301 - Excellence - 31 - rat_model - Executive Summary

Our clients, Professor Robert Radwin of the University of Wisconsin Madison and Professor Mary Barbe of Temple University, are studying the effects of repetitive use of power hand tools on their users. Today's power hand tools are manufactured to exert high torques which also apply high impulse loads on the user's hand and arms. Overtime, after repeated use, operators are susceptible to chronic injuries that can be categorized as work-related musculoskeletal disorders or WMSDs. These disorders are very painful for those suffering from them. Rehab exercises are sometimes enough to treat them but some, if treatment is neglected long enough, require surgery to be repaired. Beyond this, WMSDs are the cause of many lost work days across many fields and they account for a large percentage of compensation that must be covered by the industries. The goal of this research is to help quantify the effects of power hand tools to help set safety standards to protect users.

Professor Mary Barbe studies rats as analogous human models in her research. Currently, a device exists that can measure the eccentric load that trained rats apply to a handle using a stationary load cell. However, power hand tools respond to input forces from users. Thus, this semester, the team was tasked with continuing the design to make it possible to apply a resistive load to that which the rat applies.

The team needed to come up with a consistent way of applying an opposite force that could be controlled for testing purposes. A linear actuator was the tool decided upon to apply and control the load. The next step was to incorporate this linear actuator into the current system. The team found the best option was to attach the actuator directly behind the load cell so that the cell was between the handle and the actuator. With the use of rigid connections between all of these parts and the necessary supports between them, this system would be able to apply and measure accurate and consistent loads to the handle. We also developed a sophisticated control system to measure and respond to the input force produced by the rat.

At present, the team conducted some basic calibration test for our load cell and weight test necessary to identify the correct spring required to test the validity of our design. Future tests will include a calibration test with the correct spring in order to ensure proper calibration of our load cell, a threshold test where we will validate that the design can apply a continual load that can surpass a variable threshold load, and finally we will conduct a failure test in which we will validate that if the load registered on the load cell exceeds the maximal load recommended for the load cell or falls below the threshold load for the test the device will stop the test.

Once the testing is complete, the device will effectively be able to model a unidirectional dynamic load. The implementation of unidirectional dynamic load testing will further Professor Barbe's research from the current static load tests she is conducting and will complete the second stage of the project. The final stage for this project would be the implementation of a variable dynamic load tester which would be able to apply a rhythmic load similar to a sawing motion. This addition would model the loading experienced by power tool user and aid in the prevention of work-related musculoskeletal disorders. However, before a rhythmic load can be implemented, we first needed to transition from static to dynamic loading.