DETERMINATION OF 3-DIMENSIONAL DEFORMATIONS OF THE ALVEOLAR SAC DURING SIMULATED BREATHING. *J. M. Ferrara, E. A. DeBartolo*, Department of Mechanical Engineering, jmf9799@rit.edu, eademe@rit.edu.*

Mechanical properties of the parenchyma of the lung are currently unknown and difficult to quantify. Creating a computer model with valid property values will allow researchers to further investigate particle mixing in the lung during inhalation and exhalation. One challenge with modeling the material of the lung is the intricate geometry of the alveolar sac. Researchers are currently trying to model particle deposition within the lung using computational fluid dynamics. However, the mechanical properties of alveolar sac structure are currently undetermined. Due to the complexity of the physical structure of an alveolar sac, it has been a challenge to model fluid-structural interactions during breathing. To assist in quantifying these interactions, computer aided finite element analysis models are a necessity. These models will allow for calculation of the deflections and deformations of the physical structures of fluid containing membranes.

The focal points of the project will be to determine mechanical properties of a series of materials and then use these properties and apply them to finite element models, measuring deflection. Deflections will be determined by creating a series of finite element models and test fixtures that will allow for sufficient data collection, including validation tests, on the mechanical properties of the alveolar membrane. The research will begin with basic model geometry of a plain sphere using properties of a polymer material and will end with a complex geometric model of a scaled alveolar sac of a rat with the material properties of a human tissue. After each stage of the FEA models is complete, a validation test will proceed and be compared with the FEA results. By determining mechanical properties, future research on particle deposition studies occurring within the human lung can be pursued by allowing a solid foundation of information to be established and built upon.

Currently, load-displacement data has been collected and analyzed. The test set up includes a spherical membrane indenter. The membrane is made of a thermoplastic molding material known as Ultraflex. Membrane indention testing fully constrains the edges of the membrane, completely removing edge effects. An indenter is moved at a constant rate, pushing against the membrane generating the load-displacement data. This data has been analyzed and applied to finite element computer models. The models experience large deformations, making the models non-linear and much more complicated than a simple linear deformity. Preliminary findings show that the finite element model results are within 20% of empirical data. This large margin of error is due to the challenge in quantifying the material properties of the membrane indention data. Quantifying the stresses and strains on the membrane using the current approach is a challenge and is not in the literature. As a result, for the time being, further empirical data has been collected, using simpler unconstrained uniaxial compression tests, although there is still some concern with these tests due to edge effects in the material.