Joseph F. Ware, Jr. Advanced Engineering Laboratory

⬆A member of the National Federation for the Blind pilots the Virginia Tech Blind Driver Challenge (BDC) team's first semi-autonomous vehicle.

"Hands-On, Minds-On" Headquarters in the College of Engineering

⬇Virginia Tech's Steel Bridge team participates in an international competition in Las Vegas, Nevada. The completed bridge weighs 100 pounds but can safely carry 2500 pounds.

VirginiaTech
College of Engineering

A "hands-on, minds-on" approach has led to a tradition of success for Virginia Tech engineering students — in the classroom, as members of award winning competition teams, and later as practicing engineers in the workplace.

Engineering students at the Ware Lab put theoretical and computational skills to work while earning a bachelor's degree.

Established in 1998, the Joseph F. Ware, Jr., Advanced Engineering Laboratory is the focal point for undergraduate design projects in the College of Engineering. Ware, a 1937 mechanical engineering graduate, and his wife, Jenna, saw a need for a facility dedicated solely to undergraduate student projects and generously funded the conversion of the former Virginia Tech military laundry building. The Wares continue to contribute regularly to help support the projects in the design laboratory. The lab is an integrated 10,000 square foot project center complete with numerous work bays, a welding shop, a machine shop, and a computer design lab. A multi-use project bay has recently been added. This facility provides a unique learning environment for engineering students from various majors with currently over 420 students involved in 19 projects. Some students receive academic credit, while others serve as volunteers. Few engineering schools in the world approach Virginia Tech's level of participation in student design-and-build projects and competitions. Students may become involved as early as their freshman year.

Corporations, universities and colleges, and K-12 groups visit the lab annually to see Virginia Tech engineering students at work. Each year over 1200 people tour the Ware Lab, offering comments ranging from, "I wish we had this when I was in college," to "this is the future of effective engineering undergraduate education." Corporations and businesses are impressed with the students in the Ware Lab who are allowed to sharpen theoretical and computational skills learned in the classroom by working on challenging, viable engineering design projects.

Through public service team participation in world-class competitions, the Ware Lab continues to be the "front door" to Virginia Tech's College of Engineering.

Ware Lab Administration

Mr. Dewey Spangler, Jr., PE, is the manager of the Ware Lab and instructor for the engineering education department. He works with student teams, develops corporate sponsorships, and coordinates visits to the lab for prospective students and educational groups to promote engineering as a profession.
Phone: **(540) 231-5837**
E-mail: **spangler@vt.edu**

Mr. Derwin Stafford is the machine and welding shop supervisor in the Ware Lab. He is responsible for the daily operation of the shops, performing safety training and providing assistance to students engaged in project fabrication.
Phone: **(540) 231-4576**

For more information about the Ware Lab:
www.eng.vt.edu/warelab/

Klages Machine Shop

Arthur C. Klages, a 1942 industrial engineering graduate, donated tools and equipment needed to furnish the Ware Lab machine shop.

Equipment in the shop includes: three milling machines, three lathes, drill presses, a band saw, a shear, an English wheel, and various grinding and cutting machines.

In addition, the welding shop is equipped for Gas Metal Arc Welding (GMAW), frequently referred to as MIG welding; and Gas Tungsten Arc Welding (GTAW), frequently referred to as TIG welding; and has a plasma cutter and sand blaster.

A design team member fabricates a part for the latest Formula competition vehicle.

Students working in both facilities have the opportunity to receive training on a wide variety of machines providing a firm understanding of manufacturing, fabrication, and construction methodologies.

Ware Lab students who complete safety certifications have access to modern CNC equipment.

CAD/FEA/CDF Lab

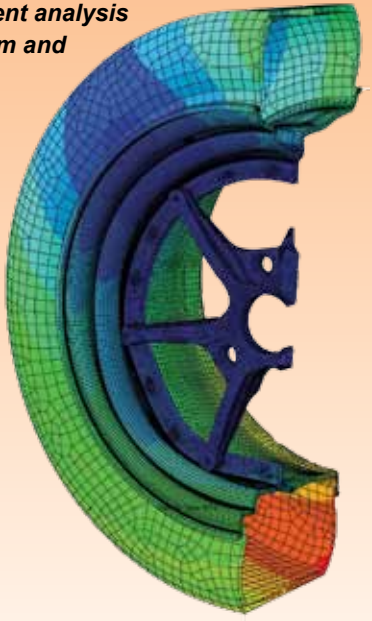
The Ware Lab hosts a 24/7 design lab that is available to students to work collaboratively on engineering design projects.

This lab is heavily utilized by team members using computer aided design (CAD), finite element analysis (FEA), and computational fluid dynamics (CFD). Facilities are also available for team discussions and group work.

Corporations make in-kind contributions of state-of-the-art software allowing for optimization of competition vehicles, structures, and components.

VT Baja team holds a meeting to discuss design parameters of the vehicle.

FSAE finite element analysis (FEA) model of rim and tire components show highly stressed regions due to a 3000 pound force.



Virginia Tech's Ware Lab is headquarters for many award-winning undergraduate engineering design-build projects.

Autonomous Aerial Vehicle Team (AAVT)

The AAVT competition vehicle is designed for an international competition.

Virginia Tech's AAVT team is comprised of eight senior mechanical engineering students and two graduate student advisors. The overall goals of the team are to design, equip, and test an aerial vehicle (AV) for autonomous flight in the International Aerial Robotics Competition (IARC).

The competition takes place in an indoor environment where the AV must fly into a building, navigate halls and doorways, and choose its navigational preferences based upon light-emitting diode (LED) indicators and sign markings. Once the AV has entered the test environment, the overall objective of the mission is to pick up and exchange one flash drive with another, and exit the environment.

AAVT is comprised of four sub-teams handling vehicle navigation and sensors, vision processing, flash drive acquisition, and stability control. Together, these components will have to communicate with each another on the vehicle and on the ground station as the quadrotor autonomously navigates the competition environment.

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Mechanical Engineering
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http://www.me.vt.edu/uav/index.php

Autonomous Underwater Vehicle Team (AUVT)

An interdisciplinary team of engineering students designs the AUVT competition vehicle.

Like autonomous land vehicles, autonomous underwater vehicles (AUVs) are equipped with sensors and controls for navigation. These underwater robots also have propulsion and ballast systems. Founded in 2002, Virginia Tech's AUVT has about 20 members representing several engineering disciplines. Each year, the team designs and builds a completely new autonomous submarine to enter in the Association for Unmanned Vehicle Systems International Competition in San Diego. In addition to operating without human intervention, the AUVs are required to navigate underwater obstacles, identify targets visually, and locate an acoustic rescue locator beacon with passive sonar.

Faculty Advisors:

Dr. Craig Woolsey
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Electrical and Computer Engineering
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http://www.auvt.org.vt.edu/

Baja SAE

Virginia Tech Baja participates in the winter competition in Michigan's Upper Peninsula.

Hard work and mud-soaked test drives are standard operational procedures for the Society of Automotive Engineers (SAE) Baja team. Every year since 1984, Virginia Tech engineering students have designed, built, and tested a new vehicle that can propel through deep water, steep inclines, mud, rocky roads, sand, snow, and ice.

Competition vehicles have a fixed power input consisting of a standard 7.5 kW (10Hp) Briggs and Stratton engine that cannot be modified to increase power output. The vehicles meet their ultimate tests during grueling four-hour endurance races at annual SAE Mini Baja competitions.

In addition to building rugged all-terrain vehicles, the SAE Baja team must insure its entries are safe, easily transported and maintained, fun to drive, and inexpensive.

The Virginia Tech team has a strong history of scoring among top national and international competitors.

Faculty Advisor: **Dr. Richard Goff**
Engineering Education
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E-mail: **richgoff@vt.edu**

http://www.baja.org.vt.edu

Blind Driver Challenge (BDC)

The BDC team displays its first Blind Driver assisted vehicle.

The National Federation of the Blind Jernigan Institute created The Blind Driver Challenge (BDC). The purpose is to allow a blind person to independently operate a vehicle.

Through the development and integration of novel non-visual driver interfaces on an existing vehicle platform, the goal is to provide the blind with a degree of independence that they have never before experienced.

The first generation car supports the core BDC mission of building a vehicle that can increase the independence of the blind, as well as break stereotypes and create a path of technology to promote the capabilities of the blind.

The BDC project was featured on the CBS Early Show as well as on the front page of the *Washington Post*.

Faculty Advisor: **Dr. Dennis Hong**
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E-mail: **dhong@vt.edu**

http://www.romela.org/blinddriver

Design Build Fly (DBF)

The DBF competition vehicle allows students to create futuristic aircraft designs.

The Virginia Tech DBF Team is a volunteer aircraft design organization. The Virginia Tech chapter of the American Institute of Aeronautics and Astronautics (AIAA) serves as the team's parent organization since the AIAA sponsors the annual competition. Each year, the team constructs a new radio-controlled model aircraft to complete a given set of missions for the competition. Rules change each year to encourage innovation.

The team participates in several other competitions throughout the year that are sponsored by airline and aerospace companies, professional organizations, and government agencies. All events are aimed at encouraging engineering students to create new concepts for future generations of aircraft.

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E-mail: **whmason@vt.edu**

http://www.vtdbf.org/

Formula SAE (FSAE)

The FSAE competition vehicle traditionally competes as a "Top Ten" entry.

The mission of the Virginia Tech FSAE Team is to conceive, design, and fabricate a high performance formula-style race car with easy maintenance and high reliability that would appeal to the non-professional weekend autocross racer.

The Virginia Tech team frequently places in the top ten at the annual international competition sponsored by the Society of Automotive Engineers. Cars are judged in a series of static and dynamic events: technical inspection, cost, presentation, engineering design, solo performance trials, and high-performance track endurance. The restrictions on the car frame and engine are limited so that the knowledge, creativity, and imagination of the students can be fully challenged.

One car is constructed each year but a two-year design process is used, involving junior and senior teams.

Typically, more than 100 vehicles from other colleges and universities around the world participate in this international competition.

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Mechanical Engineering
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E-mail: **westrl@vt.edu**

http://www.vtmotorsports.com/

Fuel Cell Project

This device produces hydrogen and helium from H_2O for the Fuel Cell Project.

Researchers around the world are working to advance fuel cell technology as a high-efficiency, low-emissions alternative to fossil fuels.

Since the Virginia Tech Fuel Cell Project was initiated in 1998, undergraduate students have worked in phases to develop, test, and build a proton exchange membrane (PEM) fuel cell that produces power and fuel through electrolysis.

The current objective of the fuel cell team is to design a regenerative fuel cell system employing renewable energy. This project has a wide range of practical applications and could possibly be developed as the large-scale infrastructure for fuel cell automobiles.

Sponsored by the U.S. Department of Energy, U.S. Environmental Protection Agency, and National Science Foundation, the Fuel Cell Project Team will continue to contribute to research and development in this important engineering field.

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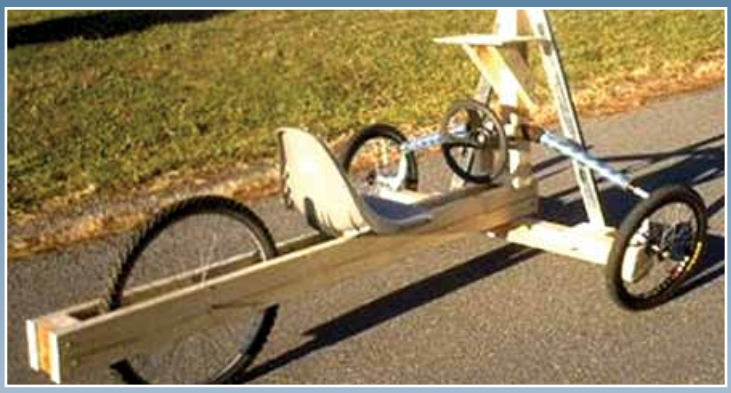
http://www.me.vt.edu/people/faculty/vandsburger.html

Human Powered Aircraft (HPA)



Pictured is an HPA full-scale proof-of-concept cockpit mockup.

The HPA group is working to design and build a viable human-powered airplane for entry in the Kremer Sport Prize Competition.

The HPA team recently completed a ¼ scale proof-of-concept model of the final craft and is on track with construction of a mock cockpit/cart system for dynamic testing of the propeller.

Subordinate teams are conducting wind tunnel testing of the wing and finalizing construction of the airfoils and box wing frame.

The completed airplane will carry one person and have a total wingspan of 60 feet.

Faculty Advisor: **Dr. William Mason**
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http://www.hpag.org.vt.edu/

Human Powered Submarine (HPS)

Phantom 5 is one of the competition vehicles designed by the HPS team.

Representing several engineering disciplines each year, the HPS team forms crews responsible for designing and constructing different aspects of a one-pilot submarine.

The team's mission is to design, build, and race a submarine that is propelled solely by human power. The team must size and shape the sub for minimum drag, design and install an efficient power transmission and propeller system, and give the submarine a control system that provides adequate forces without inducing excessive additional drag.

Virginia Tech has been competing in submarine competitions since 1996. After winning the Grand Prize-Overall Engineering Award with its Phantom series of submarines for three years — 2000 to 2002 — the team entered two subs in the international competition in 2003, broke two world speed records and won first place in the one-person, non-propeller category with Spector, the first entry of its type in the history of the competition.

The team is currently constructing a new, two-pilot sub (Phantom 6) for upcoming competitions.

Faculty advisor: **Dr. Wayne Neu**
Aerospace and Ocean Engineering
Phone: **(540) 231-7061**
E-mail: **neu@vt.edu**

http://www.hps.aoe.vt.edu/

Hybrid Electric Vehicle Team (HEVT)

The HEVT team received its competition vehicle from General Motors.

Starting in 1994, engineering students at Virginia Tech have converted cars and sport utility vehicles (SUVs) into fuel efficient, low-emission, hybrid electric vehicles without sacrificing safety, performance, or comfort.

The Virginia Tech team created the world's first student-designed, fuel cell-powered car and SUV. Since 2000, the team has developed fuel cell and other alternative power systems to prepare SUVs — including a Chevrolet Suburban and a Ford Explorer — for competition in the Future Truck Challenge.

The national competitions were initiated by the U.S. Department of Energy and major U.S. automakers to enlist the help of engineering students in developing cleaner, more fuel-efficient automobiles.

Virginia Tech's HEVT won the 2006 competition by successfully re-engineering a 2005 Chevrolet Equinox as a split parallel hybrid that uses two electric motors and runs on E85. E85 is an ethanol/gas blend that reduces the vehicle's well-to-wheels petroleum use by as much as 74 percent.

The team is currently developing a plug-in hybrid, flex fuel-capable vehicle to enter in the three-year EcoCAR Challenge competition, sponsored by General Motors and the U.S. Department of Energy.

Faculty Advisor: **Dr. Doug Nelson**
Mechanical Engineering
Phone: **(540) 231-4324**
E-mail: **doug.nelson@vt.edu**

http://www.me.vt.edu/hevt/

Multi-Project Bay

The BOLT all-electric motorcycle is just one of the projects that has access to the multi-project bay area.

The multi-project bay is a recent addition to the Ware Lab and is used as a space for up to eight different undergraduate student teams from the College of Engineering. Teams work together on a time/space sharing basis.

With generous help from the Student Engineers' Council (SEC), this bay is now stocked with basic tools and materials and includes lockers for securing parts. Any junior or senior engineering team is welcome to utilize the bay as long as space is available and the project has an engineering faculty advisor. Interested teams need to contact the Ware Lab manager at spangler@vt.edu.

Currently, the following projects along with their main engineering major affiliation and faculty advisor are represented in the multi-project bay:

- **Battery Operated Land Transportation (BOLT)**, (Mechanical Engineering, **Dr. Saied Taheri**, **staheri@vt.edu**)
- **Cognitive Humanoid Autonomous Robot with Learning Intelligence (CHARLI)**, (Mechanical Engineering, **Dr. Dennis Hong**, **dhong@vt.edu**)
- **Concrete Canoe** (Civil and Environmental Engineering, **Dr. Cris Moen**, **cmoen@vt.edu**)
- **Engineers without Boarders** (multi-disciplinary, **Dr. Theo Dillaha**, **dillaha@vt.edu**)
- **IEEE Robotics Solar Powered Car** (Electrical and Computer Engineering, **Dr. Jamie de la Ree**, **jreelope@vt.edu**)
- **VT STARS** (Computer Science, **Dr. Scott McCrickard**, **mccricks@vt.edu** and **Ms. Goldie Terrell**, **gterrell@vt.edu**)

Solar Decathlon

Solar Decathlon ME sub team installs HVAC components for LUMENHAUS.

The mission of the Virginia Tech Solar Decathlon Team is to inform and educate the public about issues of solar and geothermal energy while enhancing student education through a design-build process of innovative research and testing.

Students from the departments of architecture, industrial and systems engineering, industrial design, landscape design, building construction, mechanical engineering, civil and environmental engineering, and electrical engineering have collaborated on the design and construction of three solar-powered houses over the past eight years in order to enter the national Solar Decathlon.

Held on the Mall in Washington, D.C., this competition limited to only 20 universities and colleges is sponsored by the U.S. Department of Energy, American Institute of Architects, and BP Solar. The decathlon challenges university students to create an architecturally appealing and comfortable living/working environment, powered entirely by solar and geothermal energy.

The Virginia Tech team was one of only two U.S. schools invited to participate in an international competition held in Madrid, Spain.

Faculty Advisors for ME sub-team:

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Mr. Dewey Spangler, PE
Engineering Education
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E-mail: **spangler@vt.edu**

http://www.lumenhaus.com/

American Institute of Steel Construction Steel Bridge

The Virginia Tech Steel Bridge team placed fourth out of 45 at nationals in Las Vegas, Nev.

Each year the Virginia Tech Steel Bridge Team takes on the challenge of building a scale-size bridge entirely from structural steel. Team members belong to the Virginia Tech Chapter of the American Society of Civil Engineers (ASCE), which sponsors regional and national bridge competitions.

The ASCE specifies design rules for the size of competition bridges — typically one-tenth the size of the actual bridge — as well as other parameters such as loading requirements and clearances. Teams must construct and load their competition entries at each event.

The team competes annually in the Virginias Regional Conference, the steel bridge competition for engineering schools in Virginia and West Virginia, typically taking first place in most categories.

Recently, the team took fourth place (top 10 percent) in the international steel bridge competition in Las Vegas, Nev., which was its best showing to date.

Faculty Advisor: **Dr. Cris Moen**
Civil and Environmental Engineering
Phone: **(540) 231-6072**
E-mail: **cmoen@vt.edu**

http://www.asce.cee.vt.edu/?page_id=5

Ware Lab Outreach

An additional benefit of working at the Ware Lab is having the opportunity to participate in public events such as the annual Virginia Tech Center for Enhancement of Engineering Diversity (CEED) picnic, football game tailgates, and the Virginia state fair.

Ware Lab projects always make a big impression on young and old alike and these events serve as good recruiting tools for potential students and contributors.

Participating team members learn important aspects of soft design at these events such as effective communication and presentation skills.

Former Ware Lab Director Susan Cortes poses with Virginia Tech team members at a recent Virginia State Fair.

The Virginia Tech HPS team discusses its project with engineering alumni at the Virginia Tech vs. Nebraska football tailgate party.

Ware Lab Corporate and Organizational Sponsorships

Without the generous support of corporate, organizational, and private sponsors Ware Lab teams would not have the resources to participate in national competitions and public events.

Contributions in the form of money, materials, equipment, and software allow Ware Lab groups to produce state-of-the-art competition vehicles, structures, and components.

In addition to monetary and in-kind support, Ware Lab teams often interact with seasoned design engineers from industry who contribute their time working face-to-face with students.

Our corporate and organizational sponsorships continue to grow and include the following:

- Areva
- Associated Power
- Baker Hughes
- Black & Decker
- Ford
- General Motors
- Goodyear
- Honeywell
- Ingersoll Rand Club Car
- Lockheed Martin
- MPT
- OG Racing
- Parker
- Siemens
- Sign Systems Inc.
- The MathWorks
- U.S. Department of Energy
- Virginia Tech Student Engineers' Council
- Westinghouse

Ware Lab
Private Sponsorship

Private sponsorships are essential in helping Ware Lab cover operational expenses and in allowing teams to receive yearly stipends that serve as important seed money. These funds help teams recruit new members and purchase equipment and services necessary for completion of project deliverables.

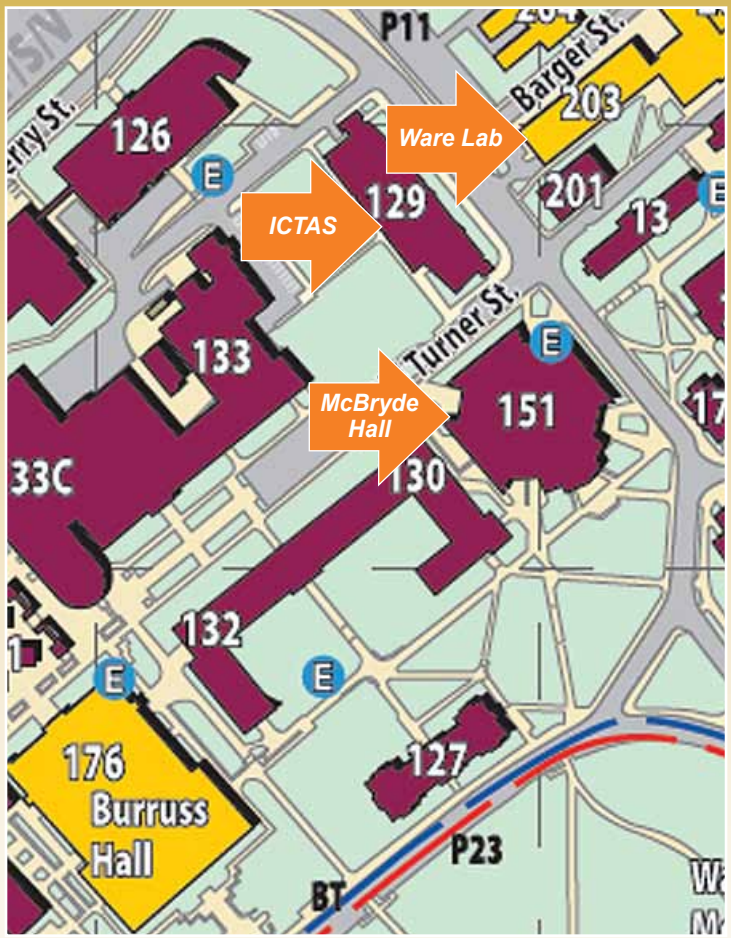
Our private contributors who have created permanent endowments, allowing projects a continual source of seed money are:

- **John and Elizabeth Donehower**
- **Marvin and Susan Johnson**
- **Virginia Tech Student Engineers' Council**

The Ware Lab teams travel to competitions and public relations events in a GM Sierra and 36' Gooseneck Vintage Trailer donated by General Motors and Baker Hughes.

For more information about the Joseph F. Ware, Jr. Advanced Engineering Lab, go to:

www.eng.vt.edu/warelab/



The Ware Lab is located diagonally across from McBryde Hall and directly across the ICTAS facility on the engineering quad of the Virginia Tech campus.

For more information on the Ware Lab's location on the Virginia Tech main campus go to:
http://www.vt.edu/where_we_are/maps/index.html

For important parking information go to:
http://www.vt.edu/where_we_are/visitor-center.html

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