Marshall Problem Statement/ Senior Design Topic

Problem Title: Shear Wave Phased Array Ultrasonic Testing Roller Probe Design

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Indicate which discipline/s is/are most appropriate to work on this problem, e.g., aerospace, mechanical, electrical, chemical, industrial, civil, computer, physics, materials, test, nuclear, earth science, other
Aerospace, mechanical, physics, materials, test

Marshall Problem Statement

Background: The big picture with references to previous work (Why would a senior design student be excited about this work?)
Phased array ultrasonic testing (PAUT) is used to inspect both metallic and composite aerospace components for internal and surface breaking defects such as porosity, cracks and inclusions. Ultrasonic testing requires an acoustically transmissive coupling medium to transmit sound waves into the part. There are many ways to couple the ultrasonic transducer to the part ranging from direct contact, to solid wedges, to water filled sliding wedges, to rolling probes. Rolling probes have several advantages: providing a standoff distance between the transducer and part surface to get the desired signal from the part out of the near field of the probe, enabling a strong signal without immersing the part by means of a standing water column within the roller, and requiring only a light mist of water as the couplant to the test surface (ideal for clean room environments). One limitation of existing roller probes is that their design limits them to normal incidence longitudinal beam ultrasonics. For composite structures this is generally adequate, but for welded metallic structures a shear wave transmitted into the material at an angle is usually required. Using shear wave ultrasonics with a roller probe would require a new roller probe design, which is the desired deliverable of this study. The full system designed for this study would include the roller design (material selection. internal couplant. and geometry), integration of an existing shear wave ultrasonic transducer, and an external misting mechanism for couplant to the part.

Recent/on-going research on the problem (What resources, if any, are available to the senior design team, such as equipment, software, facility utilization)
The MSFC Nondestructive Evaluation (NOE) Team has several PAUT instruments which can operate many modes of transducer coupling including direct contact, solid wedges, water filled wedges and roller probes. The NOE team could use these tools to provide information and test potential concepts. Depending on logistics, senior design teams could visit our facilities to work with PAUT instruments firsthand.

Details of the problem; design constraints, requirements (if any), outcome expected (one semester Senior Design course lasts 15 weeks; two semester course lasts 30 weeks.) (What do you expect the senior design team to accomplish?)
This project could be completed by either one-semester or two-semester senior design project teams. The first semester of this project would be a preliminary design phase where the problem would be researched and a set of design options would be generated. This phase would end with a design review in which a final design would be down-selected. There would be an option for a second semester in which a prototype would be fabricated and demonstrated at the MSFC NOE Ultrasound lab.

Senior Design Project Rules:

1. Weekly telecons will be scheduled to maintain proper progress and prevent dead-end ventures.

2. Deliverable/s required (e.g. one semester course - a written final report; two semester course - written final report and a prototype/model (if practical))