Highlights of the

FAA Health and Usage Monitoring Systems (HUMS) Technical Interchange Meeting (TIM)

FAA William J. Hughes Technical Center
Building 210 Main Conference Room

April 20, 2004

Purposes of the Meeting

The primary purpose of this technical interchange meeting (TIM) was to inform the HUMS community on the FAA's intentions to support HUMS R&D in 2005 and beyond and to discuss FAA HUMS R&D requirements. A secondary purpose was to have government, industry, and university experts provide their views to the FAA on current and future R&D efforts needed for rotorcraft health and usage monitoring systems (HUMS).

FAA HUMS R&D Perspectives

In his opening remarks, Dy Le reviewed current and recently completed HUMS R&D work in the FAA Rotorcraft Structural Integrity and Safety program. The R&D coordination process and working relationship between the FAA William J. Hughes Technical Center (R&D organization) and Rotorcraft Directorate (sponsoring organization) were explained. Le also announced the development of a HUMS R&D Strategic Plan used for conducting needed R&D work. FAA HUMS R&D requirements including specific four HUMS R&D areas aimed at supporting the HUMS Advisory Circular (AC) were presented and explained. Long-term vision includes a merger of HUMS and damage tolerance.

Following Le's remarks and presentation, eight technical presentations were provided. These presentations, along with particularly insightful associated comments, are summarized briefly, as follows. Additionally, there were considerable interactive discussions among the participants.

Technical Presentations

The first presentation was given by Brian Fuller of the U.S. Navy, representing Kelly McCool, on the research that the navy was conducting for the FAA. The ultimate goal of this work, which was highly leveraged by the Navy's internal research and applications work on the subject, was to provide the assessments on minimum acceptable operational parameters and sampling rates for using HUMS on civil helicopters. Their current thrusts are on quantifying the effects of parameter degradation and developing suitable remedies for the types of degradation (e.g., missing data) that can occur. As stated by Fuller, the "holy grail" for the Navy is maintenance credit that can be awarded when the actual operating conditions experienced by a rotorcraft are less demanding than the design conditions. Because of the commonality between military and civilian aircraft, the Navy's progress towards this objective will also be of value to the FAA. Finally, in response to a question raised by Ed Cuevas, Fuller stated that the Navy also works with the U.S. Army in HUMS, and while the Army is "a little behind" right now, they are catching up rapidly.

Robab Safa of Boeing, James Rozak of Sikorsky, and Mike Augustin of Bell presented RITA HUMS overviews. These three rotorcraft companies work together under the National Rotorcraft Technical Center

(NRTC) and RITA's funded cooperative agreement. Safa reviewed Boeing work on transmission vibration diagnostics in which "seeded fault" testing was done to determine suitable warning times. She labeled this as structural usage monitoring systems (SUMS), a subset of HUMS, and noted that this technology could embrace damage tolerance methods at some point.

Rozak provided a broad overview of Sikorsky's work in HUMS, noting that their objectives are to reduce costs by obtaining maintenance credit, but that there are many technical barriers and challenges that must first be overcome. They are primarily looking at operational usage, rotor track and balance, flight manual exceedances, and engine shaft monitoring. Sikorsky has met with the FAA certification office to discuss their plans in order to be assured that their data will be approved, and they want this process to move ahead as fast as possible. McCallister stated that, while their preliminary data appear to be acceptable, the FAA reserves judgment until the data can be reviewed in detail. In response to a question asked by Cuevas, Rozak stated that they have now put into their contracts that helicopter operators must share operational data with them, and that they also have access to operational data from three aircraft that have recently returned from Iraq. In response to a follow up question by Le, Rozak added that Sikorsky has not yet provided data on the S-92 aircraft as part of its certification plan.

Augustine from Bell presented Bell HUMS activities from 1985 to the present. This included the data that they have collected for the FAA. Augustine outlined a proposed three-year research effort. Based on their observations, an achievable objective of this work would be to demonstrate that, at least in the absence of corrosion and other similar limitations, parts could be flown safely for twice the time that they are currently certified for. This research would include developing (1) mini HUMS usage monitors, (2) solution validation, (3) retirement index number (RIN) monitors for heavy lift operations, and (4) credit evaluation using PHI data. This program (three years) could be conducted, according to Augustine, for $600K per year. Augustine added that there might also be a need for a recommendation given to a pilot when a critical damage condition has been detected and an immediate landing is infeasible.

The next four presentations were given by John Holmes of Georgia Tech, Adrian Hood and V. T. Nagarin of the University of Maryland, and Yann-Hang Lee of Arizona State University. Holmes began by pointing out that the "universal" sensor approach for monitoring strain and damage that is acceptable for fixed wing aircraft will not work in rotorcraft as much higher resolution is needed. Instead, a modular approach is needed with the sensor type matched to the material. This will require either an eddy current or an alternating current potential drop (ACPD) technique to be used. ACPD is being more appropriate for metallic components in rotorcraft as it has the capability of detecting cracks in the range of 10 to 50 μm. However, as this approach will not be effective for composites, Holmes suggested that Georgia Tech could also develop, in partnership with the industry, a high frequency ultrasonic array methodology utilizing an energy flow analysis that would be applicable for composite materials.

Hood and Nagarin, on behalf of Inder Chopra of the University of Maryland, next presented suggestions that UMD believe to have promise. The first of these, presented by Hood, was a diagnostic analysis, using constrained adaptive lifing for planetary gear teeth with cracks, that could be developed in collaboration with the RITA. The second, presented by Nagarin, was for the rotor head system health to be monitored with a methodology that would detect harmonics other than the passage frequencies and blade tip deviations. In the final formal presentation, Lee described an approach for assuring flight critical data integrity for systems utilizing ground based commercial off the shelf components.

Meeting Wrap Up Discussion

The discussion period was essentially focused on the FAA's potential for funding future HUMS R&D and the procedures that will be utilized for awards. Dy Le reiterated that the primary objectives of any FAA HUMS research would be to provide guidance and technical information including data for the FAA's HUMS AC. Le stated that he would like to generate a HUMS R&D Strategic Plan by September 2004. This plan, once completed, will provide the FAA with a systematic and cost effective approach for managing the diverse research projects that are necessary to achieve FAA research goals related to HUMS development, implementation, and use. Le also stated that a request for proposal to develop the HUMS R&D Strategic Plan would be issued soon so that the document would be available for initiating HUMS efforts in October 2004.