reduced, improving its fatigue life. Our approach is intended to integrate with standard carbide or indexable milling cutters; hence, it can easily be integrated with current manufacturing operations.

F-35 Impact:

The target application for our innovation is the F-35 Lightning-II program. Between 5% and 10% of the weight of the entire vehicle is comprised of 400 titanium parts that could be impacted by our cryogenic machining technology. By conservative estimates, the broad application of cryogenic machining across the supplier base could result in approximately $267 million in cost savings for the program for machined titanium parts. LM has purchased a cryogenic machine for themselves, and test results show a 52% increase in cutting speeds.

Company Impact:

As a result of our work, MAG Industrial Automation Systems (MAG IAS) exclusively licensed our technology in late 2008. MAG IAS was recently sold to FIVES in 2013, a French conglomerate, and the cryogenic machining technology has become a primary focus of 5ME LLC, an independent company focused on machining technology solutions. Our innovation has been demonstrated at major machine tool shows, resulted in several US and International patents, and featured in articles in machining trade publications, such as Modern Machine Shop. In 2011, Lockheed Martin Aeronautics Company approved the cryogenic machining process, as developed by Creare, for the production of titanium parts for the F-35 aircraft.

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F-35 SBIR Transition

Fastener Insertion Live Link System

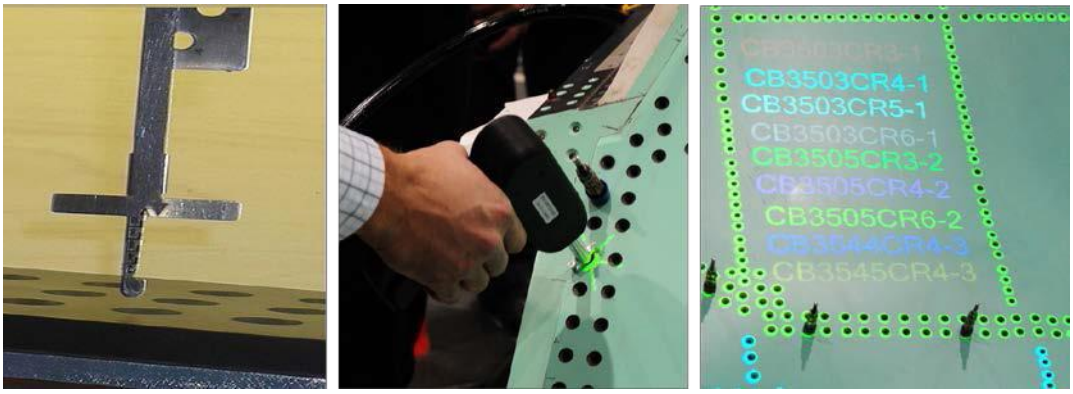
Title of SBIR/STTR Topic:
Terminally Guided Robots and Robotic Applications in Confined Spaces (TopicAF063C-011)

Company Name:
VariationReduction Solutions, Inc. (VRSI)

CompanyLocation:
Plymouth, Michigan

CompanyPOC:
Deborah Lowis

JPO Associated IPT:
Production



MANUAL HOOK GAUGE – WIRELESS GRIP GUN AND F-35 FASTENER LOCATION

SUCCESSFUL IMPLEMENTATION OF DETERMINING FASTENER GRIP LENGTH AND PROJECTING FASTENER LOCATIONS AND WORK INSTRUCTIONS DIRECTLY ON PRODUCT

Approximately 30,000 fasteners are installed on every F-35 Center Fuselage built on the Integrated Assembly Line (IAL) at Northrop Grumman (NG) in Palmdale, California. For each of those 30,000 fasteners, an operator manually measures the hole using a hook gauge to determine the grip length or, depth of hole and then writes that grip length on masking tape next to the corresponding hole. The grip lengths are then transposed onto a fastener list required to prepare the installation kit. The practice of making notes on the product using tape and sharpies is labor intensive, time consuming, highly susceptible to human measurement and transposition error, and a leading source of Foreign Object Debris (FOD) in the F-35 center fuselage assembly. The FILLS Team developed an improved process to prompt, measure, and collect grip lengths for electronic creation of the fastener Bill of Materials (BOM):

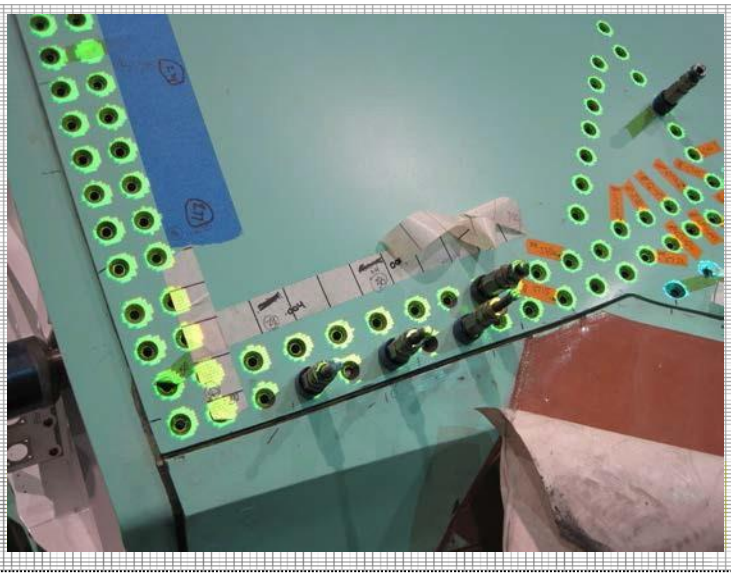
- Optical projector lights a particular hole to prompt the operator to gauge the grip length of that hole using a wireless grip gun – Repeat process for next hole
- Operator collects and prepares fasteners using list auto created by FILLS
- Optical projector lights each hole group with fastener call-outs directing the operator to place the correct prepared fastener into the correct hole
- Matured and demonstrated system to Manufacturing Readiness Level (MRL) 7 with cooperation of NGAS in Palmdale
- Automated process transitioned to numerous cost centers on the F-35 Center Fuselage IAL and two cost centers on the F-35 nacelle assembly at Lockheed-Martin (LM) Marietta

F-35 Requirement:

The initial process was manually intensive and inherently inaccurate as it sometimes used nominal engineering data for fastener lengths, not accounting for tolerance build-ups and manufacturing variances inherent in composite-to-aluminum assembly. Implementation of FILLS significantly increases the process accuracy, efficiency, and reduces the span times associated with fastener installation by eliminating non-value added tasks. All the information required by the operator is provided when it is needed at the point of use. FILLS technology ensures the correct fastener is installed in the correct hole, significantly reducing costly rework. The FOD risk has also been reduced by eliminating sticky notes, tape and sharpies.

About the Technology:

FILLS is an optical projection system implemented across numerous Lockheed Martin and Northrop Grumman work cells for the purpose of projecting work instructions on the surface of the product. The instructions have been optimized with procedures that sequence the work for maximum efficiency.



The use of a calibrated ergonomically designed wireless grip gage guided by the FILLS projections has cut in half the time it takes to manually acquire fastener grip lengths. FILLS uses the grip data to provide technicians with time-saving fastener kit lists. The measured results of FILLS implementation on F-35 nacelle assembly include reduced span times and assembly hours (hours per unit, HPU), and an increase in quality.

F-35 Impact:

Analyses by the F35 Affordability Team has shown that the FILLS system will save the program over $111M. These savings will only increase as additional applications are added, such as structural assembly, hole drilling, fastener grip length measurement, temporary assembling, surface coating, and mate surface sealing. The technician stays on task at the work station and follows easy-to-comprehend fastener installation instructions.

Company Impact:

The technology developed under this SBIR has been installed at a number of customer facilities. It has been used for:

- F-35 J345 Upper Skin and J330 Lower Skin Assembly
- F-35 center wing assemblies
- C-5 aft troop door and crown skins
- C-130 wing assembly
- P-3 wing assembly

This revolutionary technology has been proposed for: wire harness, plumbing, guidance for sealant or liquid shim application as well as paint masking, display of radar cross section data and many other exciting applications.

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200 12TH Street South, Suite 600

Arlington, Virginia 22202

F-35 SBIR Transition
Inlet Duct Robotic Drilling

Title of SBIR/STTR Topic:
Terminally Guided Robots and Robotic Applications in Confined Spaces (Topic AF063C-011)

Contract Number:
FA8650-07-C-5519

Company Name:
Variation Reduction Solutions, Inc. (VRSI)

Company Location:
Plymouth, Michigan

Company POC:
Deborah Lowis

JPO Associated IPT:
Production

F-35 INLET DUCT DRILLING – MANUAL (LEFT) AND AUTOMATED (RIGHT)

SUCCESSFUL IMPLEMENTATION OF ROBOTIC DRILLING IN CONFINED SPACES

At the onset of manufacturing the F-35 center fuselage at Northrop Grumman's Palmdale facility, it became apparent that the manual drilling process used to fasten the exterior aluminum frames by drilling from inside the ducts was not sustainable from an ergonomic, throughput and quality perspective. The F-35 Lightning II program required an affordable approach to the manufacture of precision, high volume fifth generation fighters. Achieving this goal demanded an innovative, automated approach to drilling and countersinking fastener locations never before deemed possible. To develop and implement this technology, the F-35 Joint Program Office, the Air Force Research Lab and Northrup Grumman Corporation utilized the first Critical AFRL ManTech SBIR funds to bring together a unique blend of talents.

The technology developed utilizes a laser coordinate measurement device to guide an articulated robot arm during the drill process. The net effect is that the equipment achieves positional accuracies of +/-0.006" without the need for a large mechanical system. Even more unique to this technology is that the process occurs inside the F-35 air inlet duct, which is barely large enough for one person to lie-down inside. Although this technology development program is specific to the F-35, the techniques and lessons learned are applicable to a variety of platforms. Future aircraft systems have ever shrinking and more contoured inlet ducts to achieve stringent performance requirements. This advance in manufacturing capability allows for higher production rates and precision processes inside the confined areas of aircraft inlet ducts and expands robotic applications to processes never before automated. Three robotic drilling cells have been installed in Palmdale and have been in operation since 2010.

F-35 Requirement:

The tight spatial constraints inside the F-35 Lightning II air inlet ducts, from inside which fastener holes are drilled outward into the surrounding external aluminum support frame members, precluded typical programmable drilling solutions and required NGC to undertake this process manually. The manual process was ergonomically challenging and three times too slow to make the span time required for F-35 Full-Rate Production (FRP). This project addressed the overwhelming through-put, ergonomic, cost and quality issues that the manual drilling process would have imposed.

About the Technology:

A standard, articulated arm robot employing a compact drill head and low-thrust cutter is guided by a laser tracker while inside an inlet duct, achieving process capability for hole position, bore diameter and countersink depth. A tool-changer allows the robot to utilize other end effectors, among which are a non-contact, triangulation-based, multi-line laser sensor used for product alignment and a capacitance-based probe used to measure bore diameters and fastener grip length. Robot simulation access studies for the entire F-35 air inlet duct shipset (left, right, aft) across all three F-35 variants validated the feasibility of the commercial drilling cells, shown to be capable of accessing 90% of the total hole count. Out of this effort came the design of a second production end effector to access the remaining 10% of holes and improved tool changer design. Particular emphasis was placed on a smooth transition from the prototype production SBIR cell to the commercial drilling cells.

F-35 Impact:

Analyses by the F-35 Affordability Team has shown that the robotic cell reduces span time from 50 hours to 12 hours per duct and will result in a Unit Recurring Flyaway (URF) cost savings of $7.8K per shipset. Cost avoidance, including recurring and non-recurring cost, to the JSF Program is in excess of $40M. It also has non-quantifiable benefits of improved worker ergonomic conditions that reduce medical expenses and improve the quality of the aircraft. Future benefits include the ability to achieve ever more stringent manufacturing tolerances which allow for lighter-weight, higher performance aircraft.

Company Impact:

The technology developed under this SBIR has been enhanced and adapted for use in other applications, most significantly at Boeing, where it is being used to guide the robotic rivet bucking and automated process on the 777 assembly – replacing a manual process that caused ergonomic, quality and throughput issues. As of Q4 2015, Boeing has built six production units utilizing this process. The impact to VRSI has been revolutionary – changing the way both military and commercial aircraft are built.

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F-35 SBIR Transition Surface Analyst

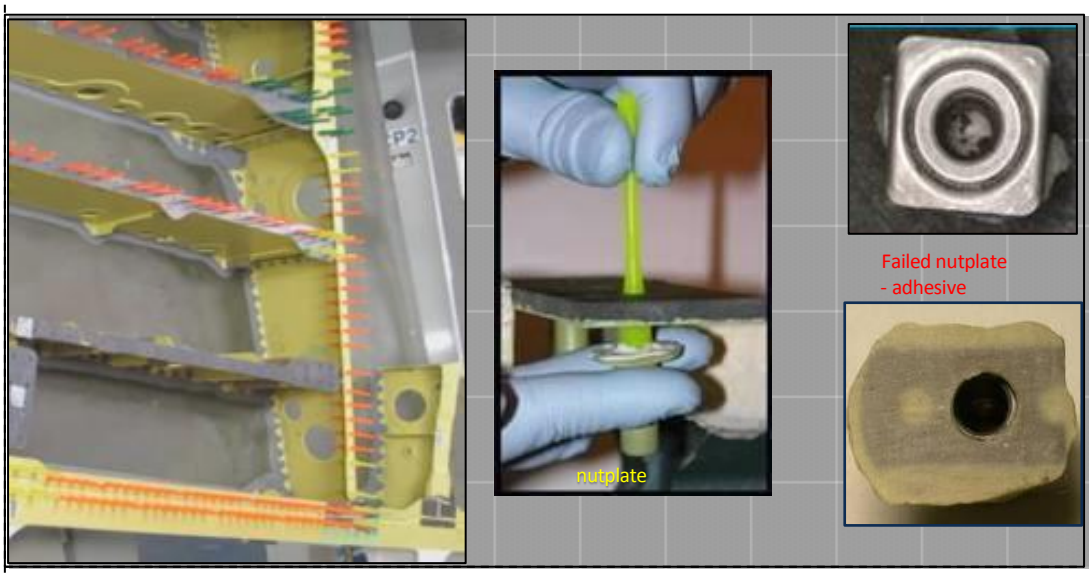
Title of SBIR/STTR Topic:
Handheld Surface Energy Probe for QA of Surface Preparation in F-35 Manufacturing, Maintenance and Repair (AF05-126)

Company Name:
Brighton Technology Group, Inc. (BTG)

Company Location:
Cincinnati, OH

Company POC:
Dr. Giles Gillingham

JPO Associated IPT:
Production



Over 30,000 nutplates per aircraft.

QUANTITATIVE METHOD FOR SURFACE CLEANLINESS INSPECTION REDUCES COST

Surface preparation and cleanliness prior to bonding adhesive nutplates is critical to ensuring proper bond strength and avoiding rework both in the factory and in the field. The baseline method of measuring how well the surface was prepared involved an artisan water-break test (that could only be used on near horizontal surfaces) accompanied by a non-ergonomic push-off test after bonding. These methods do not adequately capture poorly bonded nutplates, leading to costly rework. Brighton Technologies Group used a contact angle technique to provide a clear go/no go indication to the operator and developed it into a handheld device capable of measurement on near vertical surfaces and in confined spaces.

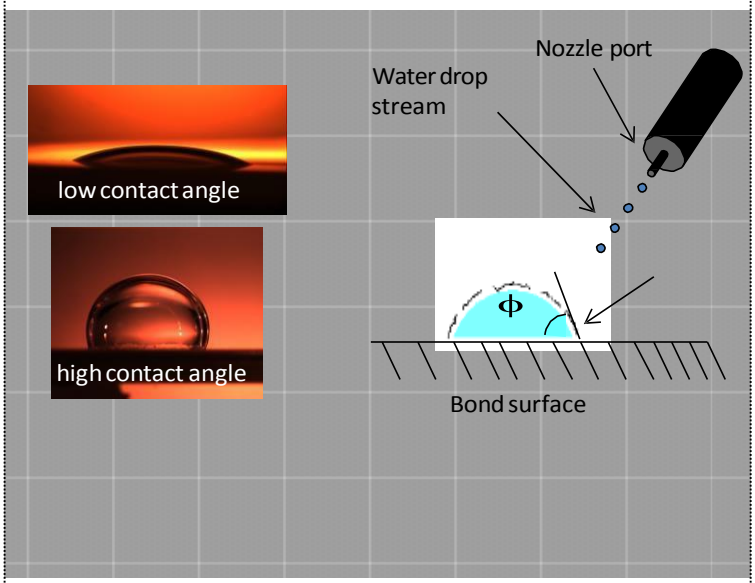
F-35 Requirement:

Current F-35 manufacturing processes require manual testing of over 30,000 nutplates on each plane to ensure they have been bonded correctly. Failure rates due to improper surface preparation are averaging around 1% or nearly 300 nutplates per aircraft. Each nutplate failure requires individual re-preparation and re-bonding with supervisory oversight. This results in lengthy and costly rework and potentially negatively impacts future F-35 production rates as well as field aircraft availability.

What is desired is a hand-held device which can quantitatively, quickly and easily determine whether a surface has been properly prepared for adhesive bonding.

About the Technology:

A finding from the DoD's Composites Affordability Initiative identified the lack of techniques for qualifying adhesive bonding procedures as interfering with the more widespread use of adhesives in aircraft manufacturing. A Phase I SBIR was initiated to develop a technique that would quantify a surface's "readiness" for bonding. This then led to a Phase II, a Phase II Enhancement, a AF Sustainment project, and then a RIF program to develop the technology specific to F-35 requirements (i.e. confined space access). The end result is a device from Brighton Technology Group (aka. the Surface Analyst) that ballistically deposits a small drop of water on the surface to be interrogated from which (knowing the volume of water and the size of the resultant drop) the "contact angle" that the water makes with this surface can be determined. This contact angle is a measure of how ready/receptive a surface is for bonding.



F-35 Impact:

Beginning in January of 2015 and continuing today, Lockheed Martin has incorporated BTG's Surface Analyst into the F-35 manufacturing line eliminating the need for manually testing every nutplate. This has reduced rework as well as reduced repetitive injury claims from employees. They have also incorporated the use of the SA into their general bonding specification. Lockheed Martin estimates this will save over 35 hours of manufacturing time per aircraft. Numerous subtier suppliers are considering using as well.

Company Impact:

The impact of F-35 SBIR support to the growth Brighton Technologies Group (BTG) is difficult to overestimate. The technology is rapidly propagating throughout a large range of non-aerospace manufacturing industries. 70% of 2015 sales of the SA were to non-aerospace industries, primarily in automotive and electronics. Recent sales into medical device and architectural glass manufacturers indicate the existence of other high value markets for this SBIR-supported technology. This high sales growth outside of the F-35 program is occurring at a rate that has brought in outside investment and allowed us to grow almost 5X since the program inception, from three employees at the start of F-35 SBIR support to our current level of 13. In no small part based on this success, BTG has recently received NSF SBIR support to further extend this technology from hand held instrumentation to automated, multi sensor modules suitable for inline process control of surface treatment in high volume manufacturing lines.

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Environment, Safety and Occupational Health (ESOH)

F-35 SBIR Transition

Hearing Protection

Title of SBIR/STTR Topic:
A Personal Active Communication System for Use in Extreme Environments (Topics N01-162, N02-151, N04-255, N05-095, N08-153)

Company Name:
Aegisound, LLC

Company Location:
Christiansburg, Virginia

Company POC:
Mike Vaudrey

JPO Associated IPT:
Systems Engineering Integration Team – Environmental, Safety and Occupational Health

Aegisound provides safe and reliable hearing protection and communications in the most demanding continuous noise environments

F-35 Maintainer Hearing Protection and Communication Systems

Beginning in 2001 the U.S. Navy established a strong commitment to addressing the problem of ever-increasing hearing loss disabilities due to excessive noise exposure. US Navy flight deck maintainers are exposed to some of the loudest occupational noise environments in the world, and the hearing protection and communications systems were insufficient to prevent long term hearing loss, or to provide clear communications in loud noise environments. A series of dedicated SBIR programs resulted in the development, and ultimate transition, of a number of advanced noise reduction and signal processing technologies that are now part of products that Aegisound delivers to the Air Force, Navy, and Marine Corps, to Lockheed Martin, and to a variety of industrial customers who work in high noise environments.

The F-35 Program played an integral role in sponsoring the SBIR programs and supporting the development and transition of SBIR developed technologies and products to provide better protection to the warfighter. While the most advanced technological solution is now being delivered to the F-35 program, many other derivative products are also available and provide dramatically improved protection for Department of Defense (DoD) maintainers working in extreme noise environments. The long term benefit of improved hearing protection is expected to reduce the number of veterans with hearing loss disability, improving their quality of life.

F-35 Requirement:

Maintainers routinely must work next to the aircraft during launch and recovery operations and are exposed to noise levels that far exceed any allowable safe exposure without protection. With hearing loss being one of the top military disabilities, improved, high performance, hearing protection and communication systems for maintainers were needed to protect their hearing and improve mission effectiveness.

About the Technology:

The technologies developed through a series of successful SBIR and transition programs from 2001 through 2012 include in-ear digital active noise reduction (DANR) and a digital noise canceling (DNC) microphone. The in-ear DANR technology delivers broadband active noise reduction performance under a custom molded earplug, which is also under a circumaural headset. This unique configuration provides three layers of hearing protection, meeting the high performance requirements established by the F-35 program to most effectively protect the maintainers. Equally important to mission success is achieving a high level of speech understanding while communicating in noise. The DNC microphone technology was also developed and tested through many SBIR and supporting transition programs. The communication microphone selectively delivers a clear speech signal over the communication network and permits high levels of speech understanding even in noise fields exceeding 130 dB(A).

F-35 Impact:

The hearing protection products developed and transitioned by Aegisound for the F-35 provide the highest level of hearing protection currently available. By simultaneously providing hearing protection and clear speech in noise environments exceeding 130 dB(A), mission effectiveness is dramatically improved. The ultimate benefit of this technology is to help ensure that hearing loss due to occupational noise exposure can be reduced, providing a better long-term quality of life for our veterans.

Company Impact:

Transition of these technologies has positioned Aegisound to be a recognized leader in providing hearing protection and communication solutions for many extreme noise environments. Aegisound also provides similar products to the US Navy for flight deck maintainers exposed to extreme noise environments.

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Arlington, Virginia 22202

Mission Systems

F-35 SBIR Transition MT-Saver Film

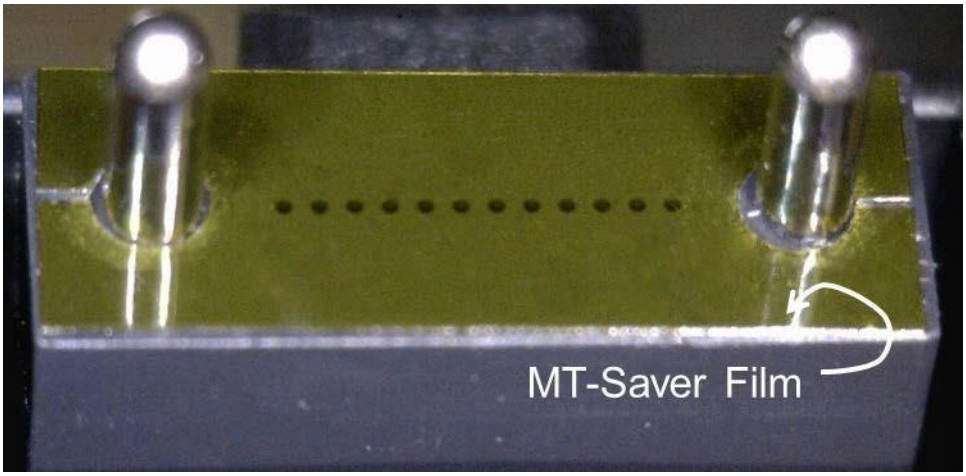
Title of SBIR/STTR Topic:
Alignment Tolerant Components for Robust Optic Signal Distribution (Topic AF093-003)

Company Name:
Ultra Communications, Inc.

Company Location:
Vista CA, USA

Company POC:
Charlie Kuznia

JPO Associated IPT:
Mission Systems



Protective film applied to MT ferrule

Film Protector for Multi-Fiber Connectors

Advanced weapons systems on military-aerospace platforms are relying on multi-fiber connectors for backplane integration into high speed networks. Inter-connections are achieved by precision alignment of module and backplane assemblies, which bring arrays of fiber termini into physical contact with each other, also known as 'blind-mating'. Fiber termini require high quality polish and clean end-faces to achieve efficient coupling. This interface is extremely sensitive to damage or contamination, both during the backplane harness assembly and during operation. Technology created by this program protects and creates a more robust interface.

The MT Saver for Mechanical Transition (MT) modules has been shipped to multiple subcontractors that provide line replaceable modules for the F-35. Through the use of this packaging and interface integration product the program has experiencing an increase in manufacturing yield and a reduction in end-face wear and tear.

F-35 Requirement:

Fiber failures typically occur in three areas: at the board-level (pigtails routed across the daughter card), self-contamination of the fibers at the MT-to-MT daughter card/backplane interface, and at the backplane (the fiber harness has loops to MT-style connectors). Methodically we focused to address failure-points by eliminating challenges of physical contact (PC) connectors (such a MT-ferrule based) at the board and backplane interfaces. The PC connector has known issues of self-contamination due to micro-scale particles becoming embedded in the fiber-to-fiber interface due to chafing.

About the Technology:

The film is applied to the MT components on the F-35 fiber backplane assembly (FBA) or line replaceable modules (LRM) during the manufacturing process. It can also be applied immediately after polishing and testing of the MT on the FBA/LRM. This ensures the FBA/LRM is then being tested with the film applied to the MT and remains on the interface throughout manufacturing.

The product allows for testing (with a slightly higher, ~0.1 dB, overall insertion loss) and can be cleaned without falling off. This approach targets issues of contamination, damage, and inconsistent MT inspection results, occurring at the sub-contractor during FBA/LRM manufacturing.

The film seals the air gaps between the fiber ends within the connector, providing many benefits: reduced loss (due to Fresnel reflections), sealing the interface from contamination, maintaining the mechanical integrity of the termini to termini interfaces and connection during shock and vibrational events.

F-35 Impact:

The immediate impact preservation of the fiber optic during the life of the LRM, which in turn reduces cost associated with producing, maintain and repairing F-35 Air Vehicle. Fiber optic networks are difficult to maintain, inspect, and fix if damaged. Therefore, this product has already shown to have saved the F-35 significant time and money. Further positive impact is expected to be extremely beneficial if the MT-Saver is qualified for use in flight. The MT-Saver would reduce damage to the fiber and seal the optical interface.

Company Impact:

As a financial impact, the MT Saver is generating a monthly source of funding from sales into the module manufacturing lines. Beyond financial, the transition success has been elemental in building relationships with contractors in the F-35 supply chain and enhanced other business opportunities.

Delivering the F-35 to the Warfighter

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Sustainment

F-35 SBIR Transition Improvements to LCOM

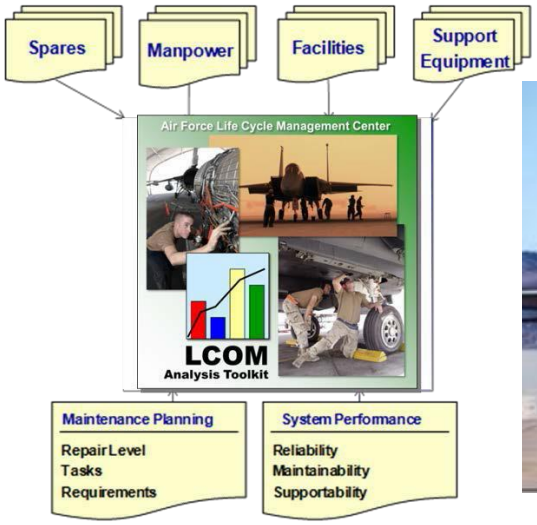
Title of SBIR/STTR Topic:
Decision Support Technologies for Weapon System Logistics Investment Decisions (Topic AF06-106)

Company Name:
Frontier Technology, Inc.

Company Location:
Goleta CA, USA

Company POC:
Joel Luna

JPO Associated IPT:
Sustainment
Modeling and Simulation



LCOM ATK provides KPP metrics for F-35 Supportability based on R&M and flight data

Automating Model Input Processing Delivers Better Analyses More Quickly

The F-35 Lightning II Joint Program Office has relied upon the Logistics Composite Model Analysis Toolkit (LCOM ATK) to provide support to planned analyses that verify Key Performance Parameter (KPP) requirements as well as conduct ad hoc analyses. As the F-35 has been transitioning into an operational environment, it has become more urgent to have the capability to robustly analyze all variants of the F-35 aircraft with the most current data possible. Incorporating new data into the F-35 LCOM ATK model inputs has become a cumbersome and manually intensive effort. The need to incorporate changing data sources required new technology to develop model inputs for the LCOM ATK models and a flexible and adaptable model building capability to model real world operational conditions and constraints. In this effort, FTI significantly enhanced LCOM ATK front- end capabilities in data preparation by developing the Logistics Data Processing Suite (LDPS) and Model Builder (MB). FTI showed how data from diverse data sources such as LM Aero's ATLAS database as well as Failure Reporting And Corrective Action System (FRACAS) could be used to produce updated F-35 LCOM ATK model input files in a fraction of the time it would have taken otherwise. Additionally, FTI was able to produce audit forms through automation that resulted in savings of hundreds of analyst hours. By reducing the time and effort to support analyses with modeling, these capabilities will help the F-35 JPO to make better decisions more quickly.

F-35 Requirement:

Incorporating new data into F-35 LCOM ATK model inputs has become a cumbersome and manually intensive effort. The need to incorporate changing data sources required new technology to develop model inputs for the LCOM ATK models as well as a flexible and adaptable model building capability to model real world operational conditions and constraints. The F-35 JPO depends on LCOM ATK for determining KPPs and evaluating impacts of reliability, operability, usability, sustainability, and maintainability.

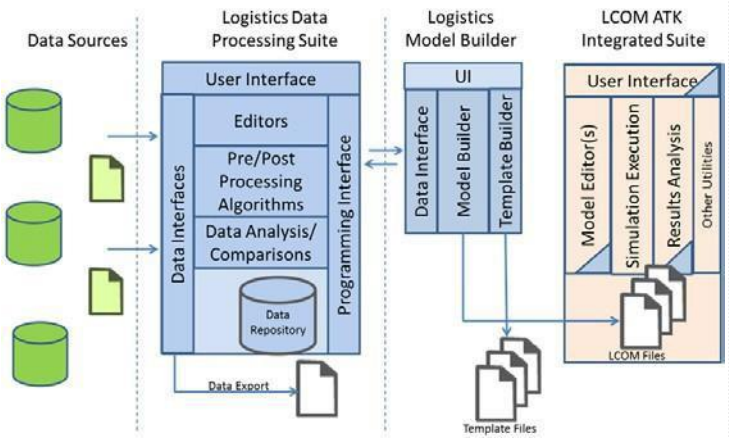
About the Technology:

The specific objectives for this technology were to:

- Develop a software tool to automate, to the maximum extent practicable, the data preparation process to produce JSF model inputs for LCOM ATK
- Provide capabilities for analysis of the data being prepared for model inputs
- Incorporate ATLAS and FRACAS data
- To the extent practicable, provide flexible model building capabilities in the data preprocessing

FTI developed two applications to bridge the gap between data and LCOM ATK models, as shown below.

New Automation Aids Accelerate Data Updates into LCOM ATK to Better Assess KPPs for Informed Decisions



The two applications are:

- Logistics Data Processing Suite (LDPS). LDPS is based on a general workflow manager concept, where the user links transformation blocks to perform data transformation from input sources to output data. The transformation blocks are individual, reusable units of capability that perform both generic actions (such as selection, filtering, merging) and specific actions (such as reading or writing to specialized formats, such as spreadsheets). The user provides the information needed to tailor the actions, such as providing criteria for filtering transformations. The workflows can be saved and reused, which essentially results in self-documenting processes that facilitate VV&A.
- Model Builder (MB). The Model Builder is based on the concept of reusable templates, where the user builds models much like a set of tinker toys, where the specific input patterns are matched with data tables processed by LDPS, and linked together to form a complete LCOM ATK model input file.

F-35 Impact:

The F-35 JPO, LM Aero, and support contractors now have technologies to efficiently and effectively build new F-35 LCOM ATK models to meet the challenge of changing data sources and real world conditions and constraints. The LDPS and Model Builder applications are already under consideration by the Joint Operational Test Team for validation of test requirements because of its ability to self-document workflows that implement data processes and merge FRACAS, engineering, and other sources of data. In addition, in a follow-on SBIR funded effort, these technologies were used to produce audit forms for field validation of R&M and resource data, saving hundreds of analyst hours.

Company Impact:

The LDPS and Model Builder technologies are excellent additions to the family of FTI tools to provide robust support of all aspects of lifecycle management.

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"Airmen, Sailors and Marines armed with confidence because we develop, deliver, and sustain the F-35 affordably, with proven capability and reliability so they succeed in every mission and return safely home"- Leadership Team Mission & Vision

For more information please contact
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