GVIS Visualizations Archive

Manufactured Ecosystems [1]

The Manufactured Ecosystems VR experience gives users a glimpse into the future! This demonstration is and imagined scenario where humans have been living on Mars long enough to fully sustain themselves in a circular, efficient, and effective manner. The settlement's design is based around making inhabitants feel as integrated with nature as possible. This VR visualization shows an example of a Martian Greenhouse Dome, fitted with a myriad of plants, drone pollinators, irrigation systems, and nutrient cycling technology.

Users can walk around the ecosystem between two connected rooms and interact with signage which explains the surrounding environment and the reasoning behind its design. One dome is designed as greenhouse, focused on growing agriculture required for a life on Mars. The other is a park with benches, meant to be a community space. The intention of the ecosystem is to give users a sense of connection with nature while also incorporating the aesthetics of the Martian landscape. The architecture of the ecosystem is created with recycled Mars regolith. There are also Solar Trees, which are solar panels designed to mimic a tree. It is fitted with "leaves" of solar panels all connected to a larger "tree trunk". These leaves are mechanical and follow the sun throughout the day. These trees further combine the aesthetics of an ecosystem with necessary technology for Martian life.

[1]

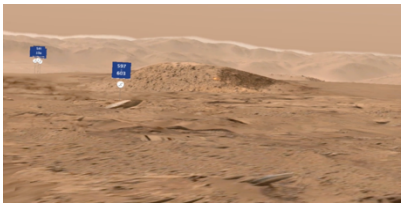
NEAT Visualizer [2]

The NASA Electric Aircraft Testbed (NEAT) is a new aeronautics test site at Neil Armstrong Test Facility (ATF) in Sandusky, Ohio. NEAT provides end-to-end ground testing of megawatt (MW)-scale electrified aircraft powertrains to demonstrate next-generation hybrid and turboelectric commercial aircraft capabilities. This facility is fitted with a vacuum chamber, allowing it to simulate altitudes up to 60,000 feet. This visualizer is a virtual reality experience where the user can explore a to-scale model of the new facility, including the control room, vacuum chamber, and office space.


[2]

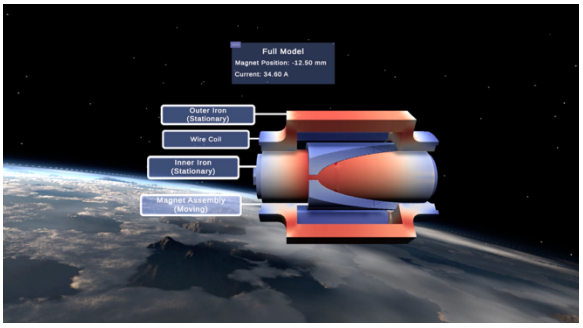
Mars Rover AR Visualization [3]

In this demo, users can don a HoloLens Headset and see the surface of Mars! The visualization creates an augmented reality of Mars's surface right in front of the user. As the user walks around in real space, they are also walking around Mars. The images of Mars's surface were taken by NASA's Curiosity Rover and stitched together to create a seamless Martian environment. While exploring the surface, users can also find Curiosity and see it up close. The visualization also allows for instant transportation across the surface as an alternative to walking in real space.


[3]

HEMM Linear Motor Visualization [1]

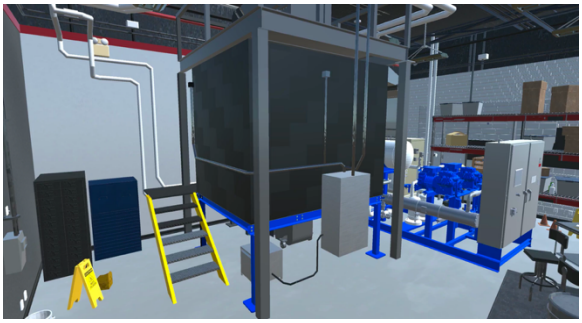
Glenn Research Center is currently developing the HEMM: High-Efficiency Megawatt Motor. This motor is being designed to meet the demand for electrified aircraft propulsion. To keep the motor as powerful and as efficient as possible, it must be kept at extremely low temperatures (62 K/-211ºC/348º F) by a cryocooler. There is a linear motor inside HEMM whose piston drives the cryocooler. This visualization, developed in Unity for the GRUVE lab, displays the magnetic flux density created by the piston of the linear motor. The pressure waves generated by the piston create a cooling effect, keeping HEMM at its necessary super low temperature.



[1]

AIT Digital Twin and Fluid Simulation [2]

The Adaptive Icing Tunnel (AIT) is a closed loop, refrigerated icing wind tunnel currently under construction at NASA Glenn. It has a 1 ft by 1 ft test section and is capable of air speeds up to 110 m/s. It will be used to mimic icing conditions for small objects, such as satellites. The test section also has an enclosed walk-in freezer allowing for in-situ ice sample extraction and testing. This visualization, developed in Unity for the GRUVE lab is a digital twin of the AIT.

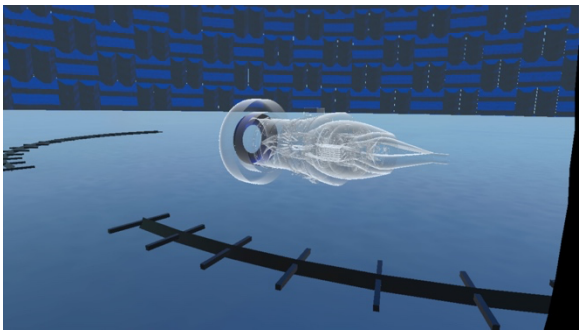


[2]

DGEN-XR [3]

The DGEN-XR audio and visualization is a recreation of an engine test within the GRC AAPL (Aero-Acoustic Propulsion Laboratory). The test involved surrounding an engine with microphones. This demo attempts to correctly recreate the spatial the audio collected during the test. In the demo, each microphone can be selected and interreacted with in isolation. Additionally, interacting with an individual microphone reveals information about the selected audio source. The user can also select swappable parts to place into the model engine, which causes a change in the audio output.

This model can be interacted with in both virtual reality and augmented reality.



[3]

Lunar Communications Architecture for Future Artemis Missions [1]

At NASA Glenn, an emulation environment within the MATRICS system is utilized to test cutting-edge technologies developed during the Lunar LTE Studies Project, or LunarLiTES. LunarLiTES aims to assess the applicability of 4G and 5G technologies in the lunar environment, with the ultimate goal of providing future lunar explorers with the same level of seamless communication they enjoy on Earth.

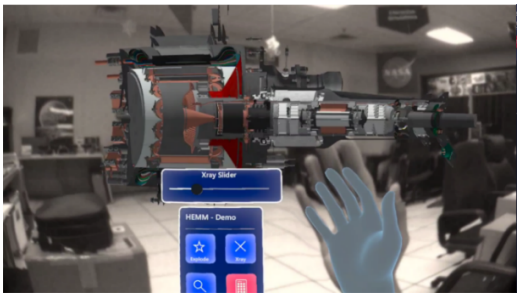
The LunarLiTES team is dedicated to enhancing the Multiple Asset Tested for Research of Innovative Communication Systems (MATRICS) emulation environment by introducing 4G and 5G capabilities. The specific objective is to analyze the performance of 4G and 5G communication systems on the lunar surface.

The lunar communications architecture animation not only showcases the Lunar LTE Studies project but also highlights the pivotal role played by SCaN's team at NASA Glenn. The primary intention with this visualization is to educate and engage the public, shedding light on SCaN's mission and its significant contributions within the NASA agency.

[1]

HEMM AR Application [2]

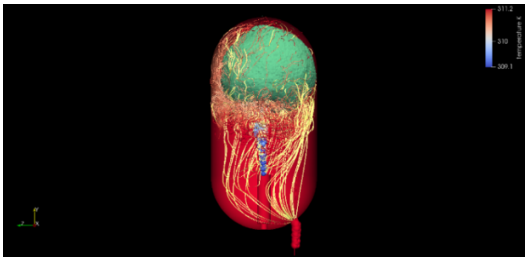
Developed within the realms of Unity 3D in C# and optimized for the Oculus Quest 2, this app is a gateway to augmented reality. By utilizing the device's external cameras, it seamlessly blends the virtual and real worlds. With intuitive hand tracing and wireless freedom, even beginners can become proficient within minutes. The app's mission is to democratize augmented reality, allowing users to experience 3D models and data visualizations affordably. This accessibility paves the way for widespread integration in education, capitalizing on the power of visual learning without being expensive.



[2]

ZBOT [3]

NASA is working to improve storage of propellants in space. One of the most efficient propellants, liquid hydrogen, cannot be stored long-term in space—it must be kept very cold (20K) or it will boil off. This visualization shows a computer simulation of a liquid hydrogen propellant tank with an internal "jet mixer" to help equalize the internal fluid temperatures. It'll be used to help analyze the effectiveness of this method with the aim of being able to store liquid hydrogen more efficiently for space missions.



[3]

W-1A Small Core Research [1]

W-1A is NASA Glenn's Low Speed Axial Compressor facility. This virtual reality experience allows the user to take an immersive and interactive tour of the facility as it is being used for recent work on jet engine casing treatments. Using a VR headset or the Cave Automated Virtual-Reality Environment (CAVE), the user can explore the facility's environment, examine the engine and pick up objects to better inspect them in a seemingly realistic way. This video displays a W-1A Visualization.

[1]

GRC Wind Tunnel Lobby (Building 54) Virtual Tour [2]

The Building 54 virtual tour provides users with a detailed look inside the lobby leading to Glenn's 9- by 15-Foot Low-Speed Wind Tunnel and 8- by 6-foot Supersonic Wind Tunnel. A virtual tour guide offers information on the facility and research as the user explores the space. The application was developed for use on both virtual reality headsets and in non-VR via the web and provides a window into the work being done at Glenn without needing physical access to the facilities.

[2]

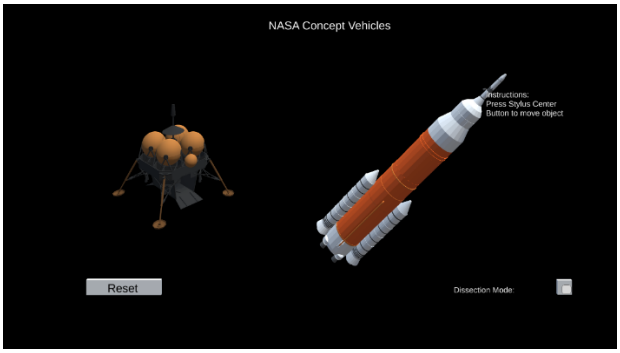
Interactive Holographic Aerospace Models [3]

NASA has a large collection of 3D models of aircraft, space vehicles, satellites and more. The 3D model viewer created by the GVIS Lab uses a hologram display, Leap Motion, and touch screen technology to provide a simple interactive viewer to examine a wide variety of these 3D models. The user navigates through the list of models and chooses one to display. The Leap Motion sensor can then be used to move and spin the model to further examine it.

[3]

NASA Concept Vehicles [1]

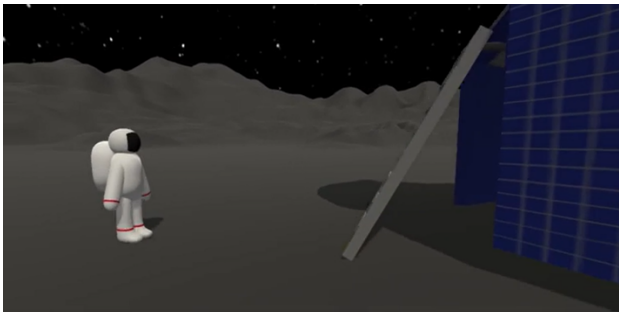
The NASA Concept Vehicles visualization allows users to manipulate, dissect, and learn about experimental vehicles at NASA, designed to be used with zSpace. zSpace is a computer operating on Windows OS along with a stylus and glasses that extend typical three-dimensional viewing by allowing the user to pull content out of the screen. This visualization consists of a central hub in which users can view all models together along with options to focus on only one vehicle. The parts of each vehicle are labelled (where information is available) so that when the users dissect the model, the app displays information on the specific part they are holding.



[1]

NASA's Work on the Moon Animation [2]

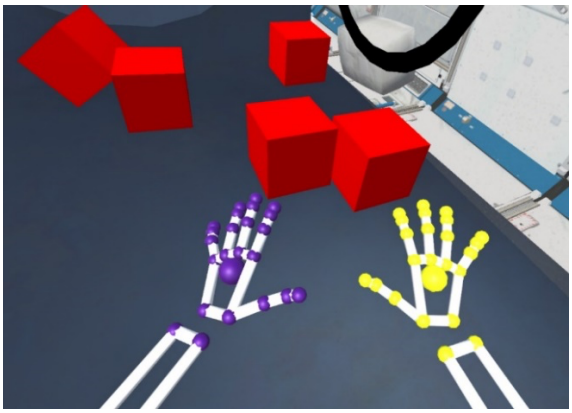
The "NASA's work on the Moon" animation is a visualization designed to be played alongside the astronaut fitting room visualization. The animation joins an astronaut on the moon who tells the viewer about the upcoming Artemis mission, lunar dust, and golfing!



[2]

International Space Station Visualization [3]

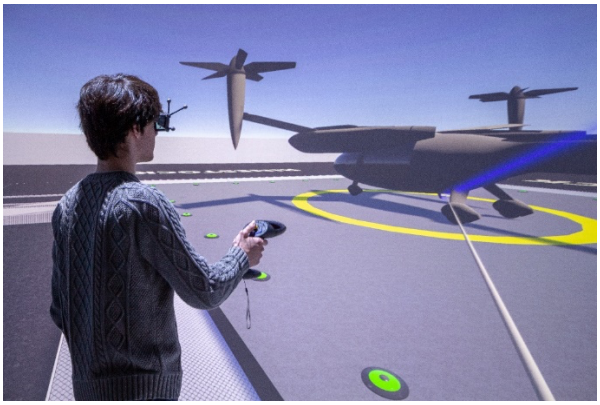
The International Space Station (ISS) visualization allows the user to virtually explore a model of the ISS. This is accomplished through a combination of technologies including a gesture recognition device, gaming controller, and a virtual reality headset. With these technologies, the user is able to navigate the ISS environment as if they were in space. The visualization also includes a game in which the user interacts with 3D blocks inside the ISS's Microgravity Science Glovebox (MSG). The gesture recognition device on the front of the virtual reality headset tracks the person's hand down to the individual fingers allowing them to move the 3D blocks without the aid of a controller. This visualization was created by a GVIS Lab high school intern over a period of two internship sessions and is used to help demonstrate what is possible with experimental VR technology.



[3]

Urban Air Mobility Project [1]

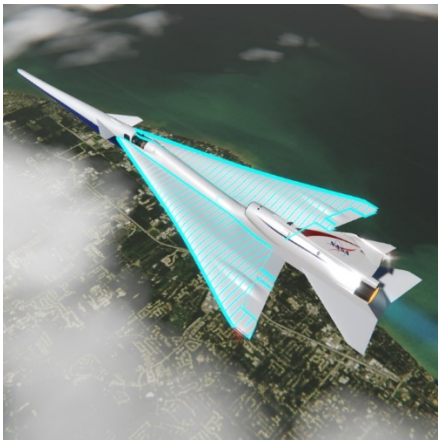
The Urban Air Mobility (UAM) task within the Unmanned Aircraft Systems in the National Airspace Command and Control Subproject attempts to identify the communications challenges associated with UAM operations. At NASA Glenn, the UAM team has developed a concept of operations for command and control of UAM, which the GVIS Lab has modeled as a 3D simulation that can be run in various VR environments. The UAM visualization is currently run in the GRUVE Lab's Cave Automatic Virtual-Reality Environment (CAVE)—a three-walled virtual reality space. Here, users wear stereo shutter glasses and walk around the CAVE to observe full-scale models of concept drones up close and watch them fly in a virtual airport. Viewing the UAM in this way helps researchers identify design challenges that are not easily determined by other methods. Additionally, this simulation in the CAVE can be viewed by individuals or large groups making it an accessible and immersive experience.



[1]

X-59 Quesst – Quiet Supersonic Mission [2]

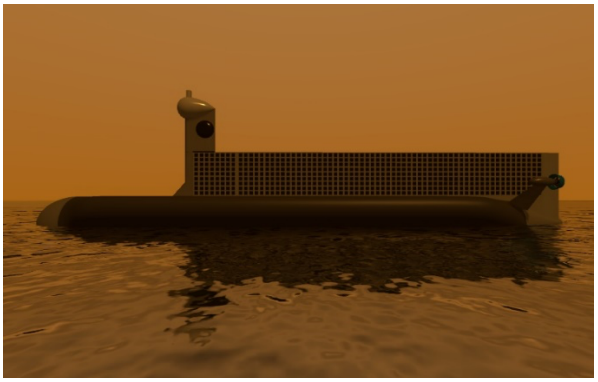
Can we develop a quieter supersonic aircraft? This is the question that NASA's X-59 Quesst mission and the GVIS Lab's Quesst visualization explore. Commercial planes aren't allowed to fly faster than the speed of sound over land because they would create sonic booms which are very loud and disruptive to humans and animals. The X-59 is an experimental aircraft that could lead to future supersonic commercial travel over land, drastically cutting flight times and saving people time in the air. This interactive virtual reality visualization drops the user into NASA Glenn's 8×6 wind tunnel where they can explore the flight test model and data from a wind tunnel test. Next, they are teleported to 50,000 feet in the air to explore the design features of the aircraft as it cruises at Mach 1.4. Inside the cockpit, an audio demonstration compares the difference between a traditional sonic boom and Quesst's quieter supersonic thump. A non-virtual reality version of the visualization makes use of a commercial flight simulator chair and motion platform that engages users by providing them a sense of movement as they virtually explore the aircraft in flight. This simulation gives NASA a portable and interactive tool to show researchers, partners, government officials, and the public the capabilities of Glenn's facilities and the goals of the X-59Quesst mission in an engaging and accessible way.



[2]

COMPASS Lab Titan Submarine Concept [1]

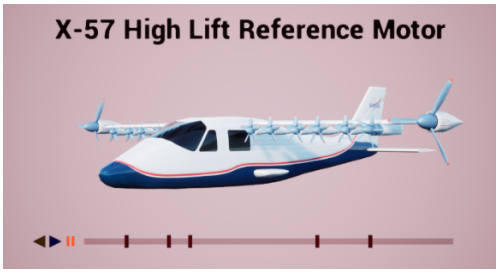
The Titan Submarine visualization is a virtual reality experience that allows users to explore a proposed mission concept vehicle as it floats on the surface of Kraken Mare, a methane ocean on one of Saturn's moons, Titan. While on the surface, one can hear the Titan wind, recorded from the European Space Agency's *Huygens* space probe (one of the few sound recordings taken from another planetary body). Users can then take the submarine under the surface of the ocean and navigate down to the sea floor. The GVIS Lab created this application in partnership with Glenn's Collaborative Modeling and Parametric Assessment of Space Systems (COMPASS) Lab to visualize what exploring Saturn's oceans might entail. In the end, another concept was chosen to move forward, but the GVIS Lab still uses the application as an educational tool to discuss the capabilities of the lab and planetary exploration.



[1]

X-57 Looking Glass Visualization [2]

The X-57 visualization displays NASA's concept electric aircraft, the X-57, using the Looking Glass. The Looking Glass is a 2 inch thick display which utilizes polarized glass to render a 3D model in a hologram-like manner, helping the user to see depth in a 3D visualization which might otherwise look 2-dimensional. The X-57 is powered by 12 high lift motors and 2 large motors, all of which are electric. This visualization contains an animation of the X-57 flying as well as a separate animation a cross section of one of the high lift motors which shows the motor's thermal loads during operation. Using the Looking Glass allows these visualizations to be viewed more in depth rather than just as a 2D animation.



[2]

Boundary Layer Ingestion Testing [3]

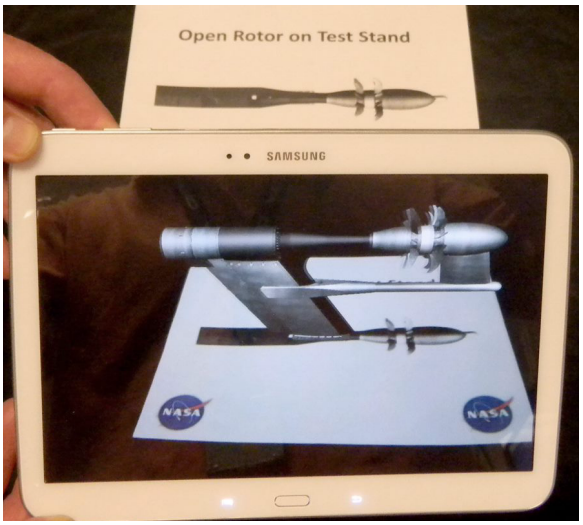
One of the ways to improve aircraft efficiency is to reduce the drag on the aircraft using the aircraft's own engines. Engineers at Glenn are testing a new kind of propulsion system using a principle called Boundary Layer Ingestion (BLI). Analytical studies have shown that this new technology has the potential to reduce the aircraft fuel burn by as much as 8.5% compared to aircraft flown today. This interactive virtual reality visualization demonstrates the testing conditions, tunnel modifications, design elements and challenges of the BLI test performed in Glenn's 8×6 Supersonic Wind Tunnel. The user controls a few simple facility parameters to visually demonstrate their effects on the BLI condition and fan engagement. This video shows the visualization.

[3]

Augmented Reality Tablet Display of NASA Concept Vehicles [1]

This is an Android augmented reality app that displays a pre-programmed 3D model version of a few NASA concept aircraft and a jet engine. The user points the tablet at one of the 2D paper versions of the models and then can explore the 3D model that pops up above the paper. The size and position of NASA logos on each sheet is unique; they are used by the app to identify the target it sees and "anchor" the 3D model's position. You can tap the models to flip them, or to rotate the blades (changing speed and direction) for the open rotor jet engine. The application displays models for:

- Open rotor engine
- Turbo Electric Distributed Propulsion concept aircraft
- D8 Double Bubble Concept Aircraft
- "SUGAR High" Truss Braced Wing Concept



[1]

Interactive Glass Wall Project [2]

The GVIS Lab has created a proof-of-concept for a next generation, natural user interface for controlling the display of camera imagery and sensor data gathered from the launch pads at Kennedy Space Center. The interface is useful for real-time views of a spacecraft right before launch (for detecting issues, checking that things work, etc.) The proof-of-concept makes use of a massively multi-touch screen which allows for collaboration with multiple users.

[2]

Spacesuit Fitting Room [3]

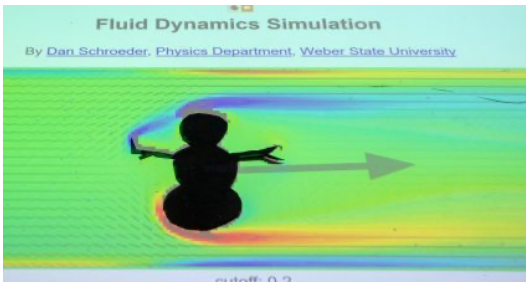
Become an astronaut on the screen and swipe through the various spacesuits that are used depending on what the astronauts are doing. This interactive, augmented reality experience puts the user into the virtual world on the Moon. You can also plant the U.S. Flag on the Moon while there. Especially unique to this one is that it was developed by a high school student who interned with GVIS. This video shows the visualization.

[3]

Augmented Reality Fluid Flow Table

[1]

The Augmented Reality Fluid Flow Table lets users put physical objects onto a table and have a computer predict the flow past the object in real time. The colors represent the rotation of the flow with green being laminar flow from left to right, blue being clockwise rotation and red indicating counter-clockwise rotation. The arrow shows the force vector on the object due to the flow. The table is mostly used for educational purposes and discovery of principles of fluid flow but similar technology has been used by researchers, engineers and doctors to explain everything from airfoils, vascular systems, wind tunnels and kayak oars.

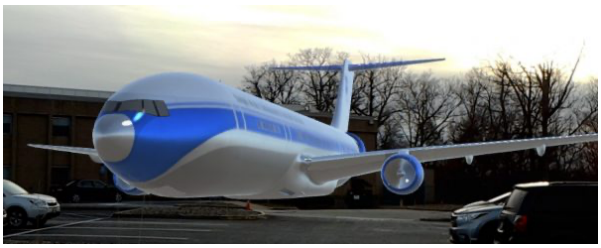


[1]

HoloAero–NASA Concept Vehicles [2]

The HoloAero application is a HoloLens app that lets the user see three NASA concept aircraft in the context of their current environment. For example, the user can display an aircraft model in the room they are in making it appear as if the aircraft is floating in that room. The users can walk around the aircraft, scale it, spin it, and have it fly, all with voice commands. There are three models shown by the application:

- Single-aisle Turboelectric Aircraft with an Aft Boundary-layer Propulsor (STARC-ABL). An aircraft design developed by NASA, the design places the engine in the back of the aircraft and is specifically designed to be more fuel efficient than aircraft designs of the past.
- N3-X Hybrid Wing Body
- Supersonic Transport

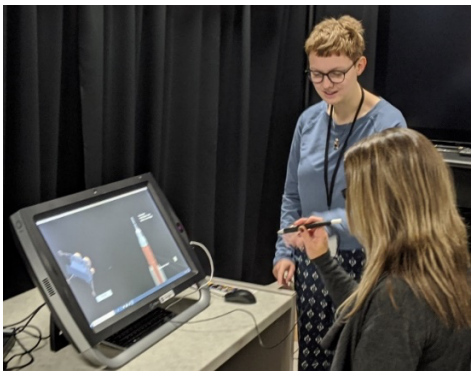


[2]

zSpace NASA Concept Vehicle Visualization [3]

The zSpace is a 3D augmented reality computer operating on Windows OS along with a stylus and glasses. The device extends typical 3D viewing by allowing the user to pull content out of the screen. The application developed for the zSpace is called “NASA Concept Vehicles” and allows users to manipulate, dissect, and learn about experimental vehicles at NASA. The app consists of a central hub in which users can view all models together or focus on only one vehicle. The parts of each vehicle are labeled, so the app displays information on the specific part they are holding as users dissect the model.

The Concept Hub app created by Myranda Uselton (former GVIS intern) includes aeronautics and space versions. The aeronautics version shows the Urban Air Mobility drones (for human transportation in large cities) and the X-57 motor (an all-electric experimental plane). The space version shows the Space Launch System (SLS – rocket for the Artemis missions) and the Lunar Surface Power (conceptual power/charging station for lunar rovers in the Artemis mission).



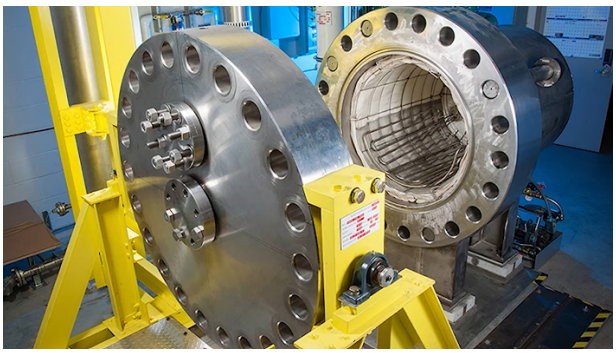
[3]

Proposal: Remote Collaboration Using AR and VR [1]

In 2016, the GVIS Team proposed creating a system that provides a remote lab researcher with an immersive, collaborative experience using medium to low cost computer-based devices. This would increase the frequency of collaborative lab-based research, reach a greater audience of researchers including those with disabilities, and reduce travel costs for NASA for inter-Center collaborations and with outside customers.

The current mode of testing requires the operational and research staff to be physically present at the facility during the test. Given increased testing from external entities and NASA's "Work From Anywhere (WFA)" program, the need to provide a level of remote testing interaction is highly warranted. If such a vehicle existed, customers and researchers could interact and/or view the real time testing results without the requirement of physically being at the testing facility. This will ultimately save money while enabling more inclusive participation during valuable testing operations.

This proposal created a proof-of-concept system that provides the remote researcher with an immersive "testing" experience using medium to low cost computer-based devices including virtual reality devices, cameras, and natural user interface devices.

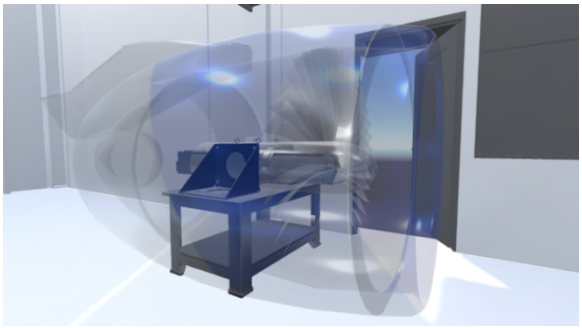


[1]

Proposal: FARSIGHT (Facility Augmented Reality System Integrating Graphical Holographic Technology) [2]

In 2017, the GVIS Team proposed exploring utilizing Augmented Reality (AR) to enhance the capabilities and project efficiencies in a Facilities Testing Environment. Using AR, the engineer would be able to insert virtual prototype components and structural models into the actual testing apparatus to: 1) simulate the integration the component into the test, and 2) enable prototype component placement, fit, and assessing engineering and maintenance access. This proposal would promote testing efficiencies by removing the requirement to physically produce engineered mock-ups to address these concerns. New designs could easily be dropped into the actual testing environment and viewed from various angles against the real hardware.

Our specified test case was the Aeronautics Research Mission Directorate's NASA Electric Aircraft Test Bed (NEAT) which intends to test electric propulsion components and designs on a test rig of appropriate size to a full-sized targeted airframe. While wearing an AR headset, the engineer can see the actual test article and superimposed virtual components. For example, in the figure below, a 3D representation of the fan and engine casing nacelle appear on the actual electric motor test stand. The AR components appear to occupy real space and can be viewed from any angle, allowing the engineer to actually "look under" the augmented reality components if desired.



[2]

Proposal: Integrating CFD Computational Results Over Real-World Test Hardware Using Augmented Reality [1]

The proposal was to investigate techniques for visually integrating CFD computational results over real-world test hardware using Augmented Reality (AR). The Team would work with Microsoft to use cutting edge streaming technology between a client and AR device targeting a future small core compressor test ARMD is conducting. The results of this effort would have enabled researchers' and engineers' insights and improved the complex relationships between the air flow and compressor blades (from the W1A Low Speed Axial Compressor Rig). The knowledge could be used to enhance the blades design and/or inspire new solutions.

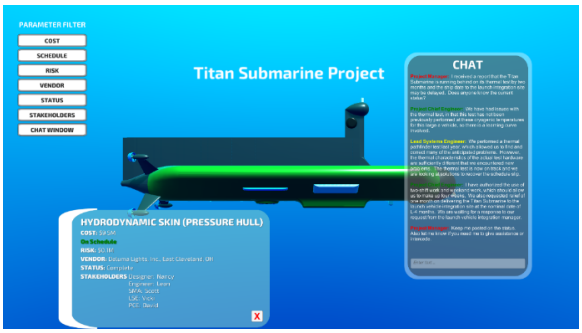
Integrated means to utilize predictive CFD test results at an actual facility before and during a test are rare. This innovation could assist in testing setup and prep, and study the direct and immediate comparison between CFD and actual testing data.

The top objective is to display CFD results, in appropriate scale, over corresponding testing hardware. This ability could help facilities with identification of potential challenges, transducer or test measuring device placement, and an overall visual representation of an outcome before and during the test. A secondary objective would be to utilize this capability outside of the facility test chamber, to examine, explain, and explore testing criteria via the CFD solution.

[1]

Augmented Images of Remarkable and Integrated Engineering (AIRIE) [2]

The Augmented Images of Remarkable and Integrated Engineering (AIRIE) application was a prototype application that displays images of a system-of-interest with information superimposed on top of or near the system's parts. Program and project managers, engineers, safety and mission assurance personnel, and other stakeholders have access to information that is of high interest, up-to-date, and in an easy-to-see and interactive format. The extensive development and anticipated use of Model-Based Systems Engineering (MBSE) within NASA would allow automated linkages of information from the System Model to the images. Ultimately, the intention is to work towards a vision for Model-Based Project Management (MBPM). The inspiration sources for AIRIE are heads-up cockpit displays, augmented reality, and traffic and weather overlays on maps or satellite images.



[2]

Proposal: Medical Station Evaluation Using Virtual Reality [1]

The Graphics and Visualization (GVIS) team in collaboration with the Human Research Program (HRP) would develop a virtual reality application as a pilot project and stepping stone for future capabilities. The application would replicate the conditions of the HRP's test to evaluate a medical station for habitat design. Just as in the physical test, a caregiver would run through a series of medical procedures and their motions would be tracked using HRP's motion capture system and later analyzed to determine operational volume in both an unrestricted and restricted environment. In this test, the caregiver will don a virtual reality headset and everything they see will be generated by the VR application.

The application developed by GVIS would visualize the habitat and patient in virtual reality, potentially using existing interior models of ISS to provide the caregiver with a sense of context and immersion. For purposes of testing operational volume, the application would provide multiple environment configurations (e.g., wide open, versus closed) which could be changed on-the-fly, allowing for a faster turnaround between tests compared to reconfiguring a full physical mockup.

The GVIS team will investigate the integration of physical models with the VR application—that is to say, having some physical elements in the test area (such as a table mockup and manikin) that are perfectly aligned with the VR visualization to provide additional feedback to the caregiver.

For the initial pilot program, GVIS will provide the computer and VR hardware needed to run the application, which will reduce initial cost and will allow GVIS and HRP to determine the VR hardware configuration that will best meet the needs of the test and the test environment.

The VR application and tests run with it will be a follow-on to the test done with a physical mockup, allowing the GVIS team to observe the test and environment to better create an application to meet the HRP's needs. This will reduce development errors and help to spot potential pitfalls that otherwise might not be evident before running the initial VR tests, resulting in a more efficient development process and better deliverable. HRP will be able to compare results from the earlier physical tests with those from the VR test, and evaluate the potential advantages of using VR for this type of analysis.

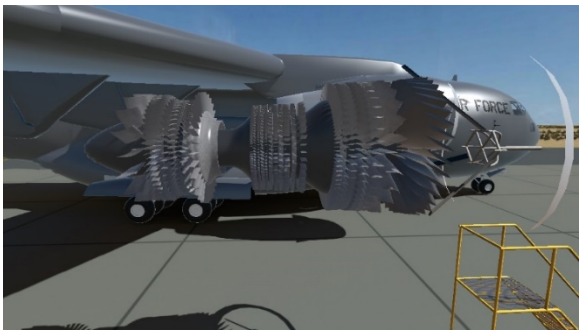
Deliverable: The GVIS team will develop a virtual reality application that mimics the HRP's physical test. GVIS will support the setup and usage of this application in a test, providing the computer and VR hardware. Based on testing, GVIS will make a recommendation on hardware for future VR test experiences going forward.

[1]

Volcanic Ash Ingestion Visualization [1]

The ingestion of volcanic ash by commercial aircraft engines is a safety issue that, until recently, hadn't been studied in a controlled way. Volcanic ash forms glass in the hot sections of engine—reducing flow and clogging cooling holes—as well as erodes compressor blades and other parts of the engine. The NASA Vehicle Integrated Propulsion Research (VIPR) tests studied these effects by sending volcanic ash through an airplane engine under controlled conditions.

The GVIS Lab created a stereoscopic 3D visualization of the test, in order to demonstrate the equipment used during testing and to explain the risks posed by volcanic ash ingestion. The user is placed on a tarmac next to an Air Force C-17 cargo plane where a rig similar to the one used in the VIPR test is positioned to blow ash into one of the aircraft engines. With the engine running and the ash being ingested, the user is presented with a cross-section of the engine, where they can see the location of probes used in the actual test. Zooming in on the rotor stages show the compressor blades being eroded by the ash. Likewise, zooming into the section just aft of the combustion area shows the accumulation of ash "glass". This visualization provided a valuable way to explain both the effects of volcanic ash ingestion on engines as well as the work being done by NASA to study it.



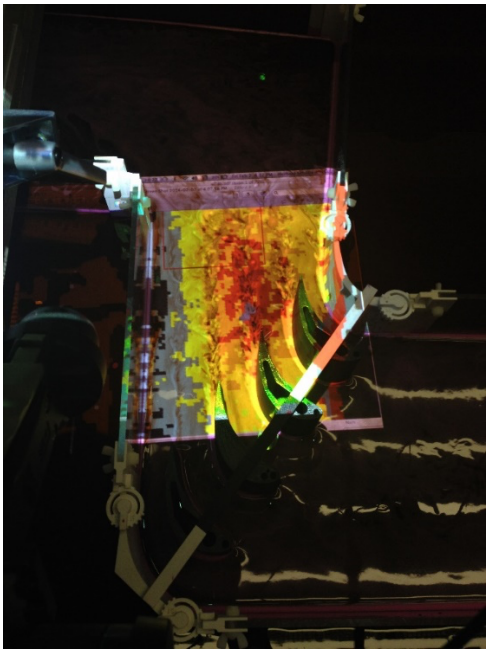
[1]

Fluid Physics Augmented Reality Projection [2]

GVIS Lab's Fluid Physics Augmented Reality Projection is a program designed to help visualize water pressure.

The Turbomachinery and Turboelectric Systems (TTS) branch at NASA's Glenn Research Center uses a water tank to test certain projects. The test article is submerged within the tank and then dye is added to collect water flow data. The entire system works similarly to any of Glenn's wind tunnels except with water instead of air. Although the dye is useful for observing the movement of the water, it can not determine its height. If the height of water in any area of the tank is known, the pressure of that area can also be calculated. In turn, knowing the water pressure can provide valuable insights from any given test article.

To help the TTS branch, the GVIS Lab designed a program for the Xbox Kinect that could determine the topography of the water and then project and color-code that data back onto the water in real time. This gave TTS a visual representation of the water pressures in the environment of their test article.



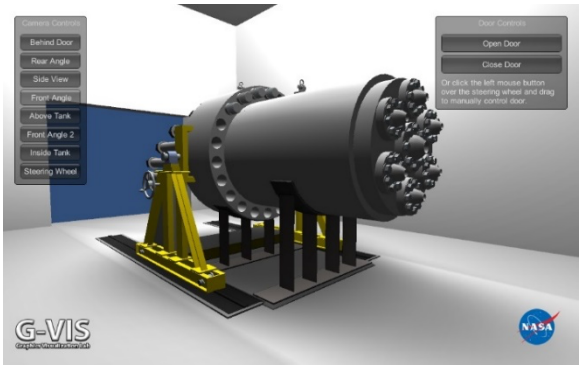
[2]

GEER Test Cell Visualization [1]

The Glenn Extreme Environments Rig simulation is an interactive visualization of Glenn's extreme environment test chamber.

The Glenn Extreme Environments Rig (GEER) is an extreme environment test chamber that creates the high-temperature, high-pressure, toxic atmospheric conditions found in extreme environments such as the planet of Venus. The largest test chamber of its kind in the country, it can simulate temperatures of up to 1,000 degrees Fahrenheit and atmospheric pressures 100 times that of Earth.

GVIS Lab created a virtual reality simulation of the test chamber for illustrative and demonstration purposes. The initial release of this virtual test chamber visualizes the chamber itself, allowing the user to explore it from various pre-set camera positions and to operate the large chamber door. GVIS Lab has also added support for the Oculus Rift so that users can experience the test chamber in 3D. The visualization also operates well with touch screens such as the Perceptive Pixel.



[1]

Pressure Sensitive Paint Visualization [2]

GVIS Lab's Pressure Sensitive Paint visualization for the Aeronautics Test Program simulates a test run in the Glenn's 9×15 acoustic wind tunnel where pressure sensitive paint was used to measure air pressure on a test article.

This simulation mimics the pressure sensitive paint (PSP) testing that was performed during an Open Rotor Engine test. It guides the user through various stages of the testing process, which includes the demonstration of the technology, the marketing of the technology, and the gathering of data. The main display utilizes passive 3D technology and audio to provide an immersive experience for the participant. User interaction is controlled by a secondary touch-screen display in front of the main 3D screen.

The user begins the simulation by initiating a wind tunnel test. Air then flows through the tunnel and the engine test article starts. To prepare for data acquisition, the user then sets up an ultra-violet light and then tunes the frequency of the strobe to illuminate one specific test article blade. Simulated data from the test follows shortly.

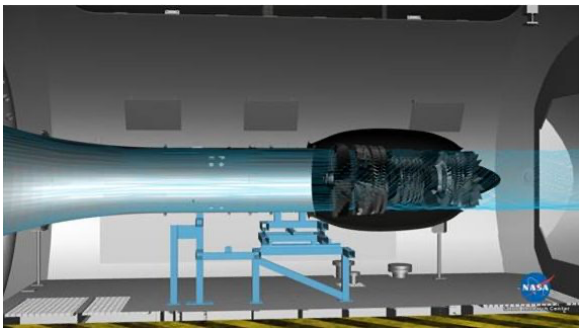
[2]

Propulsion Systems Lab Visualization [1]

Aeronautic Test Program's Propulsion Systems Lab Visualization is a custom, interactive 3D experience simulating the new altitude engine icing capabilities of the Propulsion Systems Lab at NASA Glenn.

The simulation is geared toward marketing the facility's new capabilities and providing a lightweight and immersive educational tour of facility operations. It steps the user though a virtual test run of an engine icing experiment. Spray-bars that are installed within the real-world tunnel work in tandem with the airflow to simulate conditions in Earth's atmosphere that would cause ice to form within the interior of an aircraft engine. The simulation goes into detail on how this ice formation can impact the inner workings of the engine by displaying an animated 3D cross-section of the phenomenon in progress.

This visualization allows future facility simulations to benefit from the design and code developed for this project. Additionally, it helps foster discussions about engine icing within a Glenn context.

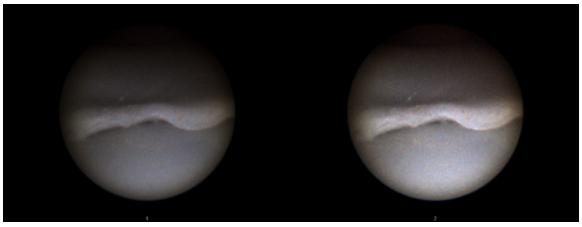


[1]

Image Processing for Endoscope Display [2]

This project focuses on the development of image processing algorithms applied to images for a fiber endoscope product. Under a Space Act Agreement with a biomedical company, the GVIS team developed initial algorithms to:

- Analyze current endoscope image quality
- Conceptually develop a method to apply image processing algorithms
- Remove the fiber patterns
- Lessen noise
- Sharpen images
- Improve color and illumination
- Optimize image quality



[2]

Space Fire Prevention Visualization [3]

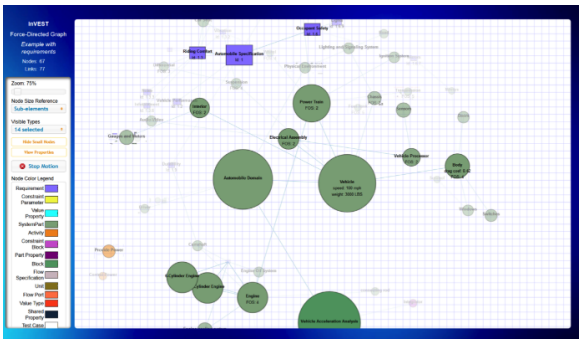
GVIS Lab's developed realistic 3D visualizations to investigate spacecraft fire conditions that will enhance safety on crewed spacecraft missions. Computational Fluid Dynamics (CFD) smoke flow solutions were calculated using the Fire Dynamics Simulator (FDS) for input into our customized visualization software.

[3]

System Modeling Language Visualization [1]

GVIS Lab supports the work of Glenn's Power Architecture and Analysis Branch.

The Interactive Visualization Engine for SYSML Tools (INVEST) was a demonstration of how project models could be made more accessible to project managers and other non-systems engineers. Systems engineers use a common SYSML modeling tool that is powerful but has a steep learning curve, making it difficult to quickly communicate status to project members unfamiliar with it. To mitigate this problem, GVIS Lab developed several D3-based visualizations that could be accessed through a web browser. Snapshots were taken of portions of a model by using the reporting tool to generate JSON files, and then used D3 to visualize the data as interactive web pages called "dashboards", depicting a force-directed graph, dependency wheel, relationship matrix, and others. Users could zoom the displays in or out, choose which data was visible, and highlight areas, with simplified controls that were much easier to use than the original systems engineering application.



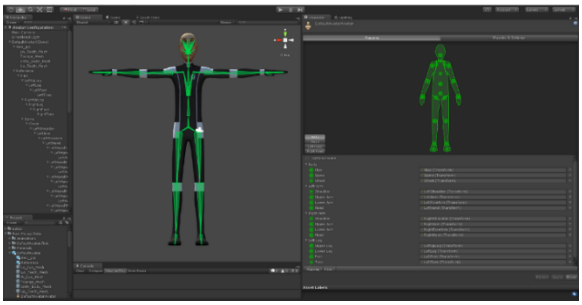
[1]

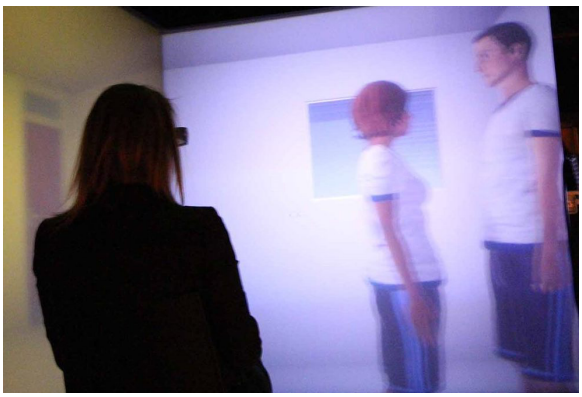
Visualizations for Cleveland Clinic Neuroscience Research Project [2]

GVIS Lab supported the Cleveland Clinic with a study involving autistic patients.

The GVIS team and the Cleveland Clinic, under a Space Act Agreement, formed a partnership to study the use of immersive 3D environments for activating mirror neuron networks in the brain through motor imagery training. The study focused on improving social interactions in persons with autistic spectrum disorders. The study took place in the GRUVE Lab.

GVIS Lab, using a motion capture system at the Center's Exercise Countermeasures Lab, created visualizations of people doing simple activities which were then displayed in the GRUVE Lab while a patient wore an EEG headset.

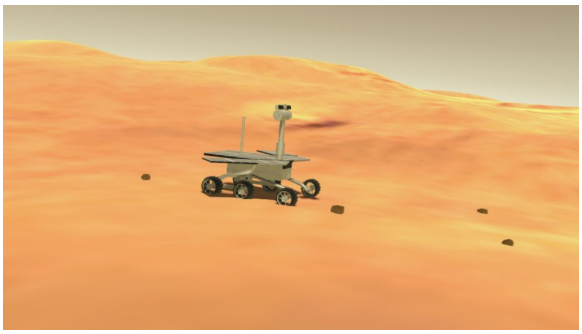




[2]

COMPASS Rock Fidelity Mars Camera Resolution [1]

The GVIS Lab developed a virtual comparison of three different camera resolutions on the Martian surface.

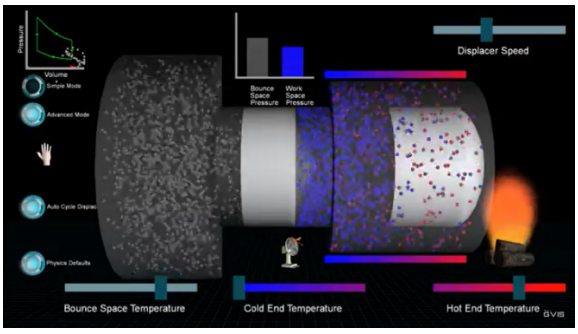


[1]

Virtual Stirling Engine Model [2]

A realistic and interactive 3D Stirling Engine was modeled for customer outreach and educational purposes.

The virtually modeled engine is fully functional and depicts the inter-workings of the system, including gas compression and flows, thermal heat transfers, power generation, and general system power-generating functionality. This video shows the visualization.

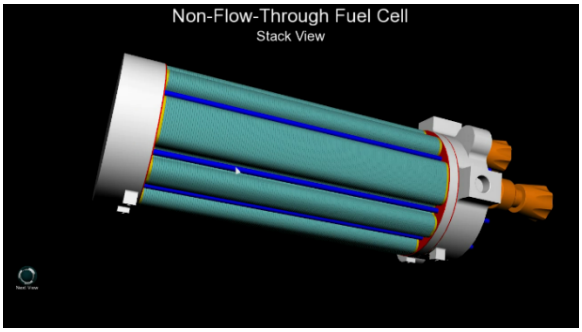


[2]

Virtual Fuel Cell Interactive Simulation [3]

The Virtual Fuel Cell Interactive Simulation used a physics-based gaming engine to visualize the chemical reactions that occur in a fuel cell.

The Space Power Facility (SPF) at NASA's Plum Brook Station requested that a visualization be made of the inner workings of a fuel cell. The main purpose of this simulation is to educate the public on how the chemical and electrical processes of fuel cells work together to produce power. Additionally, the simulation demonstrates the issues that arise when chemical impurities are introduced into the system and proposes a design solution to overcome such a challenge. This project was displayed at the Great Lakes Science Center in Cleveland, Ohio.

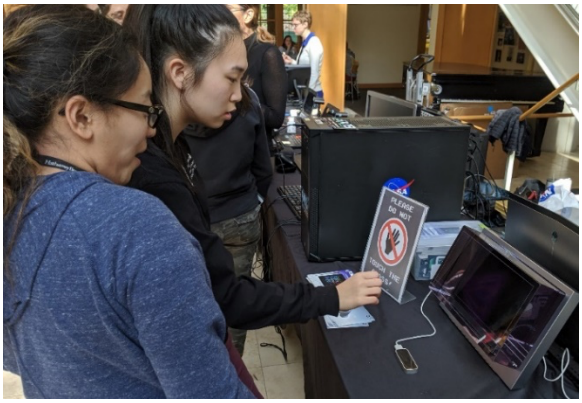


[3]

Looking Glass [1]

The GVIS used the Looking Glass display device to showcase NASA Glenn's work on electric motors for all-electric aircraft.

NASA's all-electric X-57 airplane will utilize 14 electric motors, of which 12 are exclusively for lift augmentation during takeoff and landing. The GVIS Lab took the model of a NASA Glenn designed electric motor and put it in the Looking Glass display so viewers could see it in 3D without using any glasses.



[1]

Wind Tunnel Point Cloud in CAVE Display [2]

Point cloud of the 10 by 10 wind tunnel was displayed in the GRUVE Lab.

NASA Glenn's 10 by 10 wind tunnel was scanned with a LiDAR. The data from that scan was processed to make it suitable for display in the GVIS Lab's large scale immersive environment, the GRUVE Lab.

[2]

Gateway VR [3]

The Deep Space Gateway VR app showcases the Deep Space Gateway (DSG).

The Deep Space Gateway VR app showcases the Deep Space Gateway (DSG) in lunar orbit along with Orion in 3 different orientations and positions. The first Artemis mission of the Space Launch System (SLS) rocket and the Orion spacecraft, which is being tested in Sandusky, Ohio in NASA's Plum Brook Station. The application allows the user to explore the DSG in a spacewalk or EVA (Extravehicular Activity) fashion.

[3]