

# Masters Defense

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*Wave Propagation in Structural Health Monitoring*

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## ***Abstract***

As the number of commercial and military aircraft approach their service life, it has become increasingly necessary to accurately assess the reliability of critical structural components. The standard visual inspections of these structures often cannot detect the presence of very small damages such as microcracking or, in the case of composite structures, the presence of embedded damages such as delamination. Therefore, reliable damage detection and location methods need to be developed. Recently, significant advancements have been made in the area of sensing and detection using wave propagation methods. The present research investigates the phenomenon of wave propagation and scattering as it relates to the field of structural health monitoring. First, the concept of a piezoelectric sensing architecture is investigated using a finite element approach. The model illustrates the capability of the sensing architecture to detect and locate damage in the structure based on the attenuation of the received acoustic waveform. In order to further understand the behavior of acoustic waves in composite laminates, a wave scattering model is developed to describe the attenuation behavior of composite laminates with microcracking. Experimental results demonstrate the correlation between the sensor data and the results obtained from the model. Because aircraft structures often include fasteners such as bolts and rivets, a wave scattering model is developed to describe the attenuation behavior of a bolt in a plate subjected to an acoustic excitation and varying applied torques. The model is developed based on the scattering model for a fiber embedded in a matrix with an interfacial crack. Experimental and modeled results will demonstrate the change in attenuation that occurs due to changes in bolt torque and changes in position of the bolt in the plate.