

# BADGER LOOP

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MEDIA PACKAGE  
COMPETITION IV

# ABOUT BADGERLOOP

## MISSION STATEMENT

*Badgerloop is a student organization founded in summer 2015 at the University of Wisconsin-Madison. Our team primarily consists of undergraduate students from a variety of academic disciplines who are enthusiastic about making the hyperloop concept become a reality. We provide members with an unparalleled learning environment to work on real world problems in a pseudo-startup setting that expands students' education outside of the classroom. Badgerloop is open to anyone with an interest in hyperloop technology and a passion for innovation and learning.*

## ABOUT US

What makes Badgerloop so unique compared to the other teams and organizations on our home campus is our team makeup. Consisting of primarily undergraduate students, we are represented by over 20 majors. Most of them are from the College of Engineering, College of Letters & Science, and the Wisconsin School of Business. Anyone can join our team and have a place to participate and gain leadership. Our mission statement allows for each member to foster innovation, growth, and leadership while having an unparalleled educational opportunity. Whereas most teams incorporate their pod systems into their graduate curriculum, we are teaching ourselves the necessary information while simultaneously fulfilling our school responsibilities.

Now competing in the fourth [SpaceX Hyperloop Pod Competition](#), our design not only reflects the hard work we have put in this year but also lessons we have learned from previous competitions. We have high expectations for ourselves in Hawthorne this summer, and we believe that we have the necessary members and resources to achieve them.

## ABOUT HYPERLOOP

The hyperloop system is a concept created by SpaceX founder Elon Musk in 2013. It involves a pod traveling in a low-pressure tube at speeds faster than air travel. Essentially, one could get from Minneapolis to Chicago in 30 minutes. For the competitions, SpaceX built a hyperloop tube and the teams competing are building the pods.

Since the concept was first published, hyperloop has gained worldwide interest for its incredible speeds, low power consumption, low carbon footprint, and low construction and operational costs compared to other modes of high-speed ground transportation. By reducing the pressure in the tube, pods are able to travel at significantly higher speeds due to a decrease in air resistance, and through the use of magnetic levitation there is a marked decrease in friction which also helps achieve higher speeds.

In addition to SpaceX and The Boring Company, many private companies have begun developing and testing hyperloop concepts all over the world.

For more information on the hyperloop concept, read [Elon Musk's 2013 paper](#).

# ABOUT BADGERLOOP

## ORIGINS

In August 2013, Elon Musk published a white paper on the concept of hyperloop technology. The document was met with mixed reviews, but Musk expressed interest in sponsoring a competition to further develop the technology. On June 15th, 2015, Musk's company SpaceX announced plans to hold the first SpaceX Hyperloop Pod Competition at the company headquarters in Hawthorne, CA. The competition was structured around two elements: design submissions from universities across the world and a mile-long vacuum run in Hawthorne to test the designs.

## COMPETITION I

Badgerloop was founded in Fall 2015 with the goal of competing in Competition I. We were one of over 700 teams to submit initial designs and one of approximately 120 to be invited to the first phase of the Competition, known as "Design Weekend." In January 2016, our design placed third in the world at this event, and we were invited to the second phase of the Competition. This was called "Competition Weekend" and took place in January 2017. We received an Innovation Award from SpaceX for our unique design that emphasized the scalability of hyperloop technology. Competition I was a huge success for our organization: it showed that we could compete with some of the best technical universities in the world. It was also a success for SpaceX because the competition generated a tremendous amount of interest in hyperloop technology. Based on these factors, Elon Musk announced plans for a second competition in Summer 2017.

## COMPETITION II

In April 2017, Badgerloop was notified that we were one of 24 teams to compete at SpaceX's second competition. Competition II deviated from Competition I in a few ways: it was judged only on speed, and it allowed teams to use a "pusher" provided by SpaceX to give their pods a boost at the start of the track. Competition II took place in August of 2017, and we established ourselves as one of the top seven teams in the world. Additionally, we took home another SpaceX Innovation Award for the unique design of our pod's propulsion system which utilized cold gas thrusters.

## COMPETITION III

SpaceX notified Badgerloop of plans for a third competition in September 2017. Notably, this Competition removed the "pusher" from the previous competitions, meaning that our new pod had to be self-propelled from start to finish. We submitted one of 20 designs that advanced to the third competition in Hawthorne on July 15th-22nd, 2018. We are one of only nine teams in the world to be invited to all three SpaceX Hyperloop Pod Competitions. During Competition III, we were one of four teams chosen by SpaceX to present our pod design to the public: a sign that SpaceX believed our design had substantial promise. At the end of the event, Elon announced plans for a fourth Competition in Summer 2019.

More information is available at [badgerloop.com](http://badgerloop.com).

# POD IV OVERVIEW

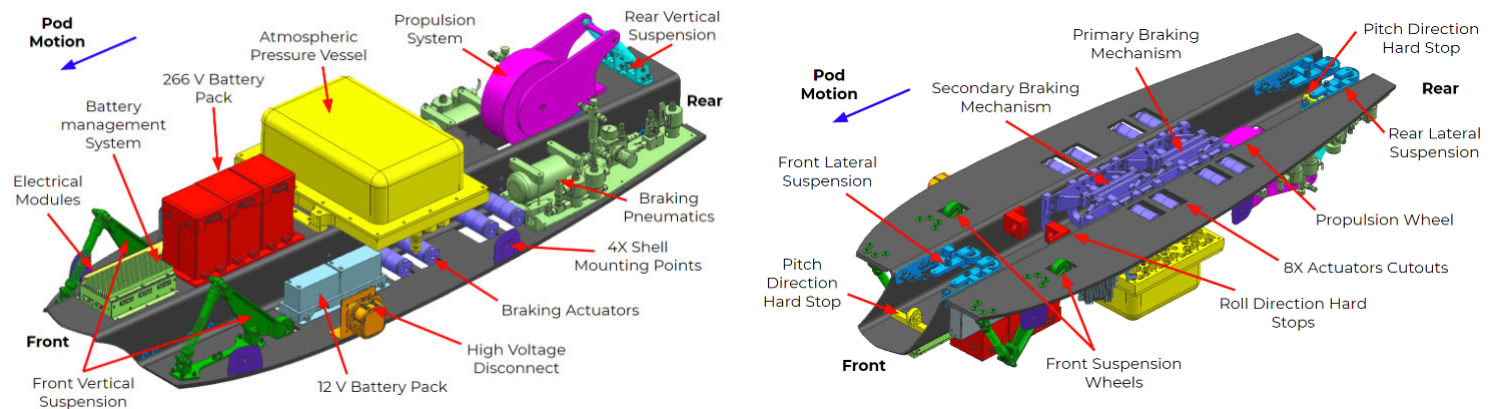
## MECHANICAL SYSTEMS

The **structural system** consists of a carbon fiber chassis and shell. The shell provides a sleek aerodynamic surface for the pod and the chassis serves to mount all of the other subsystems and hold all of the loads that we will experience during a run.

The **propulsion system** uses an electric motor and a direct drive mechanism. As well as propelling the pod forward, the propulsion wheel also acts as part of the vertical stability system.

The **stability system** is composed of two separate systems. The vertical system holds the pod's weight, and the lateral system keeps the pod from moving left and right.

The **braking system** clamps on the I-beam with 2400 lbf. and slows the pod down with friction. This system is driven pneumatically.



## ELECTRICAL SYSTEMS

The **low voltage system** handles the sensors, valves, and communication necessary for the pod to function. This system consists of single-board computers that communicate to one another, the battery management system, and the motor controller. The computers interpret the sensor data to monitor the pod's current state and safely control the pod during the run. In addition, all the sensor data is sent to an external display on our dashboard. Some of the sensors on the pod are retro-reflective sensors for detecting position within the tube, pressure sensors for ensuring that the braking system has sufficient pressure to stop the pod, and an accelerometer for monitoring the pod's acceleration. Using these sensors, the low voltage system determines when the pod needs to start braking, and in turn actuates the brakes.

The **high voltage system** is responsible for safely accelerating the pod through the tube. The high voltage battery is made of 72 lithium polymer cells wired in series to reach a maximum voltage of 295.2V. This voltage is then put through the motor controller and inverter to power the 3-phase AC 60 kW motor. The motor controller is contained within a pressure vessel, to prevent high-voltage arcing due to the vacuum environment in the tube.

# TEAM BREAKDOWN

## ELECTRICAL & MECHANICAL

SUB-TEAM NAME	DESCRIPTION	TEAM MEMBERS
Executive	Oversees the team as a whole	<b>Mark Swartz, Mitch Wall, Ethan Link, Emma Krueger</b>
Software	Create the pod's dashboard, database, and servers	<b>Eric Udalis, Luke Houge, Alex Vessel, Michael Handler</b>
Controls	Build the pod's embedded systems by writing code for microcontrollers	<b>Ezra Boley, Rohan Daruwala, Saketram Durbha</b>
Low Voltage	Work with sensors and data acquisition, pod actuation, harnessing, and system architecture	<b>Kevin Guenther, Brianna Tobin, John Eslinger, Keegan Gruss, Alex Ouellette</b>
High Voltage	Implement the motor and motor controller into the pod	<b>Wyatt Dvorak, Nate Schlueter, Griffin Hood</b>
Battery	Create a high voltage battery system to power the pod's electric motor and drive system	<b>Shelby Riggleman, Andrew Cook, Ben Janquart, Evan Palmer, Yasmine Abdennadher</b>
Braking	Stop our pod using friction brakes	<b>Mitch Wall, Katie Argo, Sarah Schultz, Mehmet Sirtalan, Jonas Tost, Travis Thyres</b>
Propulsion	Create a high-speed, direct drive system and wheels to propel the pod.	<b>Nathan Berg, Alex Wells, Achintya Krishna, Adam Wiegel, Patrice Tandifor, Peter Sviatoslavsky, Yuanheng Gan</b>
Stability	Design the pod's suspension system	<b>James Ewald, Kaushal Nair</b>
Structural	Build a composite structure for the base and shell of the pod	<b>Helena Van Hemmen, Nathan Orf, Gabby Every, Zach Kimball, Michael Niemiec</b>
Analysis	Create our pod's run profile and sensor interpretation	<b>Bryan Tanck</b>
Fabrication	Support mechanical teams by researching and implementing new fabrication methods	<b>Matt Horan, Nick Edwards, Joe Seifert, Jordan Gardipee, Alex Wells, Miles Perkins</b>

# TEAM BREAKDOWN

Our **operations team** is divided into seven smaller sub-teams: communications, finance & supply chain (FSC), feasibility, outreach & recruiting, website, virtual reality (VR) and industry relations.

The communications team to create content for our social media outlets and market our brand. The finance & supply chain team manages our funds and purchases all the materials necessary to build the pod and attend the competition. The feasibility team analyzes the practicality of hyperloop technology as a whole with the goal of understanding how our technology can have a real-world impact. Outreach & recruiting is responsible for educating the public about hyperloop technology at a variety of events, as well as recruiting and onboarding new members. The website team works to maintain and develop [www.badgerloop.com](http://www.badgerloop.com). Virtual reality is tasked with using augmented reality technology to create unique, innovative experiences at events. Lastly, our industry relations team obtains both the monetary and material donations needed to build the pod and maintains sponsor relations thereafter.

More often than not, these sub-teams collaborate and overlap with each other, and as a result of this, the goal of operations is best described as equipping Badgerloop with all the tools necessary to succeed.

<b>SUB-TEAM NAME</b>	DESCRIPTION	TEAM MEMBERS
<i>Industry Relations</i>	<i>Work with existing sponsors and build new relationships</i>	<b>Jack Swanson</b>
<i>Outreach &amp; Recruiting</i>	<i>Facilitating outreach events and onboarding new members</i>	<b>Cade Geldreich, Isak Bowron</b>
<i>Finance &amp; Supply Chain</i>	<i>Manage the team's finances, and make purchases. Implement organization methods</i>	<b>Vito Gerlach, Ben Severt, Nick Cannon, McKenna Ruppert</b>
<i>Communications</i>	<i>Show the world all about Badgerloop through social media and other multimedia content. Maintain team brand</i>	<b>Kevin Chukel, Eva Cox, Laurel Noack</b>
<i>Virtual Reality</i>	<i>Develop unique VR experiences for users, get an in-depth look at the pod and all of its subsystems</i>	<b>Nick Stoffel, Marc Zhang</b>
<i>Feasibility</i>	<i>What it would take to build a real hyperloop system through Wisconsin</i>	<b>Utkarsh Maheshwari, Johnny Kohlbeck, Josh Neerdaels, Ilyas Al-Lawati</b>
<i>Website</i>	<i>Maintain <a href="http://www.badgerloop.com">www.badgerloop.com</a>, develop database tools and improve workflow processes</i>	<b>Liam Mahoney, Luke Houge, Jules Vigy, Marcus Fang</b>

# FREQUENTLY ASKED QUESTIONS

## **What is the projected competition cost breakdown for Badgerloop?**

**Monetary:** \$21,750

**California:** \$17,000

**Pod materials:** \$50,000

## **How much does the Badgerloop pod cost?**

**Total:** \$71,750

**Monetary:** \$21,750

**Pod materials:** \$50,000

**Other:** \$200,000+ in software licenses

## **How much money has Badgerloop raised?**

**Total:** \$109,850

**Monetary:** \$79,850

**Pod materials:** \$30,000

**Other:** \$200,000+ in software licenses

**Leftover from Competition III:** \$28,767.00

## **What is Badgerloop/hyperloop?**

*The hyperloop system is a concept created by SpaceX founder Elon Musk in 2013. It involves a pod traveling in a low-pressure tube at speeds faster than air travel. Essentially, one could get from Minneapolis to Chicago in 30 minutes. For the competition, SpaceX built a hyperloop tube, and the teams competing are building the pods. Badgerloop is a student organization found on the University of Wisconsin-Madison campus. Badgerloop formed in 2015 and competed in both Competitions I and II. What makes Badgerloop so unique compared to the other teams and organizations on our home campus is our team makeup. Consisting of primarily undergraduate students, we are represented by over 20 majors. Most of them are from the College of Engineering, College of Letters & Science, and the Wisconsin School of Business. Anyone can join our team and have a place to participate and gain leadership skills. Our mission statement allows for each member to foster innovation, growth, and leadership while having an unparalleled educational opportunity. Whereas most teams incorporate their pod systems into their graduate curriculum, we are teaching ourselves the necessary information while simultaneously fulfilling our school responsibilities.*

## **What is the future of Badgerloop/hyperloop?**

*Badgerloop stands for the idea that Wisconsin students should go above and beyond any challenges, big or small. For the organization itself, we will continue being a competitive team in the hyperloop competition so long as the competition is around. Hyperloop, as a whole, is an industry that is rapidly developing and is dependent on developments on the infrastructural and political fronts. Current hyperloop technology is already advanced enough to be capable of achieving a minimum viable product, but a fully functional hyperloop system will require the infrastructure and political backing of many communities, states, and countries in order to achieve its full potential.*



# FREQUENTLY ASKED QUESTIONS

## **How does Badgerloop recruit members?**

*We attend student organization fairs held by the university each semester and we also are present at events designed to recruit current high school students admitted to UW-Madison. Being active in both of these settings allows us to recruit current and future Badgerloopers.*

## **How else can people interested in hyperloop meet Badgerloop members?**

*Badgerloop has participated in five different events during this competition, directed towards both families and students. These include Engineering Expo, FutureQuest, Science Saturday, the Wisconsin Science Festival, and multiple student organization fairs. Follow our team on Facebook, Twitter, Instagram and YouTube to stay up-to-date on any upcoming events we have!*

## **What has Badgerloop done in the past competitions?**

*Badgerloop has taken 3rd place at the first and only Design Weekend, won Innovation Awards at Competitions I & II, and was given the Dean's Award of Excellence at the 2017 Bucky Awards. Badgerloop has improved technically and operationally with each competition. We look forward to continuing on that path this summer as we approach Competition IV.*

## **When is the hyperloop competition?**

*Competition IV is July 21st, 2019 at the SpaceX headquarters in Hawthorne, California.*

## **How fast will the pod go and how is the pod propelled forward?**

*The pod is expected to reach a maximum speed of 188 mph with an electric motor connected to a direct drive mechanism.*

## **How will the pod brake?**

*The pod uses compressed air to press brake pads into the sides of the I-Beam in order to produce nearly 3 G's of deceleration. High pressure air drives an actuator that clamps down on the track with about 2400 lbs of force, similarly to when you brake on a bike, but really hard. Your hands can make about 10 pounds of force when you slow down your bike, so imagine if your hands were over 200 times as powerful!*

## **What is the pod's structure made out of?**

*The structure and shell are carbon fiber with a honeycomb core. The pressure vessel has two halves—one is carbon fiber and the other is aluminum—and it will keep electrical systems at 1 atm of pressure while we are in the vacuum tube.*

## **What software is Badgerloop using for Virtual Reality (VR)?**

*Badgerloop VR uses the Unity game engine, Autodesk Maya for 3D modeling, Leap Motion tracking software, and PiXYZ for 3D model conversions.*



# FREQUENTLY ASKED QUESTIONS

## **What type of motor is used in the pod?**

*An Emrax 188 MV with 70 kW peak power, 7000 rpm max, 8500 rpm peak, and 100 Nm peak torque.*

## **What programming language is primarily used for the pod's dashboard?**

*It uses a mix of JS/CSS/HTML.*

## **Will the pod break?**

*According to our analysis team, who uses ANSYS to simulate this, it shouldn't!*

## **How much does the pod weigh?**

*139 kg, or 306 lb.*

## **How long will the pod run take?**

*The pod has a run time of 25 seconds.*

## **Who is Badgerloop competing against?**

*Badgerloop is competing against 20 other university teams from around the world, both graduate and undergraduate.*

## **What is the feasibility of hyperloop in the midwest?**

*The goal of hyperloop in the midwest is to connect Chicago and Minneapolis with a high speed transportation system through Madison and Milwaukee. This transportation system would also tremendously help the economies of mid-major cities like Eau Claire, for example.*

## **What is the Badgerloop team breakdown?**

*Most of our engineering students come from mechanical, electrical, computer, industrial, and aeronautics backgrounds. Other team members have backgrounds in biology, physics, mathematics, computer sciences, finance, communications, and sociology. In total, we are represented by students from 21 majors!*

## **Why does the pod need a pressure vessel?**

*The pressure vessel protects the high voltage components that are not rated to operate in a low pressure environment. The batteries can be in a vacuum environment, but will begin to outgas and expand when they are placed under a large load in vacuum conditions. The motor controller has internal traces that are not spaced correctly for high voltage in a vacuum environment.*

# MEDIA INQUIRIES

## CONTACT INFORMATION

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## POD IV REVEAL

*Wednesday, April 17, 2019      7:00 PM CST*  
*Memorial Union Great Hall, UW–Madison*

Doors open at 6:45pm. This event is free and open to the public.

## PHOTOS & VIDEOS

A collection of photo and video content for use by the press is available [here](#).

\*\*All photos and videos are property of Badgerloop and should be credited as such.

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