HyperXite 10

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Overview

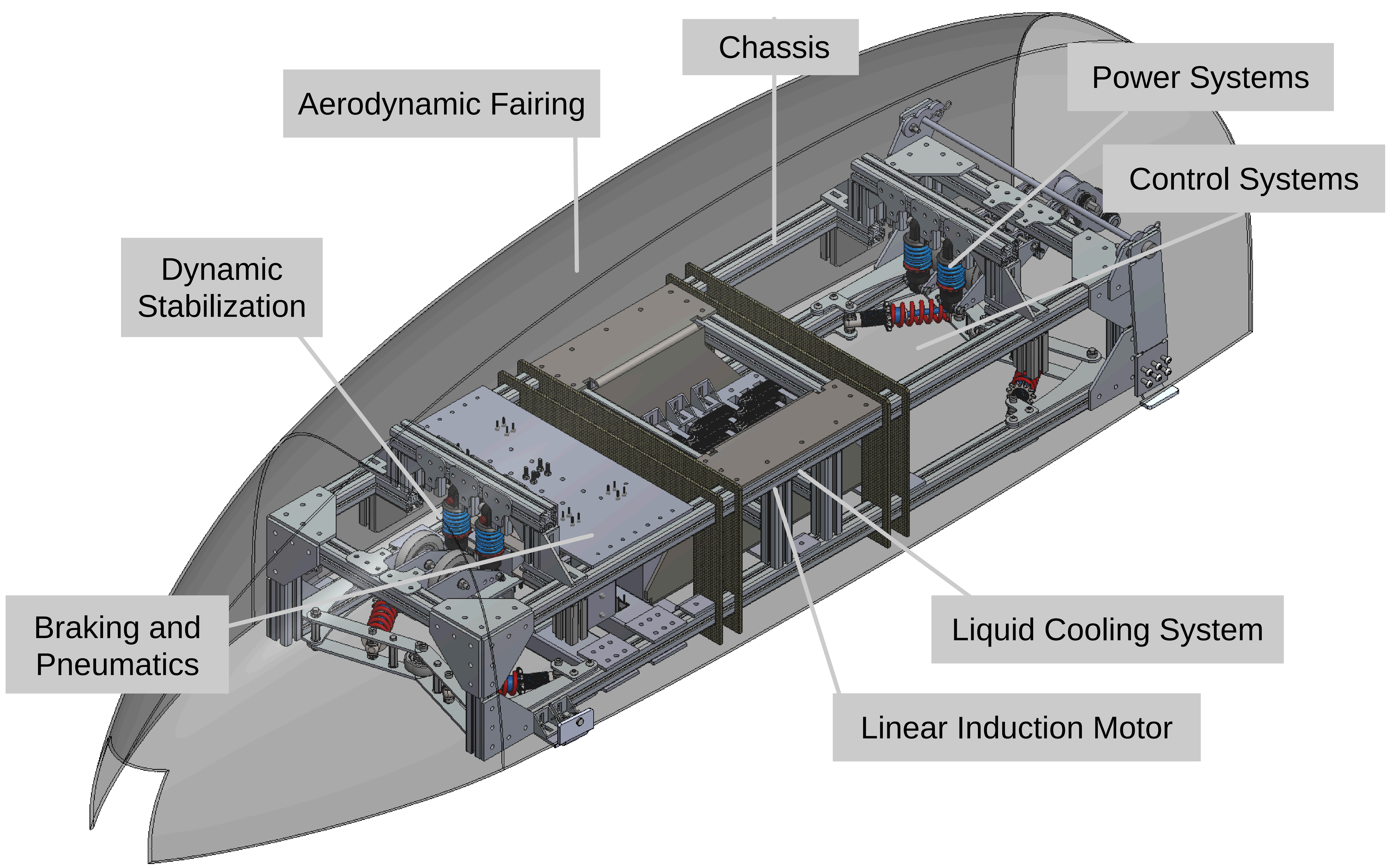
U.S. transportation sector emits 1.9 billion tons of CO2 annually [1]. The Hyperloop is a clean and sustainable alternative form of transportation, relying solely on electric power while being able to travel up to 670 MPH, about 3 times the speed of a high-speed passenger train. Established in 2015 at the University of California Irvine, HyperXite is a team of undergraduate students working to develop a small-scale Hyperloop pod.

Timeline

- Fall Quarter
  - Conduct analysis of previous designs
  - Preliminary subsystem design
  - Final subsystem design
  - Create budget and choose components
- Winter Quarter
  - Component procurement
  - Subsystem manufacturing/assembly
  - Subsystem testing
  - Mechanical pod assembly/integration
  - Communication system integration
- Spring Quarter
  - Control system testing
  - Low and high speed testing

Cost

Static Structures	**$2,929**
Aerodynamic Structures	**$4,254**
Braking and Pneumatics	**$1,966**
Dynamic Systems	**$802**
Propulsion Systems	**$5,580**
Thermal Cooling	**$1,884**
Power Systems	**$4,721**
Control Systems	**$498**
Total cost **$22,625**	

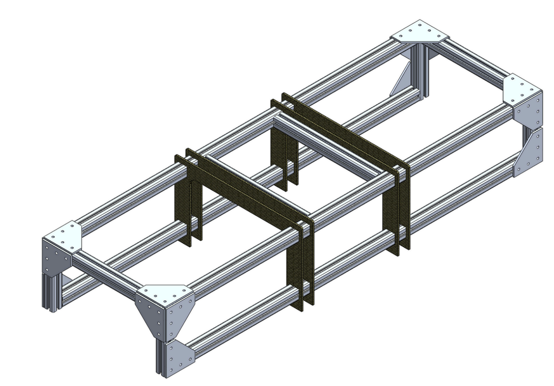


Subsystems

Aerodynamic Fairing

The aerodynamics subteam optimized fairing profiles for efficiency and aesthetics, resulting in a 2.5m pod with only 7 N of drag at 20 m/s, validated through simulations and wind tunnel testing, while also pioneering carbon fiber fabrication using CNC-cut foam molds and composite layup to enhance structural rigidity and advance Hyperloop technology.

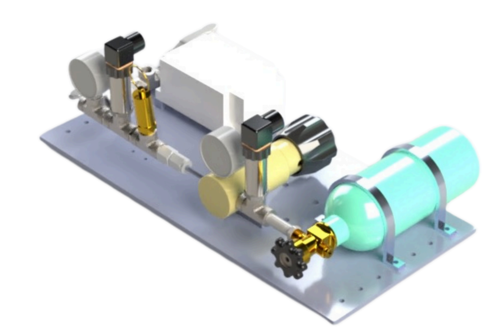
Chassis



This year we focused on designing robust mounting structures for all pod subsystems while optimizing space and weight efficiency. This is achieved by managing a master CAD for reference, maximizing strength-to-weight through FEA simulation, and maintaining regular communication between subteams for design coherence.

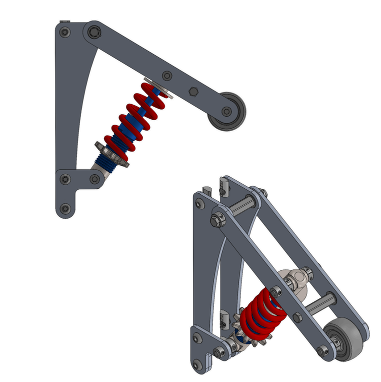
Braking and Pneumatics

The braking system uses six pneumatic actuators and three gas springs to apply a 4000N force on the I-beam track, slowing the pod to a stop. Pressurized air retracts the gas springs, allowing the brake pads to generate friction and ensure a controlled stop, even in failure modes.

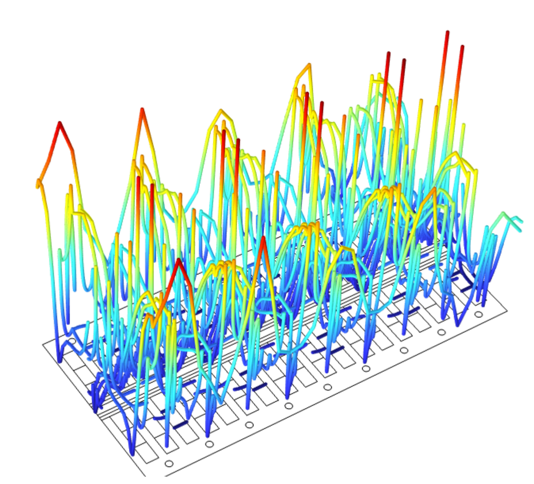


Dynamic Systems

The pod's dynamics, including springs, dampers, and linkages, are designed for effective impact absorption and quick stabilization after bumps. By using six degrees of freedom equations of motion and simulating behavior in Simulink, the suspension system is optimized to minimize vibrations that could dislodge parts.

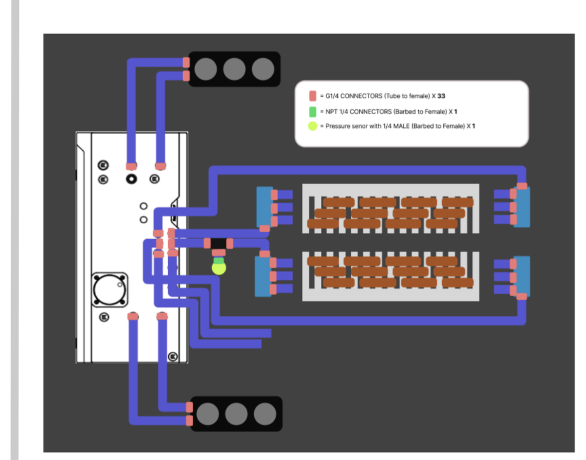


Propulsion System



The pod uses a 3-phase double-sided linear induction motor (LIM) for propulsion, leveraging electromagnetic forces without moving parts for greater energy efficiency. This year, we have optimized the coil winding scheme for increased thrust and developing a winding jig to streamline manufacturing.

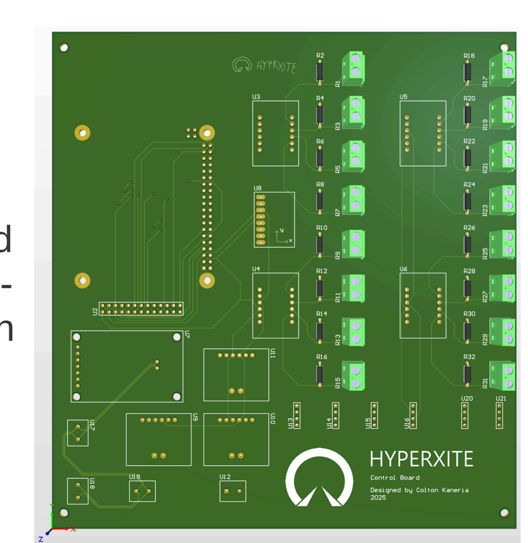
Thermal Cooling



This year, we characterized heat generation in the linear induction motor (LIM) and designed an embedded liquid cooling system to maintain optimal temperatures. The system uses a combined pump and reservoir to enable parallel flow through the coils, maximizing heat transfer.

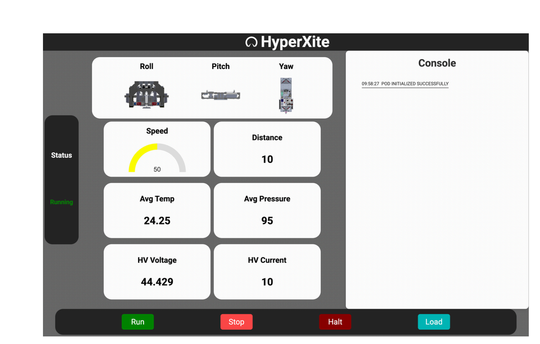
Power Systems

The power subsystem includes a low-voltage system for electronic components and the control board and a high-voltage system supplying three-phase AC power to the linear induction motor (LIM) via a variable frequency drive (VFD). A battery management system (BMS) is being integrated for safety and monitoring.



Control Systems

We have developed a control system for the pod, integrating a finite state machine (FSM) and a user-friendly graphical interface for seamless communication and real-time operations. We aim to enhance system robustness, optimize control flow, and ensure accurate signal processing through rigorous testing.



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Alex Parker: Thank you for your contributions that will enable us to take our pod to competition in Canada.

Sponsors

References

[1] "Transportation Replaces Power in U.S. as Top Source of CO2 Emissions", Yale Environment 360, https://e360.yale.edu/digest/transportation-replaces-power-in-u-s-as-top-source-of-co2-emissions