

# F-35 Inlet Duct Robotic Drilling (IDRD)

## PROBLEM/OBJECTIVE

F-35 aircraft inlet ducts must be manually drilled from the inside in order to attach frames around the duct. This process is ergonomically difficult and requires excessive tooling, labor costs, and long cycle time (approximately 50 hours of drilling per duct).

Even though robotic drilling cells have been used in the past, fifth generation fighter aircraft, such as the F-35, required higher positional hole drilling accuracy. Also, drilling these inlet ducts from the inside-to-out demands an innovative robot guidance architecture that differs from traditional robot or computer numerical control drilling applications.

## ACCOMPLISHMENTS/PAYOFF

**Process Improvement:** The Air Force Manufacturing Technology Division awarded a Phase II Critical SBIR (Small Business Innovative Research) program contract to Variation Reduction Solutions, Inc. and multiple team members, to design, build, and demonstrate a production prototype IDRD cell.

The program has shown that >90 percent of the holes in the forward and aft ducts can be drilled robotically. Successful demonstrations have allowed the supplier(s) to ramp the design from development and demonstration cell level to Integrated Assembly Line production level architecture.

**Implementation and Technology Transfer:** To date, the program has matured the technology to Manufacturing Readiness Level 9. Three production inlet duct robotic drilling cells have been purchased and installed at the Northrop Grumman production line in Palmdale CA by the robotic integrator, Comau, Inc.

Precision closed loop laser metrology developed as a key enabling technology for this program can be used for robotic positioning applicable to other military and industry applications. As a direct result of the IDRD program, Air Force ManTech and the F-35 Joint Program Office have initiated a Phase III SBIR spinoff entitled Affordable Accurate Robot Guidance. This will provide articulated arm robotic drilling cells for cost effective drilling of the F-35 center fuselage wing mate point, assembled at the Lockheed Martin Fort Worth facility.



## **Expected Benefits and Warfighter Impact:**

The automated cells will enhance manufacturing process repeatability and product quality related to the F-35 inlet ducts. The new IDRD cells, installed and operational in 2011, will meet full-rate production capability for the F-35 by 2014. The production rate of one aircraft per day will result in a 75% reduction in drilling cycle time (from 50 to 12 hours per duct), resulting in savings in excess of \$40M for the F-35 program.

## TIMELINE/MILESTONE

Start Date	September 2007
End Date	March 2010

## FUNDING

SBIR ManTech	\$4,600K
JSF JPO	\$1,000K
NAVAIR	\$1,000K

## PARTICIPANTS

AFRL ManTech, WPAFB OH  
Northrop Grumman Corporation, Palmdale CA  
Variation Reduction Solutions, Inc., Plymouth MI  
Comau, Inc., Southfield MI