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UNITED STATES AIR FORCE
Highlights

Air Force Research Laboratory • Materials & Manufacturing Directorate

Joint Air-to-Surface Standoff Missile Composite Body Program Reports Saving$ in the Million$

By Gary Cunningham

WRIGHT-PATTERSON AFB, Ohio – A manufacturing process improvement for the composite body of the Joint Air-to-Surface Standoff Missile (JASSM), will save more than $19 million over the production life of the missile according to representatives of the Manufacturing Technology (ManTech) Division of the Air Force Research Laboratory's Materials and Manufacturing Directorate here.

Most of the surface area and load bearing structure of each JASSM is manufactured using a braided composite process to place fibers in their proper orientation and shape. The majority of these parts are then molded using the Vacuum-assisted Resin Transfer Molding, or VaRTM, process.

A costly, hands-on, trimming procedure was required after the VaRTM process, however. This led to ManTech approving a plan for Lockheed-Martin, in conjunction with FII, to develop the JASSM Composite Missile Body R^2PI Program. By eliminating the post-VaRTM trimming steps, R^2PI would succeed in reducing the manufacturing risk to cost and schedule goals for JASSM by improving the manufacturing process. Cost and schedule goals are associated with reducing manufacturing hours, cycle time, scrap and rework. This was accomplished through R^2PI by developing net-shaped preforms for fuselage components, and improving the net edge molding

JASSM takes flight following its launch from an F-16. (U.S. Air Force Photo)

The ManTech-led cooperative effort, officially called the JASSM Composite Body Rapid Response Process Improvement (R^2PI) program, included representatives of Lockheed Martin Corporation and Fiber Innovations, Inc. (FII).

JASSM is a joint Air Force-Navy program developed and produced by Lockheed-Martin Integrated Systems. It employs stealth to penetrate enemy air defenses at ranges of more than 200 miles, and can be launched off most types of aircraft in the Air Force inventory. JASSM is designed to destroy high-value, well-defended, fixed and moving targets.

of the upper and lower composite fuselage by improving the inner mold line dimensional control and optimizing the resin infusion through automated temperature and pressure controls.

Results of the ManTech-led R^2PI program exceeded expectations. The huge cost savings of $19 million over the life of the JASSM production helped bring the program in below its objective cost of $400,000 each (FY95 dollars). Making the JASSM more affordable led to high praise from Department of Defense and Air Force leadership.

According to an Air Force News Release, Undersecretary of Defense Pete Aldridge gave the JASSM program the go ahead for low rate initial production on Dec. 21, 2001, which prompted Secretary of the Air Force, Dr. James G. Roche, to state, "JASSM is a flagship program for acquisition excellence. Not only do our combat forces get an unprecedented precision attack capability, but they get it at an affordable price never before achieved on a cruise missile program."

The Air Force plans to make the decision for full rate production in late 2003.

For more information on this and other ManTech programs, call the Technology Information Center at (937) 255-4689. For JASSM, refer to **ASC-02-0090.**

Data Mining Breakthrough Benefits Aging Air Force Aircraft Fleet

Increasing requirements placed on the Air Force's aging aircraft fleet in recent years created a search for innovative technologies that could reduce escalating costs and improve the fleet's sustainability.

A group led by the Manufacturing Technology (ManTech) Division of the Air Force Research Laboratory Materials and Manufacturing Directorate, have made a quantum leap in meeting some of those goals. Together with researchers at InfoScribe Technologies, Ltd. (ISTL), and Veridian Engineering, they've developed the first integrated data management system for the Eddy Current Inspection System (ECIS). ECIS is a state of the art inspection station for many of the Air Force's gas turbine engine disks, headquartered at Tinker AFB, Okla.

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Within the current fleet, sustainment of gas turbine engines cost the Department of Defense $2.2 billion in fiscal year 2000, according to information released by the Government Accounting Office. This represented 63 percent of the Air Force's gas turbine propulsion budget.

When implemented Air Force-wide, the crucial new data mined will improve safety thresholds, support initiatives to reduce disk replacement costs by 50 percent and increase depot throughput while reducing the overhaul cost per component. This invaluable information will give aircraft engine maintenance officials the ability to save millions of dollars in parts acquisition through enhanced management of turbine engine disk life cycles.

Turbine engine disks were traditionally replaced upon reaching a predetermined number of operating hours. The disks are made of exotic alloys that push their price tag from $25,000 apiece upwards of several hundreds of thousands of dollars each. There has been a perception for a long time that with the gathering of more accurate measurements, processing the measurements intelligently, adding more precision to the calculation of engine disk life cycles

would substantially increase the current life limitations and increase overall safety.

Manufacturing processes improved the quality and durability of aircraft parts like engine disks, but the retirement timeframe did not change because the computer technology of the day wasn't available to provide sufficient analysis of the disk's condition that would warrant continued operation. It was believed that many disks had one or more cycles remaining beyond their established timeframe.

The Retirement For Cause (RFC) program was implemented to focus on finding ways to improve inspection methods, locate flaws or cracks in components, thus reducing the cost to maintain the readiness of the air fleet. Early inspections, using hand-held probes, collected information to confirm that a large number of disks were being retired prematurely, but not enough to change the policy of life cycle retirement.

In the mid-1980s, Veridian Engineering led a consortium that married state-of-the-art nondestructive inspection with fracture mechanics modeling to develop an automated method of detecting cracks or flaws in F-100 and F-110 engine parts. Their efforts produced the ECIS Station.

The station is a large manipulator consisting of an electronic arm atop a large granite block to give it stability. An engine disk is placed on a turntable that rotates as needed. The manipulator arm, holding a probe, maneuvers over, around and through the various surfaces of a disk being inspected, collecting an assortment of status readings. Different geometric features on a disk require different probes. So, one type of probe is used to inspect bolt-holes, for example, while another probe is used to inspect turbine blade slots.

The accuracy and throughput provided by the ECIS proved to be a huge step forward. It provided Air Force maintenance officials with a clearer "go/no go" status of each disk inspected. Since the RFC program was initiated, and the first of what is now 26 ECIS Stations went into

Below: Next generation single-bay Eddy Current Inspection Station (photo courtesy of Veridian)

Data Mining Breakthrough Benefits Aging Air Force Aircraft Fleet

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Editor's Note: Submissions for the ManTech Highlights Winter Calendar of Events, that will cover January through April of 2003, should be e-mailed to: Gary.Cunningham@wpafb.af.mil no later than Nov 15, 2002.

operation at Tinker AFB, Okla., more than $850 million in cost avoidance has been realized.

Technology was still a barrier, however, in reaping the full benefits of the ECIS. Computer hard drives of the day were extremely limited in storage capacity. They were only capable of storing a single disk's inspection analysis until a final report was generated. The stored data then had to be deleted from the hard drive to make room for the analysis from the next inspected disk. Purchasing additional hard drives was simply cost prohibitive at the time.

ISTL, in 1995-96, developed a data collection software application under a Small Business Innovative Research (SBIR) project for a different government program. This application was capable of collecting and organizing hundreds of unique parameters simultaneously. Engineers from ManTech's Materials Process Design Branch saw the potential of adapting ISTL's application for the ECIS Station. ManTech succeeded in having the companies join forces under a SBIR enhancement.

ISTL modified their software to enable communication with an ECIS, and vice versa. ECIS control software was modified to pull data out at relevant points in time during an engine disk inspection, and send it to the ISTL computer. The Veridian-built interface has allowed ISTL to archive the data in their system, which is predicted to reach a storage capacity of one terabyte (1,000 gigabytes) per year.

Working together, ISTL and Veridian installed the prototype system, using one of the stations at Tinker AFB, to collect and manage the inspection data. In a five-month period the prototype collected more than five gigabytes of data. An updated version was installed, mining more than twice the amount of the first in a similar five-month time frame. This wealth of raw data paints an operational status picture of the surface of each disk inspected. With the memory storage problem solved, the usage measurements of each disk can be charted for comparison during subsequent inspections.

The future for this program promises even greater benefits.

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Representatives from ISTL and Veridian, along with ManTech, are working on a data mining application to reuse and reanalyze previously archived data to perform "simulated re-inspections" on engine disks. The rationale is simple. Inspections are repeated by recalling archived data from InfoScribe. By interactively modifying the standard inspection parameters, disks can be inspected to smaller crack detection limits. If flaw indications are found, then all similar parts can be reinspected without recalling engines from service, providing a powerful tool for fleet managers to assess risk.

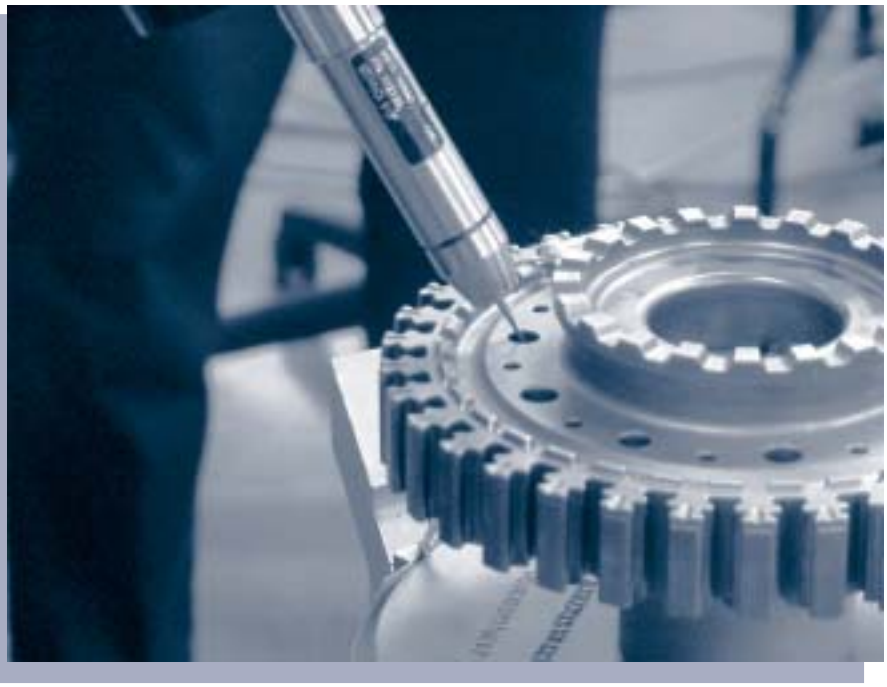
This capability will tell engine life management personnel if there is a widespread problem, or just a one-time occurrence. This can mean the difference between grounding the entire fleet or not.

The underlying area this research will assist in is the determination of what is causing engine disk flaws to grow, how many and how fast. By combining the information collected on the ECIS with maintenance and flight data it will be possible to correlate the operational conditions to flaw growth. This correlation is critical in determining the readiness of the fleet and maintenance cycles required based on flight profile information.

This data can also be used to see if any other trends were present that might have led to a part failing. For instance, was this part located in a very cold, humid climate, and recently transferred to a very dry, hot climate?

Quantum leap forward in improving flight safety, millions of dollars saved annually in parts acquisition, increased fleet readiness and the capability to expand the system's use to benefit other Air Force assets.

For more information on ECIS, call the Technology Information Center at 1-937-255-4689 or email techinfo@wpafb.af.mil.



Eddy Current Inspection Station probe collects readings from an engine disk (photo courtesy of Veridian)

Successful Redesign of F-22 Turbine Engine Exhaust Casing May Reap Similar Durability, Affordability Benefits for Other Weapon Systems

WRIGHT-PATTERSON AFB, Ohio – A redesign of the F-22 Raptor's turbine engine exhaust case (TEC) on the F119 engine has been so successful the program is being considered for use with other Air Force aircraft. The TEC on a jet engine is located just aft of the turbines, and directs the exhaust of the turbine in a particular flow pattern out the rear of the engine.

A priority of any ManTech program is the constant search for potential cost-saving measures within the manufacturing process. In this case, TEC vanes were an area believed to be one that improvements could be made with a fairly high degree of confidence in success. Original built up sheet metal components historically comprise a lot of the cost in the engine due to the need for laser cutting and drilling, welding, brazing, assembly and more. This has always made the TEC a labor-intensive section of each engine.

The Reproducible F119 TEC Castings Program was conducted under a contract between the Manufacturing Technology (ManTech) Division of the Air Force Research Laboratory's Materials and Manufacturing Directorate, and Pratt & Whitney (P&W). This program directly supports an alternate manufacturing approach for the F119 TEC making extensive use of thin wall casting technology in the Initial Service Release design.

Development and incorporation of thin wall castings, in place of the existing, complex, multi-walled and diffusion-bonded sheet metal assemblies, offer advantages. They eliminate many sub-assembly details and manufacturing processes by designing simplified cast details that serve the same function as the previously used sheet metal sub-assemblies.

The cast TEC consists of four vane panels, box assemblies, inner diameter and outer diameter panels that are assembled into a vane section. A total of 16 vane airfoil segments are assembled around a ring-strut-ring configured frame to complete each TEC. The nickel based alloy used to create the cast TEC is an Equiaxed alloy (the grains of the alloy are roughly the same size, and go in all directions) that offers higher temperature capability over Waspalloy used in sheet metal construction.

Results of the Reproducible F119 TEC Castings Program not only provided a significant reduction in cost (ManTech predicts at least a 35 percent savings), but also improved the engine's durability, while maintaining weight parity with the former sheet metal design.

From the Warfighter's perspective, this success translates to an aircraft's downtime for maintenance being far less than before, resulting in an increased mission ready status.

For more information on this and other ManTech programs, call the Technology Information Center at (937) 255-4689, and reference Technology Information Center item number 01-184.

ManTech's partnership with Pratt & Whitney to redesign the turbine engine exhaust case of the F119 engine has made the F-22 Raptor both more affordable and durable!

Near Right: A turbine engine exhaust case from an F119 engine. Far Right: Turbine engine exhaust case vane panels. (Photo courtesy ManTech)

(U.S. Air Force Photo)

End of Contract Forecast

September 2002	Web-Based Collaborative Warfighter Cost	Frontier Technology Beavercreek, Ohio	F33615-00-C-5903
November 2002	Lean Value Chain For Critical Part Procurement	Knowledge Based Systems, Inc. College Station, Texas	F33615-98-C-5168
November 2002	Advanced Resin System For RTM/VARTM Processing	Shade, Inc. Lincoln, Nebraska	F33615-00-C-5301
November 2002	Advanced Casting Technology For Low Cost Composites	Waukesha Foundry Waukesha, Wisconsin	F33615-99-C-5300
December 2002	Enterprise Synchronous Manufacturing and Investments (ESMI)	Boeing Company Canoga Park, California	F33615-99-2-5100
December 2002	Forging Supplier Initiative	Pratt & Whitney West Palm Beach, Florida	F33615-99-2-5303
December 2002	Affordable Manufacturing of Advanced LO Coatings	General Atomics San Diego, California	F33615-98-C-5165
January 2002	Lightweight Titanium Heat Exchangers	Materials Resources Int'l	F33615-02-M-5323
January 2002	Supply Chain Operational Excellence (SCOPE)	Aerojet-General Corporation Sacramento, California	F33615-00-2-5901

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