New Initiatives and Continued Progress at the Center for Aviation Systems Reliability

The Center for Aviation Systems Reliability (CASR), an ongoing program at the Center for Nondestructive Evaluation (CNDE), received eleven new awards from the Federal Aviation Administration (FAA) this fall. The program includes research efforts in all the major techniques including eddy current, ultrasonics, radiography, thermal methods, magnetic particle, and fluorescent penetrants. While much of the research is performed by CNDE investigators, ISU partners with other organizations in programs to provide improved safety through advances in inspection technology. Participants in the current CASR program include: Iowa State University; Northwestern University; Wayne State University; Ohio State University; North Carolina A&T University; Michigan State University; Boeing Commercial Airplane Co.; Boeing Phantom Works; Delta Airlines; United Airlines; Rolls Royce; Pratt & Whitney; D&W Enterprises; Sherwin Inc.; PRI Inc.

A new CASR website has been developed which can be accessed at http://www.cnde.iastate.edu/faa-casr which provides details of the individual projects. A summary by technical area is provided here:

Electromagnetic methods - The current program includes several tasks in the area of eddy currents and magneto-optic imaging (MOI). John Bowler and Marcus Johnson are completing the final prototype of a pulsed eddy current inspection system. Based on their work and communications with industry partners in the program, a new task has been initiated that will develop new sensors for detection of smaller cracks, particularly in complex structures. CNDE staff will be teaming with microelectronics experts from ISU to develop a new generation of high-sensitivity, semi-conductor magnetic field sensors which show promise to address this need for smaller crack detection. Lalita Upda continues to work with Bill Shih of PRI Inc. in improvements to MOI technology. A combination of empirical and model-based development is planned to lead to improved sensors and more sensitive inspection for the MOI commercial device.

Ultrasonics - The use of ultrasonic techniques for crack detection in aerospace components is seeing increasing use. Challenges related to geometry and design of an optimal inspection method continue to face the NDE engineer. Tim Gray and Mike Garton are developing a PC-based simulation tool to assist in inspection design for contact ultrasonics. The software tool is nearing completion of its initial development and validation is beginning. Projects at partner organizations which

include Igor Komsky of Northwestern University and Stan Rohklin of Ohio State University are also under way in the CASR program. Komsky's effort focuses on detection of cracking in complex-layered structures and Rohklin is working in inspection for the integrity of adhesively bonded structures. Dave Hsu and Dan Barnard are also building on "lessons learned" during the development of the computer aided tap test in a new project to understand the relationship between mechanical integrity and repair morphology. A companion project was also initiated this fall at the Center for Composite Materials Research at North Carolina A&T University.

Radiography - Castings are seeing wider application in critical aerospace components both in airframe and propulsion applications. To ensure their safe introduction into critical applications, radiographic inspection in combination with knowledge of the effects of flaw morphology/location on part life are often required. Changes are also occurring in x-ray inspection technology, all with implications for FAA's regulatory role. Understanding limitations of inspection technology and assessing the role of inspection in life management decisions is needed. The objectives of this work include development of probability of detection (POD) models for x-ray images and a means of determining inspection coverage for complex parts. Tools from this program will be available to assist in engineering decisions regarding safe implementation of cast components including consideration for the probability of detection for casting defects.

Thermal methods - The strong partnership between Iowa State University (ISU) and Wayne State University (WSU) continues with the efforts by Bob Thomas, Skip Favro, and Xiaoyan Han in the development of ultrasonically-assisted thermal wave inspection or thermosonics. The WSU team is focusing on development of this inspection method for aircraft inspection including design of a prototype system adapted for the inspection of aircraft structures. As with all the CASR tasks, technology transfer is a key element of their program.

Magnetic particle inspection (MPI) - Improvements in the understanding of MPI and factors which affect its sensitivity have been identified as a need by the airlines. Current direction in common inspection documents to "complete 100% inspection" is insufficient to ensure that adequate inspection is being performed in all critical locations because of concerns regarding over and/or under magnetization. Inadequate inspection could lead to missed defects and ultimately to failure of a critical component. Ability to assess the effect of geometry, inspection parameters, equipment variability, and material effects on detectability is needed. Empirical studies and simulation development is planned as part of this program which will lead to a validated simulation tool for magnetic particle inspection. An industry working group is being established to guide the development activities.

Fluorescent penetrant inspection (FPI) - A new program was initiated in September 2001 to provide engineering data regarding those factors that affect the performance of FPI as practiced by the aviation industry. The program to be led by ISU includes participation of the following industry partners: Boeing Commercial Airplane Co., Boeing Phantom Works, Delta Airlines, United Airlines, Rolls Royce, Pratt & Whitney, D&W Enterprises, and Sherwin Inc. A more detailed article can be found in this issue of the newsletter.

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