January 2023

New year, new things happening within Penn State Formula Racing! We've hit the ground running with the start of the spring semester; everyone has been super eager to get involved and back at it. Keep reading to hear from our Team Captain, our efforts to improve the team, a fundraising opportunity, and updates from all of our subsystems.
Captain's Note

Friends of Penn State Formula Racing,

We’re back! It’s a new semester, and that means new members, new projects, and renewed drive. Over the last month – even through a break – the team has achieved many milestones that will be detailed thoroughly in the pages to come. Despite being notoriously wordy, I’ll do my best not to overstep in my level of description here.

Over winter break, major progress was made on the Chassis front, with high-density foam molds having been manufactured. That’s far from the only area of progress, though – our Aero team has nearly finished the design phase and is thoroughly validating its manufacturing methods, the Controls, Brakes and Safety team has moved out of the prototyping phase, both Electronics teams are hard at work establishing communication between major components and honing in on circuit designs, and the Drivetrain and Suspension groups are awaiting the arrival of their major components to begin manufacturing and integration.

In addition, I’d like to give special recognition to our friends at the Penn State Applied Research Laboratory (ARL). Several engineers from across multiple disciplines came in their free time to serve as scrutineers in our first Design Review event of the year, providing invaluable feedback on our team designs and objectives as well as preparation for communicating to judges in the Design event at competition. Their help made our team stronger and revealed new angles from which to tackle engineering problems, and we are grateful for their help.

I’d also like to thank Dr. Jess Menold and the Penn State Learning Factory Staff for hosting a wonderful Diversity, Equity, and Inclusion workshop with our team. As a group, we had the opportunity to embark on several challenging exercises which inspired everyone to keep learning how to be compassionate, welcoming, accountable individuals, and how to build teams that value those same virtues. It also helped us set several targets for our own membership in the near and distant future, all with the aim of becoming a club of more diverse academic and personal backgrounds.

Over the coming month, the team anticipates significant progress in both purchasing and manufacturing across all subsystems. Much of this is thanks to our vast young membership, which just recently received a boost from interest at the Spring Involvement Fair. Many of these dedicated new members have jumped right into the fray and are enthusiastically tackling projects. Their ability to learn on the fly has contributed significantly to the team’s success, and I can’t wait to see what they do in the coming month. Until then, enjoy this edition of the newsletter, and I look forward to checking in again!

Best regards,

Nate Dreyer, Team Captain
Events

Diversity, Equity, and Inclusion Workshop

On January 19th, we held a diversity, equity, and inclusion (DEI) workshop at the Penn State Learning Factory with the help of Dr. Jessica Menold, an Assistant Professor in the College of Engineering and the Associate Director for Outreach and Inclusion within the Learning Factory, and Steven White, the Learning Factory Shop Supervisor. We had over 75 members attend the workshop, with everyone contributing with ideas on how to improve the team's environment and ensure that all members feel comfortable on and within the team's space. We received a significant amount of useful feedback, with the smaller items implemented immediately or soon to be implemented, and the larger items in the works. We are looking forward to having another DEI workshop in the latter half of the semester and are hopeful about creating a more welcoming environment. If you have any suggestions or would like to talk to our team more about DEI, please reach out to the Team Captain, Nate Dreyer (ngd109@psu.edu), and/or the Outreach Lead, Lauren Waer (lmw5895@psu.edu); any feedback is appreciated. Lastly, a big thank you to Ana Cristina Vasquez, who documented the process!

Panda Express Fundraiser

We are having a nationwide fundraiser via Panda Express on **February 15th**! If you are interested in helping us out, make an online order with any Panda Express via [www.pandaexpress.com](http://www.pandaexpress.com) or through the Panda Express app. At online checkout, put the code **913260** in the Fundraiser Code box; this will ensure that we are actually credited for your order! This is only valid on the 15th but we receive 28% of the sales completed using the code. Make sure to grab some friends and/or family and support us!
This month, Aero has been working on getting designs finalized so that we can start manufacturing. This included a large push to get many members working on CFD projects for various flow simulations. The most important of which was running 8 iterations half car simulations, which we are using to find the downforce and lift the car produces. In addition, these simulations give us data on how each aerodynamic element is performing and gives us an idea of the balance of the aerodynamic loads. For this year, we are aiming to place the center of pressure in the rear of the car to create a more stable driving experience.

Looking forward, the next step for Aero is a hefty amount of manufacturing. We recently traveled to Akron, OH to pick up foam for making mold for our airfoils. We also got to visit some new friends at Zips Racing in Akron! We are currently working on getting the large boards of foam cut up to make all our airfoils. In addition, we hope to soon cut the mold for the undertray using foam left over from Chassis’ rear monocoque mold. Once we have everything cut, Aero will be in a great spot to begin manufacturing parts that will end up on the 23 car. This means we will get to move on to testing.

One of the most exciting developments this month in Aero was the announcement that we will be testing at Ford's wind tunnel in April! This is an extremely exciting opportunity and will give us amazing data to compare against our simulations. The testing team has started putting together a testing matrix for a variety of tests that we want to run on the car to validate our designs. The progress this month has been great and hopefully next month we’ll have some finalized parts manufactured!
Aerodynamics cont.

Jon Baer's (Aerodynamics Lead) Car with the Airfoil Mold Foam

Chassis

January has been a busy month for chassis. We started off by submitting our first draft of the SES with hopes of very few fixes and comments from judges. This month we also welcomed new members with the start of a new semester, and they are already putting in the hard work manufacturing. We finally were able to manufacture our nosecone with only slight difficulties while vacuum bagging, and the good news is that it looks great. In order to finish it up we have spent a couple hours sanding to remove any extra material or bumpiness from the carbon fiber. We also have had the opportunity to work on the foam molds for the monocoque itself. Last month we glued them together, but we have spent January applying layers of bondo to even out any gaps on the foam and sanding, going all the way up to 500 grit. With yet another successful manufacturing month in the books we are looking towards fiberglass in February. We are planning to create our fiberglass monocoque molds as well as putting together more layups with aramid. Our timeline has now been given an end date as we have been set the Ford wind tunnel date for midway through April. We are beginning to feel the excitement as it will not be long until we manufacture the monocoque itself.
Controls, Brakes, and Safety

After a final push to get our designs done, CBS is in the midst of purchasing materials and parts to begin the manufacturing process. In the meantime, we have been making progress on our design binder to have concise summary of everything we worked on during the year for competition. This past week, we had a small hiccup with our steering column design. With some thoughtful design reviews, we have found a solution and are finishing it up as soon as possible. For pedal tray, we have recently received a sponsorship from HGSI and will be using their linear potentiometers for the accelerator pedal! We are thrilled to receive this sponsorship and thank them for their donation. Finally, we are working on the CNC program to manufacture new spindles for the car, and are looking forward to gaining some valuable experience in using the CNC machines in Penn State’s FAME lab.

Drivetrain

Drivetrain has had a busy start to the semester. With the help of Saint Mary Tool and Die (SMT&D), the motor and differential mounts have been completely manufactured and are shown below. Furthermore, SMT&D also manufactured our motor shaft. Both of these parts are a huge step forward in our subsystem’s progress. The cooling system for the car has been finalized and the components are going to be ordered in the coming weeks. Over the next few months, we hope to finish the remaining mini projects to finalize all the responsibilities of our subsystem. The mini projects are as follows: the chain and motor guards, the chain tensioner, and the sprocket adapter. Each of these projects have been assigned to a member of the team and progress should be made soon. I (Josh Kaleida, Drivetrain Lead) am very proud of the progress of the Drivetrain subsystem and I expect to have everything done ahead of schedule.
Finance

Recently the Finance subsystem has been communicating with sponsors. PSFR would like to Welcome KCF Technologies as a partner for the 2022-23 season. We would like to thank all of our sponsors for their support of the team and hope to welcome more sponsors onto the team in the next few months.

High Voltage Electronics

High Voltage Electronics has been gearing back up for the semester (no pun intended). We first would like to warmly welcome back LV lead Christopher McKinney from his coop at Tesla in California. With his return, we took a step back to regroup for the semester. We worked to make a systems diagram (Figure 1) which is a layout of all wires and connections that need to be made for the EV car. This is a template for the wiring harness and will act as an ultimate reference when looking at physical mounting and wire routing. For high voltage specifically, we have received our BMS and are in the process of reading and documenting and formulating an integration plan. Additionally, we have been looking into grounding for the chassis carbon fiber. We will likely include a copper mesh in the layup of the rear half of the monocoque. This will keep anything close to high voltage safe from broken connectors or loose HV cables. Additionally, our team has been working on manufacturing a transportation cart for our battery pack. This is a rules-required item that must be used when moving the main battery pack. A piece machined in house by Cooper Denmark can be seen in Figure 2. Moving forward, we will be submitting version 2 of our Electrical System Form on February 5th. This is a huge step for us as the acceptance of this document essentially means our design for the HV tractive system is theoretically sound. Several members have worked to accomplish the revisions to version 1 of this document; shoutout to Eric Junker, Aiden Kluck, and Phil Han. Additionally, we are working on debugging our battery pre-charge controller. This is a simple circuit but must be very robust to ensure that components like the motor controller and motor are not damaged. Simulations of this circuit board are completed and our team, namely Kyle George and Bryan Lim, will be working this week to resolve the issues we are experiencing with the current design. Version one of this PCB (the one with issues) can be seen in Figure 3. We are looking forward to the semester and are excited to build this team’s first electric car!
High Voltage Electronics cont.

Figure 1: Systems Architecture Design

Figure 2: Accumulator Hand Cart Component

Figure 3: Pre-charge Driver Board V1
Low Voltage Electronics

The Low Voltage Electronics subsystem is kicking off the Spring semester with new leadership! Chris McKinney (Junior) has returned from a fall semester internship with Tesla and is very excited to apply the engineering skills he has learned to the club. Since the beginning of the semester, the LV team has been hard at work making consistent progress on firmware development, system architecture, and circuit design. The two microcontrollers that drive our CAN-bus system on the vehicle continue to be tested and integrated with additional vehicle sensors. A detailed full-car schematic of our power and signal wires has been created to prepare for the manufacturing of the wiring harness. This will begin in the next few weeks. Finally, the Low-Voltage team has completed the design for the HV indicator light, and the Tractive System Active Light (TSAL). These designs will be transferred onto a PCB and manufactured within the next two weeks.

Outreach

Winter break and the month of January have marked fun times for Outreach. With the start of the new semester, there has been a reignition of outreach to and involvement with other student organizations that we have previously collaborated with, such as the Society of Hispanic Professional Engineers. We are hoping to expand our collaborative events to other, non-engineering based student organizations as well, such as the Sports Business Club. Merchandise for the new semester is also underway, with designs being done to correlate with our pink and black livery (soon to come), after Penn State's original colors. Social media ideas have been circulating and we are in the planning process of an Instagram competition against the University of Pittsburgh so stay tuned and help us win! 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. Lastly, more professional events are in the works as the spring career fair approaches. If you are an alumni interested in talking 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 11.
Suspension

Returning from winter break means that it is officially manufacturing time. Over winter break, the first accomplishment was finalizing the suspension geometry. This allowed us to start and finish the CNC program for the uprights as well as the CNC program for the ball joint holders. January was all about purchasing the materials and tools needed to manufacture. We also manufactured a couple of parts needed to work-hold the uprights in the CNC. We decided to delay the manufacturing of the uprights themselves in order to run a test program for machining the bearing hole because it is a very critical dimension. The only parts left in the suspension that have not been finalized are the anti-roll bars. Designs have been made and FEA is currently being run to determine the stiffness of the design. The current design is very simple and uses a series of holes in the lever arm to allow for adjustability on the fly. The design should be finalized and ready for manufacturing by the end of February. In the meantime, we can continue to manufacture the parts that we have finalized.

Simulation of Rear Left Upright After 1/3 CNC Operations

FEA of Front Anti-Roll Bar
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.

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- The Applied Research Laboratory
- Dr. Jessica Menold
- Steven White & The Learning Factory

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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