Example:
I want to test the stress on end plates created by a newly designed interbody cage for spinal fusion surgery. I will look to see if the force per unit area of the newly designed cage is less than current interbody cages. When the stress is too much for endplates to withstand, it can cause interbody cages to migrate or subside leading to further complications. I will use the Instron SC34-05 to test the compression and stress of the new interbody cage in spinal cadaver sections. I *hypothesize* that a rectangular cage design should allow for more surface area between the cage and the endplate, reducing the force per unit area. This should result in a decrease in the incidence of endplate failures lowering the migration and subsidence of the interbody cages.

Model system/Method:
The intervertebral space of 30 functional cadaveric spinal units will be instrumented with titanium straight cages, poly ether ether ketone (PEEK) banana-shaped fusion cages, and the newly designed PEEK rectangular cages. I am using PEEK to create the new design as the elasticity closely resembles cortical bone and minimizes stress shielding as demonstrated by test with the banana-shaped fusion cage [3]. Once the cages are secured with a pedicle screw fixation system, the instrumented spine unit will be tested under varying compression loads (400-1200 N). Compliance of the cage-endplate interface and cage subsidence will be computed. Two-way repeated multivariate analysis can be computed to test the effect of the cage design on the compliance subsidence of the cages. The method for obtaining cadaveric spinal units is still unknown and more research and communication with Dr. Rosen would be needed to fully conduct the described experiment if chosen as my ME project.

Controls:
I will use the titanium straight interbody cage as a negative control in comparison with the newly designed interbody cage. The straight cage used to be the standard, but the high subsidence design of 14% has caused clinicians to move to using the banana shaped cages with a subsidence rate of 6.6% [2]. Banana-shape cages will be used as the positive control since this design has a larger surface area and lower subsidence compared to the previously used straight cage. The goal of the experiment is to lower the force per unit area on the endplates with the newly designed cage to ultimately lower the subsidence rate. I will be able to obtain the break force for each of the three cages as well as the force per unit area using the known geometry specification for each cage.

Expected Outcomes/Possible Issues:
The expected outcome is the newly designed cage will have a lower force per unit area on the endplates than the straight and banana-shaped cages. With further testing, the next expected outcome would be a lower incidence rate of cage subsidence. Possible issues include the positioning of the cage which significantly affects the degradation of the cage-bone interface. The peripheral location of the cages and the use of peripheral subchondral bone of the apophyseal ring could be advantageous [2]. In addition, location of pedicle screws could impact the fixedness and vastness of the surface area of the cage with the endplates, and could be the major cause behind interbody cage subsidence rather than cage design (See Melissa Malette's Experimental Design for more information) [4]. The anatomy of the spinal units may pose an issue causing varying results depending on the harvest method and the cadaver retrieval source e.g. child, adult, male, female, etc. However, with known cadaver information, the functionality of the cage can be determined for the differing subgroups and the results compared.

1. https://pubmed.ncbi.nlm.nih.gov/29526639/
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6187892/
3. http://msfx.com.tr/profile/tlif-transforaminal-lumbar-interbody-fusion-banana-cage/#:~:text=TLIF%20(Transforaminal%20Lumbar%20Interbody%20Fusion)%20(Banana)%20Cage,-1&text=TLIF%20Cage%20allows%20the%20surgeon,scarring%20around%20the%20nerve%20roots.
4. Melissa Malette -ME project partner and is referenced since we collaborate on potential problems and projects to explore