**Expedited Model Building Method for Rocket Nozzle Side Loading**

Statistical analysis of test data is currently the preferred method of creating models for uncharacterized side loading in rocket nozzles. However, statistical analysis requires multiple data sets to be reliable; getting these sets requires building and testing multiple rocket motors, which is not feasible given the incredible time and cost required to do so.

By using a combination of geometry, simplified finite element analysis (FEA) analogs, and algebra we can create a limited predictive model from only one test data set. Once created, the model requires only the input from one strain gauge located at each yaw and pitch attachment bracket for the actuation system. This process is not computationally intensive, therefore saving an abundance of time and budget over using full 3D FEA models to develop a similar predictive model.

To develop the model, conversion factors between the strain at the gauge locations and corresponding actuator load is derived from the data. These conversion factors are used to create a "conversion ellipse" that bounds the constitutive properties of the nozzle as one lumped factor.

Using a 2D cross-sectional analog of the nozzle exit plane, we create a function that allows us to determine the azimuthal location of the unexpected load based on the ratio between yaw and pitch strain readings. Combining this with the "conversion ellipse" yields a function that given the strain reading outputs an induced actuator load, regardless of the azimuthal location of the unexpected load.

As previously mentioned, this predictive model is limited in its application as there is inaccuracy introduced by the use of data by only one test as well as simplifying assumptions. This approach makes a useful tool to quickly determine whether uncharacterized actuator loading events can damage actuation systems or induce loading that exceeds design limits.