List of Acronyms

AFCS	Automatic Flight Control System
CDU	Control Display Unit
DEU	Display Electronics Unit
EMD	Engineering Manufacturing & Development
FADEC	Full Authority Digital Engine Computer
FCC	Flight Control Computer
FCSIR	Flight Control System Integration Rig
FSL	Flight Simulation Laboratory
IAS	Integrated Avionics System
IGE	In Ground Effect
ILS	Instrument Landing System
MC	Mission Computer
MFD	Multi Function Display
NRP	Navigation Reference Point
OGE	Out of Ground Effect
PFCS	Primary Flight Control System
SIL	Systems Integration Laboratory
TACAN	Tactical Air Navigation

Introduction

The V-22 Osprey is being developed by Bell Helicopter Textron and Boeing Defense and Space Group, Helicopters Division and is currently in the Engineering and Manufacturing Development stage of the military acquisition process. The Osprey is a technologically advanced aircraft combining the vertical lift capability of a helicopter with the speed and range of a turboprop aircraft to meet the requirements of the joint services.

To maximize the V-22 mission effectiveness, it is necessary to reduce the amount of time the pilot spends controlling the aircraft and increase the amount of time spent on mission tasks such as navigation, communications and visual search. Pilot workload is inherently higher for a tiltrotor because it requires a control device to direct the rotor thrust vector in addition to the conventional longitudinal, lateral, directional and thrust controls.[1] For this reason, an autopilot system has been incorporated into the V-22 design.

The designers of the autopilot system had to overcome some unique technical challenges in tiltrotor control. These include the automatic control of the transition between helicopter and airplane modes using thrust vectoring capability and the integration of navigation and guidance modes. In addition, the autopilot design had to possess redundancy, failure monitoring and component isolation to minimize the effects of failures.

Because the V-22 autopilot system is complex, it was necessary to develop a comprehensive validation test approach to maximize efficiency associated with developing this system. This approach involved two phases. The first test phase, the integrated lab phase, includes development of an integrated lab hardware-in-the-loop test facility and autopilot system development using the facility. The second phase is the flight test assessment. The integrated lab approach provides a cost effective and time efficient alternative to flight test evaluations. Figure 1 shows the significant amount of testing and development that can be accomplished in the integrated lab testing phase.

The first phase of the validation test is the focus of this paper. An overview of the V-22 autopilot system and the integrated lab environment is presented as well as the test plans and test results. The paper will show results of the integrated lab testing that lead to software improvements prior to flight test and conclusions on the effectiveness of the lab testing prior to flight test.

Autopilot System Description

The V-22 is controlled by a full authority, digital fly-by-wire flight control system. In helicopter mode, pilot inputs control the rotor thrust vector through swashplate deflections similar to conventional helicopters. In airplane mode pilot control inputs deflect the conventional airplane control surfaces of elevator, flaperons and rudder. In conversion mode pilot control inputs deflect a mix of swashplate and control surfaces. Figure 2 shows the V-22 control functions for helicopter and airplane mode.

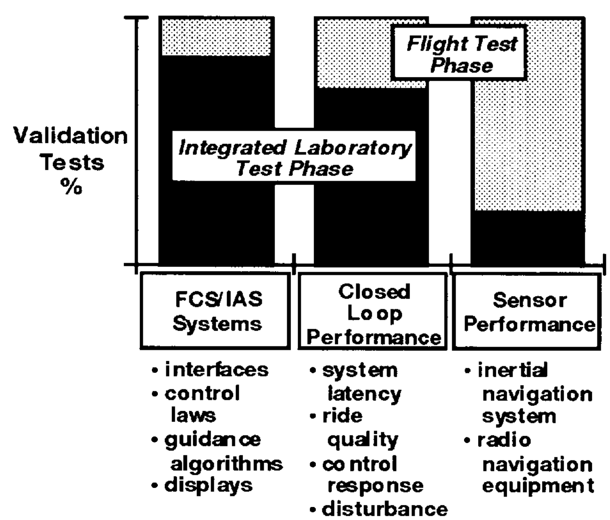

Figure 1: Autopilot Test Requirements