February 2023

The shortest month of the year has been nothing short of exciting for Penn State Formula Racing. Big steps have been taken order and manufacturing wise and we're getting more and more excited for the Formula Electric competition in June every day. Keep reading to catch up on the specifics of how our February went!
Captain's Note

Friends of Penn State Formula Racing,

Time sure does fly! The first half of Spring semester has come and gone, and the pieces are (quite literally) all falling into place. We’ve begun finalizing travel plans to competition in June, our largest orders are arriving, and most subsystems are doing extensive work on a daily basis to complete their projects by mid-April. Mark your calendars for the 25th of that month – if you’re a stone’s throw from Penn State or have some time in your day to tune in virtually, we may have some news that you’ll be excited to see.

Specifically, over the last month, our Aerodynamics team has been hard at work creating the more than twenty elements that make up our variable-incidence package. The Chassis team has fully completed their negative molds for the creation of our structural bodywork, and once they receive the go-ahead from FSAE judges, the main body will be laid up and cured. The High-Voltage Electronics group has taken delivery of our cell modules that will make up the tractive system battery, which is soon to be integrated into its housing. And those are just the highlights – our other subsystems are deep into the manufacturing phase, spending countless hours in campus machine shops.

Outside of manufacturing, we recently received some invaluable feedback in our second mock Design event of the semester, this time involving faculty members from the Department of Mechanical Engineering. I’d like to pass along a sincere thanks to the individuals who volunteered their valuable time to scrutineer and allow our members to defend their design decisions. In addition, I would like to thank the Ford Motor Company for their generous sponsorship in the form of a testing session in their wind tunnel facilities, which will take place in April. I’m excited to see everyone’s hard work be proven for the first time in the real world.

Next week is spring break, and much like over the holidays, several team members will be sacrificing some of their time off to machine, wire, and fabricate. For their above and beyond efforts we’re incredibly thankful, and for the rest of us, the return will mean hitting the ground running. I hope you enjoy this edition of the newsletter and I look forward to updating you again next month!

Best regards,

Nate Dreyer, Team Captain
Events

Design Reviews

Last month, on January 17th, we invited members of the Penn State Applied Research Laboratory (ARL) to review our designs and help us prepare for the competition event of the design review. This month, on February 28th, we had our second design review with feedback from College of Engineering faculty, inclusive of Dr. Mary Frecker, Dr. Stephen Lynch, and Professor Sachin Gore. We received great feedback from both of the sessions that we have been working to apply to our designs and how we present them. A big thank you to all of our members who attended and spoke about their designs, as well as the ARL members and CoE faculty!
Subsystem Updates

Aerodynamics

This month, the Aerodynamics subsystem focused heavily on the manufacturing of all the components that we have worked to design thus far. This includes cutting out all of our 26 airfoil molds that will be utilized on the vehicle out of low density foam. We then wrapped these molds in carbon fiber weave using epoxy and vacuum bags. Once cured, the parts are removed and any excess carbon is removed. The airfoils are then sanded and clear coated for a nice smooth surface finish. The picture below shows some airfoils after clear coating.

Undertray manufacturing will begin when we receive our molds, which are being cut using the same materials and methods used on the monocoque molds. We will be using carbon sandwich panels for these parts, in a similar manner to the front monocoque.

In addition to manufacturing, Aero also had the opportunity to test some of the test parts we manufactured earlier in the year. Using the test jig pictured below, we ran a 3 point bend test which we will use to validate the strength of our layups on the Front and Rear wing main elements. Using this data we can find the failure load of our wings, which will likely be much greater than that of our mounting.
Chassis

Fiberglass February is coming to an end for chassis who has been very productive on some sweet looking molds. In January we put the pieces of the foam mold together, but February was a long hard month of applying various gel coats and sanding. We went through various stages of applying neutral and gel tooling coats as well as adding mold releases to help make sure our molds come off easily. In between every round of applying coats our members got done to do the dirty work by sanding for what seemed like endless hours. In the end the molds are almost complete and require only a bit more time to finish up the fiberglass itself. In other news the aramid panels have been completed. After taking a trip to ARL to learn more tips and tricks for vacuum bagging our chassis members were able to pull off some amazing panels. The aramid panels performed even better than expected. Chassis has also been working towards the future in prepping for roll hoop rewelding by practicing during their free time. Some lovely members helped Electronics on Accumulator welding and as such are ready to tackle the roll hoop in the upcoming weeks. In March we are looking forward to finishing the fiberglass molds while also starting the layup of the entire chassis and remanufacturing the main roll hoop.

Controls, Brakes, and Safety

After completing our purchasing phase, the CBS subsystem is hitting the ground running to bring our designs into the real world and start the manufacturing phase. We have been lucky to find plenty of aluminum material in our shop to begin water jetting parts for the pedal tray and steering system. We are excited to work alongside Penn State’s engineering services to get these all completed. Once we have the blank water jetted parts, we will work on post processing. This will include use of both manual mills and CNC mills for the pedal tray and welding for the steering column mount and shafts. Welding the steering system will be a challenge for us as we do not have a lot of experience in our subsystem, but this will be a wonderful chance for our members to gain this valuable experience. Finally, the Spindles, Brakes, and Rotors team is working on making a CNC program for our new titanium wheel studs and nuts as well as new spindles, which we are also using to gain experience with Mastercam to code the CNC machines. We are excited to see all the designs we worked tirelessly to complete, and Will look forward to reporting our progress next month!
Drivetrain

With only a few months before competition, the Drivetrain subsystem of PSFR is continuing to make steady progress. With all the components for the cooling system ordered and arriving shortly, the last of the major projects is coming to a close. Throughout this month, we have made significant progress on areas that didn’t get as much attention when working on the larger projects. Tasks such as updating and finalizing the drivetrain layout, designing the chain guard, ordering the parts for the chain tensioner, and more. Shown below is the final assembly for the drivetrain of the 2022-23 electric vehicle. The only tasks left to complete are designing a sprocket adapter, drilling the holes in the mounts, and pressing the bearing into the system. Thanks to the hard work of all of the subsystem’s members, Drivetrain is in a great position to complete their tasks for the EV car ahead of schedule.

Finance

This month Finance has continued their support of the PSFR season by organizing funding and purchasing. This month Uline continued their support of the team with product donations that keep the team organized. As we move into March, Finance will be placing more focus on the Formula SAE events of the Business Presentation and the Cost Report.
High Voltage Electronics

This month, High Voltage made some great progress. First off, battery cells arrived from Lithuania over a month ahead of schedule. This was great for us as it means that we can begin testing and integration with the cells far sooner than expected. This puts us slightly ahead of schedule and increases the chance of having more days to test the car before the end of the semester. We ran some preliminary tests on the cell specs and housing fitment, and everything looks great. Additionally, the accumulator (battery) container was welded in the learning factory which marks the completion of the largest stage of accumulator housing manufacturing. Our members did a fantastic job on a relatively tricky aluminum welding job and the box came out fantastic.

We also received our Battery Management System (BMS) from Orion and have begun the testing and integration of that unit. We had some initial issues establishing communication as the BMS needs a proprietary connector to correctly communicate. This has since been fixed and we are in the middle of setting parameters and dialing in the settings. On a similar note, HV has been working closely with LV to finish PCB fabrication for all of the power and control circuits that we design in house. Our team did a great job hitting some tight deadlines on manufacturing and the success rate for designs is well over 50%; this is better than expected for a version 1 of most of these PCB’s.

Lastly, the Electrical System Form (a large spreadsheet documenting the car’s high voltage safety features) is still under review. We revised our charger connections and protocol to be rules compliant, and fixed a few more issues here and there. Once this document is accepted, we will order the last of the HV components needed for the vehicle and begin the final assembly. This follows the shift in our team’s focus from design to manufacturing. Over the next few weeks, we will begin seriously laying out the wiring harness and print housing for our PCBs and other miscellaneous connections.
Low Voltage Electronics

This month was focused on finishing the PCB designs for the car. During this time, we were able to complete the manufacturing of several boards including the power distribution board, brake system plausibility device (shown in the figure below), high-voltage indicator, pre-charge/discharge circuit, and the tractive system active light. We received the boards towards the end of the month. Now, we are in the middle of the testing and validating process, with several boards already tested and confirmed to be functional. Once all the individual boards are tested, the Low-Voltage Team will begin to focus on integrating the components together and start manufacturing the wiring harness.

On the firmware side of the projects, we have outlined several tasks that the embedded system must handle during the vehicle’s operation. Since the number of tasks that the system might handle has increased, we are now investigating the potential benefits of using a Real-Time Operating System (RTOS) compared to our current looping mechanism.

Outreach

The shortest month of the year has proved to be a fun one filled with the continuation of merchandise and livery planning, with a plan set in place to represent the old Penn State colors through pink and black. Similar to last month, Outreach is still coordinating events with other clubs and are looking forward to introducing some more people to our Formula One watch parties! Lastly, keep an eye out for subsystem and project managers coming soon.
Outreach cont.

We are still in the process of doing alumni social media features - if you are an alumni interested in being featured on our Facebook, Instagram, and/or newsletter, please fill out this link: https://forms.gle/iw84Aph4itegWXRJA. If you are an alumni or an individual interested in representing your company and willing to talk with us about what you currently do and any tips or tricks on moving from college into a professional field, please reach out to our Outreach Lead, Lauren Waer (lmw5895@psu.edu)! Also make sure to follow and keep updated with all of our social media, including Facebook, Instagram, and TikTok, where all of the usernames can be found on page 10.

Suspension

The end of February marked a crucial milestone in the design of the suspension, all designs have been frozen, and we have moved 100% to manufacturing. The anti-roll bars were the last designs to be finalized. We have decided to go with a blade arb design in the rear and a normal tube arb in the front. Both of these designs are adjustable allowing us to hone in the perfect setup once we start having track days again. The manufacturing completed in February include the dovetails for the ball joint holder stock. These dovetails are critical because they allow the stock to be held in the 5-axis CNC. We also completed the front arb lever arms (pictured below). Our goal for March is to finish the manufacturing of the uprights and the ball joint holders.
Sponsorships

Thank you to our sponsors for the year thus far:

- Altair, Altium, BEST Center, Calspan Tire Research Facility, MasterCAM, Penn State Department of Mechanical Engineering, Penn State Engineering & Entrepreneurship Program, Penn State Engineering Undergraduate Program, Penn State Institute of Energy and the Environment, Rapid Harness, Rock West Composites, SimScale, Stackpole Engineering, The Piper Group, Uline, and VI-Grade

We are looking forward to your continued support.

Acknowledgements

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- The Applied Research Laboratory
- College of Engineering Faculty
- Ford Motor Company
- Dr. Karen Thole

And thank you to all others who have provided us with constant support throughout our switch to electric.

Contact Us

Interested in joining or sponsorship opportunities? Please contact our team administration below or keep updated with our social media.

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