**Learning Board Design**

When I started solar car, one of the first things I was taught was how to design PCB's using Altium Designer. I was then placed on my first project, buttonboard. The job of this board was to take inputs from latching and nonlatching buttons on the steering wheel and have them read by our microcontroller to turn on different lights and our horn. The circuit itself was pretty straightforward, consisting of pull-down resistors that would be connected to each of the buttons and read by the compute. We also later down the line included some filtering with an RC circuit to denoise the lines. I was able to get our first rev of the board ordered around winter break and test it. Testing the board mostly consisted of checking the power circuit and seeing how much voltage drop was on it to adjust it with the trim up resistor on the 5V switching regulator. We have talked about stepping the voltage down to 3.3V in the future since the microcontroller can still handle that and since it would also save us a little bit of power. This board was implemented in the front of the car behind the steering wheel. It was really fun to see my first board get tested and implemented over the course of my first year.

In the Spring, I also helped to redesign and layout another one of our boards, Headnode. This board is in charge of turning on three large relays that are in our battery pack box to start the battery pack. This works by using logic IC's with AND gates to check to make sure different pins are connected and what we expect. For example, we have a button on the outside of the car called external kill, and if that is pressed then Headnode shuts out the relays and makes sure the battery pack relays are not closed. This then cuts off power from the battery pack in a "safe state". We moved these relays to Headnode on the rev I worked on and also added a third one, the charge relay, to help meet regulations for our car for rayce. The board got much “busier”, since we had to keep it the same size as a previous rev while also packing in more parts. Headnode was the first 4 layer board that I helped design too. This board was much more complicated than my first board but it was very fun to learn about it throughout the Spring and Summer.

I also began work on a new project for solar car in the Spring for a power supply board. This board was designed by two alumni of the team for a senior design project, intended to be used for solar car. After the fall semester was over, they handed the board off to us with one of the project members to help ease us into it. We tested the first rev of the board while identifying a few key issues. The board takes in AC power and turns it to 34V DC through 4 transformers. This is then stepped down by various power regulators to 12V and 5V. One issue was that the enable pin for the linear regulator was taking 34V instead of the maximum of around 12V. To fix this, we added a voltage divider to the next rev to ensure we wouldn't fry the IC again. We also had lots of issues with software connections to multiple pins on our microcontroller. I helped lead redesigning the 4-layer board to help clean it up too at the start of the Summer. We made 1-layer horizontal traces and another vertical for the in-between layers. The top layer had many different planes spanning different voltages, depending on which section of parts were close. The bottom layer was ground which contained mostly vias to help ground parts on our top layer. I am now going into my second year of solar car as the manager of this board which I am very excited for. We will start with testing the newest rev that we had designed over the Summer.

**Summer 2021**

Throughout my first year, I spent more and more time working on solar car since I joined it. This was mostly obvious during the Summer, where after work at my internship ended, I would go to help work on the car. During my time over the Summer, I was able to learn about the overall electrical system of our solar car. I worked to meet with different managers during this time so they could help explain boards I was unfamiliar with to understand how our battery pack fully turned on. This in turn helped me understand more what I was doing on Headnode from the Spring before. On weekends we would take our car out to the Jack Trice Stadium on campus to drive it around parking lots. This helped us see what did and didn't currently work on the car. We were also able to give drivers the chance to practice driving more in figure eights like we would for dynamics testing on rayce. The summer was also a great time to learn better how to debug a full electrical system. When something didn't work, we would pull out multimeters and probe around to check for continuity or different voltages of lines on test points. This was great, because I was able to watch other people test this at the start of the Summer and ease in to doing my own debugging as I got more confident with our system as a whole. I came to realize how much I learned over the Summer after I was teaching other members who hadn't been around the whole Summer about different aspects of the car as we led up to rayce.

As for the actual rayce, there are two. The first is FSGP, which is a track event including many different cars from teams around the United States. The track event includes both the single occupant and multi occupant cars, where we had a multi occupant. I was slated to go on the second rayce, ASC, that would be a cross state rayce to compete who could drive the most miles on their car. Due to some technical problems, we were not able to get on the track until the third and last day of the first rayce. So, our team failed to qualify but we still did learn a lot about the whole process of scrutineering and what it takes to rayce. There will be a rayce coming up next year so the team is working hard currently to get our car in a reliable driving state before then. We have also been working hard on outreach as the next school year starts to bring on new members to the team.

**Librarian**

In the spring of my first year, I had got picked to be the librarian for our electrical team. This meant I would be in charge of organizing parts, helping transition to Altium 365, and building parts libraries. My main focus of the Summer was to organize and catalogue all of our parts. This meant that I had logged and labeled over 500 parts in our parts system, EPCOS, that some of our software team had designed the year prior. This was something that I heard was very helpful on rayce, and I'm hoping it will be nice as we get new board orders coming in this year too. Going forward, I have started the process of building a parts library containing all of our currently used parts. After we have filled in all of our current parts, I plan to buff out the library with other common resistors, capacitors, and MOSFETs. This should help make board orders much easier in the future, but the initial switch will be the hardest part. Hopefully in a year this is all done so it makes future revs much easier to manage and order!