Preparing for Flight

FDM CUTS TIME TO PROTOTYPE JET ENGINE FROM 1 YEAR TO 6 WEEKS

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– Dr. U. Chandrasekhar, GTRE

CASE STUDY

The Tejas is a lightweight, multi-role jet fighter. Its engine was developed with the assistance of FDM technology.

The Gas Turbine Research Establishment (GTRE) in Bangalore, India is a government laboratory charged with developing gas turbine engines for military use. GTRE's flagship product, the Kaveri jet engine, was commissioned for use in the Hindustan Aeronautics Limited (HAL) Tejas aircraft, a multi-role light fighter designed to operate in a variety of demanding environments.

Real Challenge

One of the greatest challenges in designing the Kaveri engine was optimizing the location of the subsystems in order to minimize pipe length. The initial layout was created in a CAD software program, but this alone couldn't effectively represent the complex system to all of the project's stakeholders.

"The virtual environment cannot represent the design to the level that was needed to meet our requirements," says Dr. U. Chandrasekhar, GTRE Group Director. "The computer comes close, but close isn't good enough when you are about to make a decision to invest tens of millions of dollars to bring a new product to market."

Building an engineering prototype is easier said than done however.

The Kaveri engine project required the creation of approximately 2,500 engine components. Previously, GTRE would have probably built the prototype using CNC machined parts, but this would have taken at least year and cost $60,000 to complete.

GTRE began to investigate the benefits of additive manufacturing. While sterolithography had definite benefits over CNC machining, it was not well-suited for the Kaveri project because it required numerous supports to create components like turbine blades, combustor swirlers, inlet guide vanes and combustors. What's more, it blocked GTRE's ability to conduct flow tests of the lines because stereolithography could only produce solid pipes. In the end, GTRE settled on FDM technology.

Real Solution

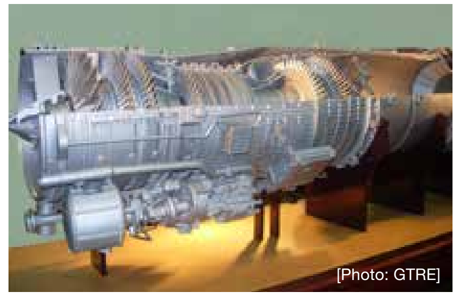
"FDM technology provided the ideal solution because the supports and interior of hollow components can be easily dissolved in a water-based solution," says Dr. Chandrasekhar. "It allowed us to create the geometry we needed. FDM was also much faster (than traditional means) because it is possible to combine several parts into assemblies, which can then be produced in a single run."

Dr. Chandrasekhar also appreciated FDM's ability to utilize actual engineering thermoplastics like ABS, so that the resulting parts would have the strength and durability needed to withstand the numerous tests required for design validation.

Real Benefits

With over 2,500 FDM components, the Kaveri jet engine prototype may well be the most complex rapid-prototype ever created, but it took GTRE only 40 days and $20,000 to produce from print to final assembly — a savings of 83% and 66% respectively.

"With FDM we created an engineering prototype that perfectly reflected our design intent and facilitated the complex engine's development," says Dr. Chandrasekhar. "It enabled engineers to identify and resolve problems that would have been easy to miss with only the computer model."


[Photo: GTRE]

The Kaveri engine prototype had 2,500 FDM parts.


[Photo: A.D.A.]

The Kaveri engine on display at Aero India 2007.


[Photo: Ksquarekumar]

The Kaveri engine prototype on a test-bed.

How Did FDM Compare to Traditional Prototyping Methods for GTRE?

METHOD	COST	PRODUCTION TIME
CNC	$60,000	12 Months
FDM	$20,000	2 months
Savings	$40,000 (66%)	10 Months (83%)

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