Primate Startle Response

Final Report
BME 400
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Introduction

Our client, Andy Roberts, wishes to quantify the startle response of the rhesus monkey to improve the accuracy, repeatability and overall quality of his experiments. Currently a researcher qualitatively analyzes the response of a rhesus monkey during a startle experiment. This limits the results due to the bias of the researcher.

This semester we have been faced with the challenge of redesigning our system to accommodate our force transducer. Because of a mix-up during the ordering process we received a transducer with insufficient moment capabilities for our design (See Figure 1). After this problem was solved we began implementing our design and are currently beginning the testing phase.

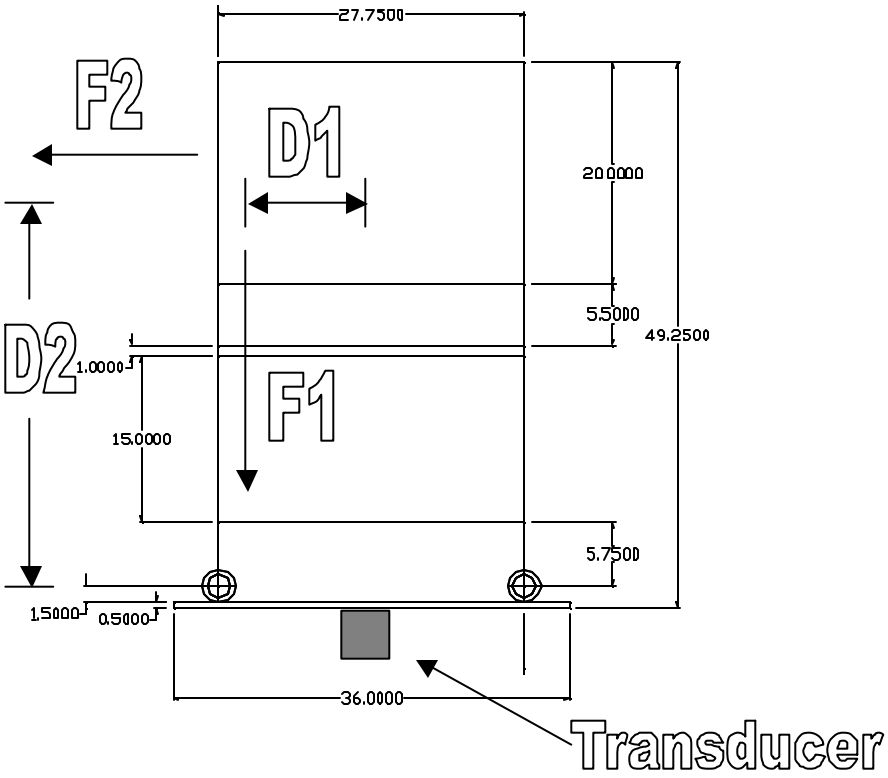

Figure 1: Old Design With Critical Forces Labeled

Details

After consulting with Prof. Roderick Lakes on the 14th and 17th of September we decided that our old design would not work. Prof. Lakes suggested we meet with Dr. Kreg Gruben, who has a broad knowledge of force transducers. After our meetings with him on the 21st and 28th of September we had three possible ideas for a new design.

Design 1:

Mount the transducer directly to the top of the cage and suspend cage from arm mounted to wall (See Figure 2). This would effectively reduce the moment arm as seen in Figure 1 labeled D2, thus resulting in a moment within the transducer's range.

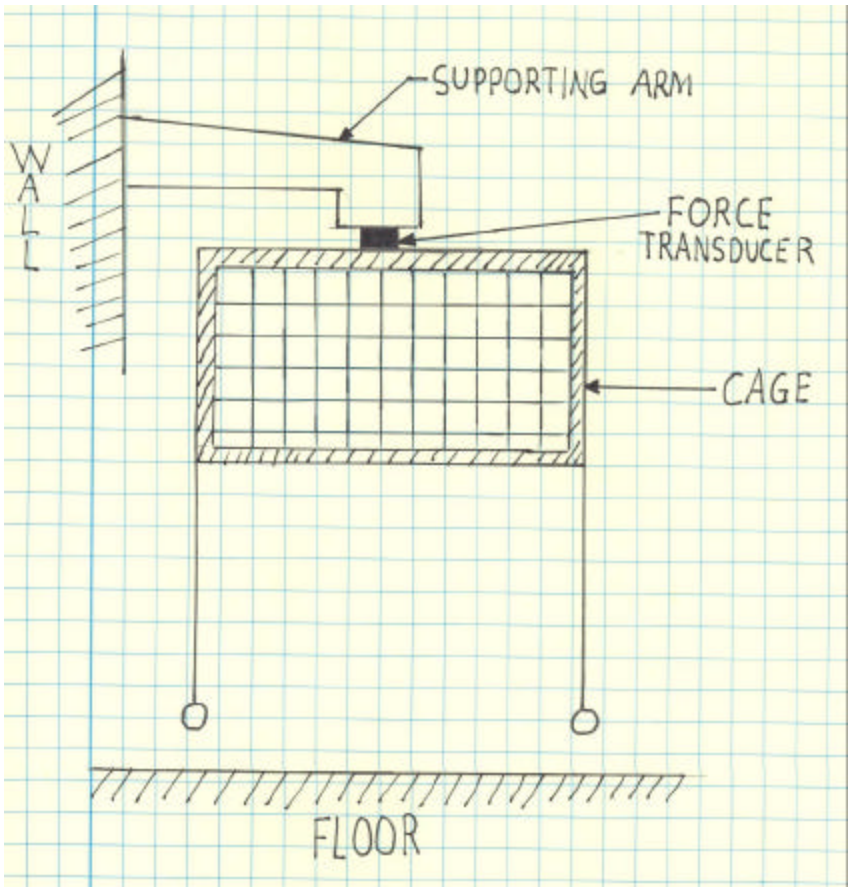

Figure 2: Supporting Arm Design

Design 2:

Design a smaller cage bottom to fit inside existing cage. This smaller cage bottom would be directly mounted to the transducer and the only monitored forces would be those exerted on the smaller cage floor (See Figure 3). This would eliminate D2 because the second bottom would not be attached to the side of the cage. It would also decrease D1 and it's corresponding moment because the monkey could only exert force on a smaller cage bottom.

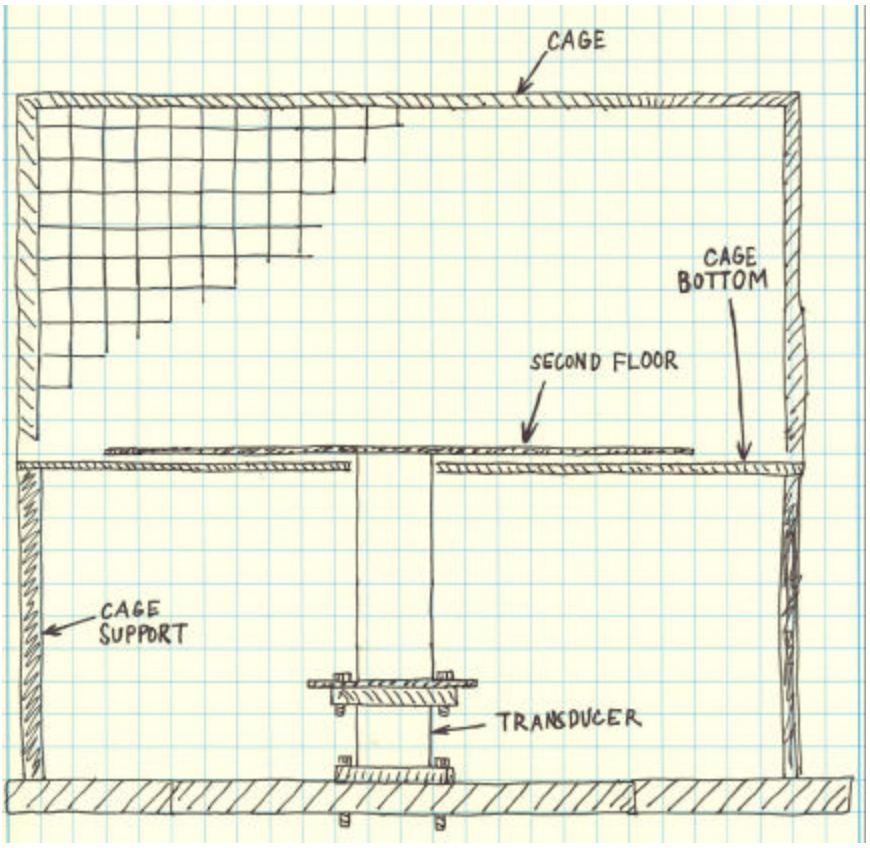

Figure 3: Second Cage Bottom

Design 3:

Use our current design or a slightly modified version of our current design and order a new transducer that can accommodate a larger moment. From the beginning of the semester Matt Delisle, a former team member, has attempted to contact AMTI about the possibilities of exchanging the transducer, but no ground has been made.

Evaluation of Designs

Design 1:

Advantages:

- Reduce moments
- Use current transducer
- No need to modify cage

Disadvantages:

- Extremely complicated to design and build
- Expensive
- May still fail under certain conditions such as accidentally bumping bottom of cage while suspended

Design 2:

Advantages:

- Reduce moments
- Use current transducer
- Cheaper
- Easier to design

Disadvantages:

- Must modify cage
- Reduces amount of data as monkey can move off second bottom

Design 3:

Advantages:

- Use current design

Disadvantages

- Ordering time
- Expensive

Chosen Design

Upon our request Andy brought the exact monkey cage to our lab at the Waisman Center. To our surprise the exact cage was different than the cage he had shown us previously. Namely, it was much smaller (See Figure 4). This allowed us to use the current transducer and modify our design slightly. With the new dimensions of the cage we no longer had to worry about the moment generated by the monkey standing at the edge of the cage because the moment arm was greatly reduced. However, D2 in Figure 1 was still a problem. This was easily solved by the fact that the cage can detach from the cart and the transducer can then be mounted much closer to the bottom of the cage. Our client had no problem with this minor change. In our new design the transducer is mounted directly beneath the splash guard (See Figure 4). With this design and the new cage size all moments are within our transducer's range of measurement.

Figure 4: New Design

Attachment Mechanism

In order to start testing our new design, we had to first come up with a way to attach the cage to our force transducer, while incorporating our box system. To get started on this, we talked to our client, who then told us that the cage can be permanently fixed to the force transducer. Then, we went to the mechanical engineering shop and discussed our new problem with Bill Hagquist. Mr. Hagquist advised us to make our box system out of metal that was either bolted or welded together. Since the former was the easier choice he thought that it would be the best. Then, he suggested that we use j-bolts or some u-shaped brackets to attach our box to our cage as seen as part P-1 in Figure 5. These brackets will be attached on all four corners of the box mechanism by bolts which will effectively hold our cage steady in place. With this attachment mechanism, the cage is not altered in any way, and we still are able to use the splash guard that came with the cage and cart. Currently we have just received the metal that is needed to build our box mechanism.

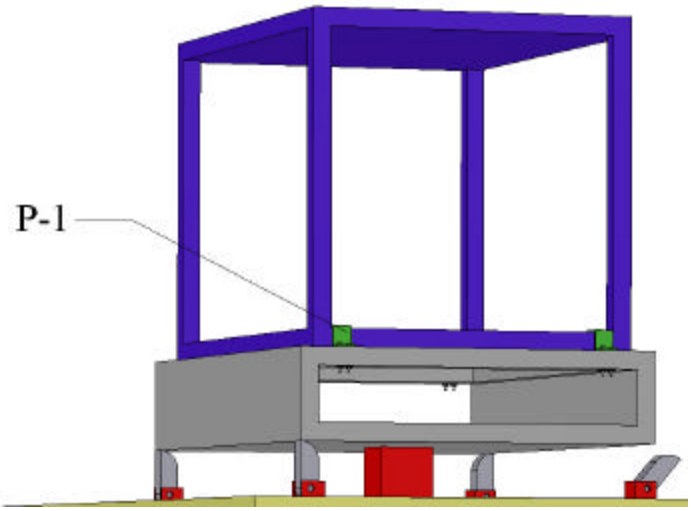

Figure 5: Mounted cage with labeled attachment bracket

Startup Procedure

In order to make sure the force transducer gives us accurate measurements, it must be used the proper way. In order for this to occur, a proper startup procedure must be followed. This procedure is listed as follows:

1) Allow amplifier to warm up (~20 min)
2) Zero amplifier
3) Tare the force transducer

Testing

While we were waiting for the metal for our box mechanism to arrive, we decided to do some preliminary testing of our force transducer's accuracy. In order to measure the accuracy of testing a force in the z-direction, we applied 5 lb increments of known weights ranging from 5 to 20 lbs. The results from this testing is shown in Table 1. In order to get a better measure we will need to add weights approaching the maximum forces that will be created by the Rhesus monkey. Currently, we do not have enough weight in the lab to perform this task.

Actual Weight (lbs)	Measured Weight
5	4.9
10	10.1
15	15.2
20	19.9
25	25.0
20	19.9

Table 1 shows the results from the 5 lb incremental testing.

The testing of the moments will take place in similar fashion. Previous attempts at testing the moments have been hindered by difficulties getting a consistent moment arm in all of our trials. The problem occurs because the weights have a very large surface

Output

One of the key features to our design is the software's ability to output data directly to Microsoft Excel. The data can be outputted in volts, pounds, and newtons. This feature allows the user to easily manipulate the data into graphs of the forces, moments, and center of pressure. A sample graph of force in the z-direction using data from the force transducer is shown in Figure 6.

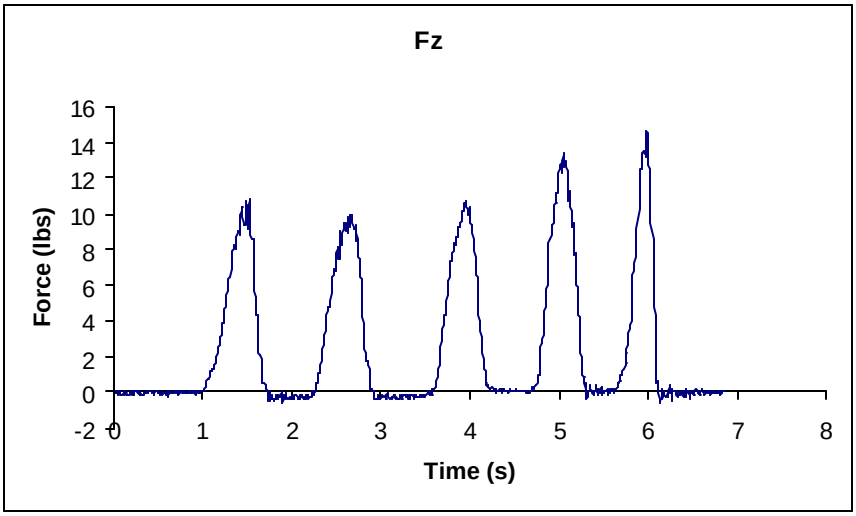

Figure 6: Excel graph of Fz

Difficulties

The major difficulty we faced was waiting for materials. This occurred in a number of instances. First, we needed a coaxial Ethernet card. We sent the specifications to the client, specifically telling him that we needed a PCI card. However, when the card arrived it was a ISA card, so we needed to reorder. Our next challenge occurred when we started testing with the new card in place. After running the system check, provided by AMTI, we were told that our computer was very slow. This slowness translated into a delay from the transducer to the output on screen. We informed out client of this problem and he agreed to get us a new computer. While we were waiting for this new computer, he provided us with a substitute, which worked very well. It was with this computer that we conducted our preliminary testing. We expect our new computer before next semester. The final delay occurred in getting the metal for our box mechanism. The metal came in December 11 and we are currently in the process of building the box. The other difficulty we encountered was with testing the moments, which we discussed previously.

Current and Future

Currently we are finishing the construction of our box mounting mechanism. We hope to have this completed before the beginning of next semester. We also plan to fabricate rotating safety supports in order to prevent the transducer from exceeding its maximum load capacity. These supports will be placed underneath each of the four corners of the box. The design of these supports is shown in Figure 6. Once completed with construction we will focus on testing our transducer. Testing will consist of placing known weights at known distances and then verifying the output of the transducer. We will also use this to verify our positioning of the center of pressure. Ideally, we would

like to interface our setup with LabView software. This will help make our device more user friendly.

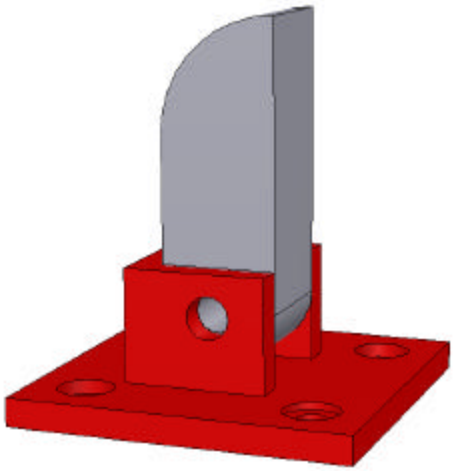

Figure 6: Design of support piece.