Drug delivery via nasal cavity is becoming more prevalent. This is because of the epithelium mucosa in the nasal cavity which gives direct access to the brain. So, in cases where the medication needs to be delivered directly to the brain (like when medicating for Alzheimer or migraines) it is often to the patient’s best interest to do so via the nasal cavity. This reduces the amount of medication lost to the body. In addition, the brain itself has a protective barrier, the blood brain barrier, meant to protect the brain but when it comes to medicating the brain it prevents even the good medicine from being absorbed. However, the epithelium mucosa in the nasal cavity lacks this barrier, which gives a direct path to the brain. Unfortunately, the percent of the medication that actually reaches the epithelium from a simple nasal spray is not significant. If the aerosol particles from the nasal spray could be controlled and the path of the particles directed to the desired part of the nose, then the success rate for brain medication would increase. This summer I and my research partner looked at the possibility of controlling the path of both a charged particle and a Ferro-fluid using a magnetic field.

Our research consisted of going back to our basic physics on magnetism and getting a good grasp on how a magnetic field would affect a particle. The multi-physics software COMSOL was utilized for our research, to conduct finite element analysis. It took several tutorials and practice model analyses to get the full grasp of what COMSOL has to offer and how to utilize it fully. We began by looking at how the magnets would affect the particles in a 3-dimensional level. I looked at the effects of using multi-turn coils. Where current is passed through a coil of wires, which results in a magnetic field around the coil. My initial design started as a simple cylindrical coil where the particle goes through the center of the coil. The particle I used was magnetic. The flow itself was assumed to be that similar to air flow because the intention was to simulate the flow from a nasal spray.

We later moved onto the 2-dimensional analysis of the nose. Looking at studies done by other researchers I was able to model an analysis with multi-turn coils creating the magnetic field and ferrites as the particle being studied. The study analyzed the magnetic force acting on the particle. Once a starting point was established, I begun making slight variations to the setup of the magnets. There were four magnets used, three on the top of the nose and a long one on the bottom. Each magnet had certain amount of turns and amount of current going through the coil. By changing the turns or current the magnetic density of the magnet changes.

From the several analysis I ran I was able to see that with Ferro-fluids, the particles can be affected by a magnetic field created by multi-turn coils. With additional analysis, the best parameters for the magnets which would increase the percent of the released particles that goes the desired location, could be determined. From the analysis that I have completed, the best setup for the magnets are the three magnets set with an increasing magnetic flux density as you go up the incline of the nose. The magnet at the lowest point of the incline had 10 turns and 100 Amps going through the coil, the next magnet had 10 turns and 200 Amps going through the coil and at the top of the incline the magnet had 20 turns and 500 Amps. The magnet at the bottom of the nose had 10 turns and 20 Amps of current going through the coils.

This research with Professor Si and Hezkiel has been a blessing. It allowed me to get a better idea of how finite element analysis is used by Engineers. It also incorporated a focus in medicine that I am interested in. Allowing me to get a small glimpse of how Engineering and Medicine can be merged in the research field. I also got a better understanding of electromagnetism. I have really appreciated working with my research partner and faculty mentor.