TO: Seunghwan Jo (jo30@purdue.edu)
Nathan Wang (wang4425@purdue.edu)

FROM: Team Nugget's Samuel Graham (graha205@purdue.edu),
DATE: April 15th, 2022
SUBJECT: D7 Engineering Models

The purpose of this memorandum is to develop an engineering model for the piston gear system of Team Nugget's product. This particular model analyzes the effects of pressure and gear radius on the torque outputted by the system.

For Team Nugget's product, the user will apply a force on a step that will use a hydraulic piston to open a door. Within the product there are four distinct systems being the step, the one way friction device, the piston-gear, and the door arm. This model analyzes the piston-gear system, displaying the effects of fluid pressure and gear radius on output torque.

The model poses the question what ranges of pressure and gear radius will provide a sufficient torque to open the door. The answer depends on the door arm model, however this model seeks to provide the necessary torque and gear radius combination to output the torque required by the door-arm model.

The model uses a simple dynamic analysis of the piston and gear using a variety of assumptions. The assumptions used are as follows: Friction is negligible, no gear skipping, hydraulic fluids act ideally, uniform flow of fluid, no deformations, component mass is negligible in comparison to output. The model could be improved by not only accounting for all these assumptions, but also accounting for the system of the whole product. Accounting for the whole product would allow us to model not only the forces but also the equation of motion for the system, creating a generally all encompassing function to represent how the system functions.

The model generates a range of pressures and gear sizes that could occur within our system and models the performance of the unit using the given conditions. Given a torque, the model will be able to provide several combinations of varying gear sizes and pressures to determine what combination would be most optimal.

The model demonstrates that the larger the gear radius, the larger torque can be produced, with the same being true for a larger input pressure. The torque required to open a door will be revealed by the door-arm model, however assuming a fluid pressure of 230psi and a gear radius of 1 inch, the output torque will be 180lb-in, which assuming the lever arm is 6in, will result in a 1080 lb-in^2 moment, which is more than enough to open a standard door.

If you would like any further details, please contact me at the following email (graha205@purdue.edu),

Sincerely,
Samuel Graham

SG

Attachment:

- Model of Piston Gear System