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After-Action Review: Ferrofluid

Things that went well:

1. **Arduino Coding** – learning how to code in Arduino for the first time for the purpose of this project was very straight forward. Many sources were available to help beginners start coding and outputting codes to the chip and there were hardly any issues with the performance.
2. **3D printing** – this comes mostly due to experience, but the prints that were produced from the CAD files were consistent and had very little quality issues.
3. **Fabrication** – this relies heavily on planning, and we had come up with many references and conducted extensive research going into this. The foundation of the research made the fabrication process simple and many issues that were to be expected were planned for accordingly and considered into the fabrication. For example, we knew that many trials and stator configurations needed to be tested, so we made the machine modular and added connectors for easier switching between stator configurations.

Things that went poorly:

1. **A/C integration** – since we started out knowing what was needed to be done to complete our minimal goal, we had focused on the control aspect more heavily than the speed and magnetic field manipulation types. We went straight to Arduino control using motor driver amplification, this provided us with a great foundation and understanding of how the ferrofluid was controlled. As we progressed however, we figured out that if we needed to get past our minimal goal, we had to utilize alternating current for better control and higher speeds. Our Arduino based system is purely digital and integrating an analog signal to be used for the stator would have needed us to redesign the entirety of the controller aspects and ditch the Arduino.
2. **Ferrofluid contamination** – working with ferrofluid was messier than expected and the staining and spillage was a definite occurrence. It's difficult to contain it in containers and shield it off any magnetic fields and the 3D prints had to be sprayed in rubber coating to prevent the ferrofluid from moving through the cracks of the layered prints. Gloves were a must.
3. **Coil heat control** – as the magnetic field strength grew as needed, so did the current draw and the heat that produced by the coils. This wouldn't be too much of an issue if we didn't build our structures out of printer filament, as it would begin to melt. Since filament was our only option to produce complicated structures at a reasonable production time and cost, we had to stick to it. We couldn't contain the heat produced by the coils and this limited us to how strong we can get the magnetic field strength to be and for how long we can turn them on.

Things that I could change next time:

1. **Making way for A/C integration** – If could restart this project I would make sure I had a plan to easily migrate from DC to AC. This would have potentially made us reach a higher goal within the limited time we had available.
2. **Waiting to invest in specialized tools –** this would have helped with cost and fund availability for better and much needed components. Starting out you tend to buy tools to aid you in a certain aspects of the build process, but you come to realize later on, that certain aspect you were trying to build wouldn't work or sometimes better components are available, and now you're stuck with expensive tools and components that you can't use.