MASTER OF SCIENCE
IN
AERONAUTICAL ENGINEERING

DESIGN OF A LIFT FAN ENGINE FOR A HEAVY LIFT AIRCRAFT

James E. Goebel-Commander, United States Navy
B.S., University of Notre Dame, 1988
Master of Science in Aeronautical Engineering-December 2003
Advisor: Raymond P. Shreeve, Department of Mechanical and Astronautical Engineering
Second Reader: E. Roberts Wood, Department of Mechanical and Astronautical Engineering

Recent conflicts have highlighted the difficulties in using aircraft to supply troops in modern warfare. Lift fan technology is seen as one way in which to improve future supply aircraft to meet the needs of the military. A previous study designed a heavy lift aircraft with lift fan engines that used future engine technology. This present study modified the design by using current engine technology for the lift fan engines. The modification is important because a design that uses current technology is more likely to be brought into service in the near future.

This thesis documents the process required to use current technology in a lift fan engine for a heavy lift aircraft. The process uses current software and focuses on the design of the following components: the powerplant, the transmission shafts, and the lift fan. The result is a propulsion system which allows a 185,000 lb aircraft to takeoff vertically, as well as cruise at speeds greater than Mach=0.6.

KEYWORDS: Heavy Lift Aircraft, Lift Fan Engine, Lift Fan

IMPROVEMENT OF THE PERFORMANCE OF A TURBO-RAMJET ENGINE FOR UNMANNED AERIAL VEHICLES AND MISSILE APPLICATIONS

Dimitrios Krikellas-Captain, Hellenic Air Force
B.S., Hellenic Air Force Academy, 1993
B.S., National Technical University of Athens, 1999
Master of Science in Applied Physics-December 2003
Master of Science in Aeronautical Engineering-December 2003
Advisor: Garth V. Hobson, Department of Mechanical and Astronautical Engineering
Second Reader: Kai E. Woehler, Emeritus Professor

An existing turbo-ramjet engine was modified in order to increase the produced thrust and sustain combustion at increased freejet Mach numbers. The engine's afterburner fuel system was redesigned to improve the vaporization and atomization of the fuel. The engine performed satisfactorily at speeds up to Mach 0.3, producing 100% more thrust over the baseline turbojet. The data acquisition system of the turbo-ramjet engine's performance measurement in a freejet facility was also updated. Various computational fluid dynamics models of the flow through the turbo-ramjet engine were developed to visualize the flow and to predict the engine performance at different Mach numbers.

KEYWORDS: Turbo-Ramjet, Afterburner, UAV Propulsion, Missile Propulsion, Computational Fluid Dynamics, OVERFLOW, Freejet, Small-Scale Engines

INVESTIGATION OF INCREASED FORWARD FLIGHT VELOCITIES OF HELICOPTERS USING SECOND HARMONIC CONTROL AND REVERSE VELOCITY ROTOR CONCEPT

Steven G. Van Riper-Major, United States Army
B.S., Embry-Riddle Aeronautical University, 1991
Master of Science in Aeronautical Engineering-December 2003
Advisor: E. Roberts Wood, Air Force Institute of Technology
Second Reader: Raymond P. Shreeve, Department of Mechanical and Astronautical Engineering

This thesis describes the behavior of a rotorcraft equipped with Higher Harmonic Stall Control (HHSC) and a Reverse Velocity Rotor (RVR). Current rotorcraft are limited in forward flight speed by retreating blade stall and compressibility effects on the advancing blade. Stall occurs as the blade encounters increasingly severe reverse flow. HHSC enables conventional rotor systems to fly on the forward and aft sections of the rotor disk, greatly reducing reliance on the mixed flow regions defined by the advancing and retreating blades. Employment of the RVR allows lift generation while the rotor is experiencing reverse flow. A similar type of two per revolution (2/rev) input can be tailored to deliver maximum benefit to RVR equipped rotorcraft. Modification of the Joint Army Navy Rotorcraft Analysis and Design (JANRAD) computer program allows 2/rev cyclic input, use of the RVR, and analysis using high fidelity graphical output to examine angle of attack, coefficient of lift, and air load. Computational results show performance gains in conventional helicopters and high speed flight potential for RVR equipped aircraft. The RVR is applied to the Joint Heavy Vertical Lift (JVHL) aircraft conceptual design for preliminary analysis. This conceptual design can be used as an indicator of the performance of a high speed RVR equipped aircraft.

KEYWORDS: Higher Harmonic Stall Control, Reverse Velocity Rotors, Heavy Lift Aircraft