Case study

University of Wisconsin-Madison Badgerloop Team

Students use HP Z Workstations to develop immersive VR, defining the future of Hyperloop travel possibilities

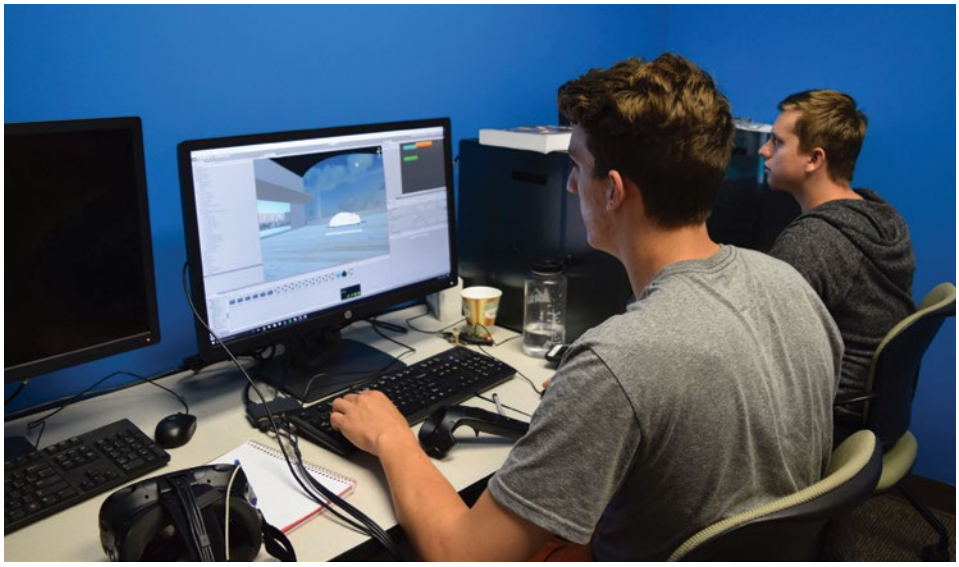
Industry
Higher Education

Objective
Create virtual reality experience to showcase Hyperloop team's pod design for SpaceX-sponsored competition

Approach
Use HP Z Workstations and HP Z Displays to perform, complete, and see compute- and graphics-intensive rendering

IT matters
- Accelerate rendering
- Enable fine-grain shading and lighting
- Perform complex calculations

Business matters
- Advance to next level in first SpaceX competition, winning an innovation award
- Enhance VR experience for second competition
- Free students to envision and explore futuristic applications

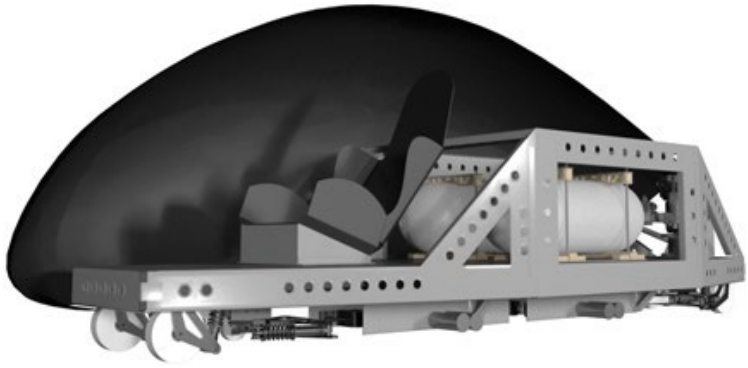


"The HP Z Workstations made it possible not only to inform people what Hyperloop is, but also to give students a chance to learn cutting-edge VR technologies unavailable in most classrooms."

– Peter Procek, Leader, Badgerloop Virtual Reality team, University of Wisconsin-Madison

In the summer of 2015, a new student organization called Badgerloop formed at University of Wisconsin (UW)-Madison. Their mission is to tackle the science and engineering challenges of Hyperloop—a concept of super-fast passenger and freight transportation using pods propelled through reduced-pressure tubes, first proposed by Elon Musk of SpaceX. To encourage students to explore the topic, SpaceX has sponsored competitions open to participants globally.

In the first competition completed in early 2017, Badgerloop won an innovation award—one of six awards given—for their pod design and ventures into virtual reality (VR) explorations. HP Z Workstations are at the forefront of the Badgerloop efforts, managing the intensive computations to support the team's vision and 3D interpretation.



As a public land-grant university and prolific research institution, UW-Madison has empowered students to pursue world-class education and solve real-world problems for nearly two centuries. Peter Procek was an undergraduate in computer engineering and computer science when he first learned about the Hyperloop competition, and he joined Badgerloop to help out with the embedded systems the team was building into its pod. Upon joining, a new opportunity beckoned: using virtual reality to let people experience what the pod was all about, inside and out. So Procek formed Badgerloop's VR team and started enlisting participants. His first recruit was Cale Geffre, another UW-Madison student in computer engineering and computer science. The two had already worked together at the university's Living Environments Lab, on VR uses in fields such as healthcare.

Musk initiated the Hyperloop Pod Competitions to spur exploration. At 700 miles per hour, a Hyperloop pod, if it could become a reality, would propel passengers from San Francisco to Los Angeles in roughly half an hour—half the time of a passenger jet.

"We wanted to use virtual reality to inform people what Hyperloop is and, more importantly, to create a platform for students to learn various computational graphics and design concepts through virtual reality while exploring meaningful applications in fields such as engineering," Procek says. "I wanted to create a place where students could learn about and use cutting-edge technologies that aren't available in most classrooms."

VR development requires massive computing and visualization power

Virtual reality is computer-generated simulation of 3D images or environments with which participants—using electronic equipment like head-mounted displays or sensor-fitted gloves—can interact in ways that seem real. For the Hyperloop competitions, Badgerloop wanted to create a VR experience that let participants put on a headset and see the pod appear before them in full scale. Then, pushing a virtual button, they could see the exterior shell of the pod come off to reveal the underlying components, and the mechanical and electromagnetic forces at work.

To render their simulations with high fidelity, it takes massive computing and graphics power. Procek and his team use a combination of Autodesk® Maya® 3D and Blender® computer graphics software and export the models into the Unity® game development platform. Attempting to build robust visualizations with anything less on an average desktop results in long wait times, a fast crash, or intermittent combinations of both.

HP Z Workstation delivers high-end performance

That's where HP Z Workstations come into the picture. Built for high-end computing and visualization, the HP Z840 Workstations are configured with heavy duty processing power, professional graphics, memory, and internal storage capacity. The first test of these workstations came during the first Hyperloop

Customer at a glance

Application
Virtual reality simulation using Autodesk® Maya® and Unity®

Hardware
- HP Z840 Workstation, configured with:
  - Intel® Xeon® E5-2637 v4 processor
  - NVIDIA® Quadro® M6000 Graphics Card
- HP Z Display 27i

HP provided University of Wisconsin-Madison Badgerloop Team with Z Workstations.

competition. Under deadline pressure, the team had no time to optimize its intensively detailed design models, which ran into millions of polygons. Dropping the models into Unity and running the application on any other computer Badgerloop had available would not have been feasible. "The HP Z Workstations didn't even break a sweat," Procek says. "They allow us to render incredibly fast and efficiently—and they're powerful enough to stay current for years even as the software grows more demanding. This machine allows us to drop in our CAD models and view them in rapid succession with little hassle, providing an opportunity for the potential of using VR as a means of prototyping."

Procek utilizes the NVIDIA® Mental Ray Maya plug-in to leverage the HP Z Workstations for real-time rendering. The 3D models Badgerloop uses employ richly detailed shading, lighting, and coloring. Under typical technology constraints, the models would be rendered in batches, forcing the creator to wait perhaps hours for the final image or animation. The ability to render in real-time frees the creative process, allowing more and faster iterations to perfect the work for VR applications. "My computer at home struggles to render the things I'm doing, whereas the HP Z Workstations rip through them, so you can afford a higher fidelity in the things you're trying to visualize," Procek says. "That smashes barriers between what you can imagine and what you can achieve." Badgerloop also has three HP Displays to complement the workstations with high-resolution images. "With 5K, you have very dense pixels per square millimeter," Procek says. "It means you can visualize amazing things with great clarity and colors."

Noah Pulvermacher, media team lead, utilizes one of three HP Z Workstations the Badgerloop team has to render all 3D images of their pod for their media and documentation. On his personal laptop, featuring a GTX 960M, some renderings done at 1.5 quality settings in Maya took eight minutes compared to about 50 seconds on the HP Z Workstations. That's a lot of time savings when having to render hundreds of images.

Procek also uses the Z Workstations to perform simulations of the SteamVR tracking system they use in their VR work to optimize sensor placement when creating custom tracked objects. Running 10 simultaneous simulations on a scaled version of their second pod, Procek can complete these simulations in about 25 minutes on the Z Workstations, compared to his laptop—running on a GTX940mx GPU and quad core Intel® i7-7500U CPU—completing the same simulations with same parameters in over an hour.

Unlocking the potential of discovery

At the Hyperloop Design Weekend competition in 2016, Badgerloop earned third place out of 120 international teams. Since then Badgerloop has competed in two Hyperloop Pod competitions and won back-to-back innovation awards. In their most recent competition on SpaceX's test track in California, Badgerloop's vision to create a light, fast, and safe pod—along with an interactive virtual museum depicting the pod and how it works—garnered much attention as they demonstrated proof of concept using VR for design prototyping. They are now gearing up for their next competition.

Procek and Geffre are already thinking about new applications for virtual reality. VR imagery of home environments might help medical-device makers design products to function effectively in the home—something already being explored at the Living Environments Lab. Or, VR might become a manufacturing prototyping tool to explore product designs before fabricating components. All of these are rich areas for student learning and exploration. Recently, HP introduced the VR-ready HP ZBook G4 Mobile Workstations.

"You open your mind and see a lot of potential to where you can go with virtual reality—in living environments, healthcare, manufacturing processes, and more," Procek says. "The HP Z Workstation brings the power to unlock that potential."

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