

# The Robotics & Mechanisms Laboratory at Virginia Tech

BRINGING ADVANCED ROBOTIC SYSTEMS TO LIFE WITH SOLIDWORKS

At RoMeLa, student teams use SolidWorks software to tackle challenging projects, such as the Blind Driver Challenge issued by the National Federation of the Blind.



## CHALLENGE:

Support advanced robotics and mechanisms research at Virginia Tech, one of the leading US engineering universities.

## SOLUTION:

Provide graduate and undergraduate student researchers at Virginia Tech's Robotics & Mechanisms Laboratory with access to SolidWorks design solutions.

## RESULTS:

- Shortened design time and reduced errors
- Completed a string of high-profile, award-winning projects
- Developed the world's first vehicle that can be driven by the blind
- Developed the first full-sized, autonomous humanoid robot in the United States

With more than 5,000 engineering majors, Virginia Tech focuses on design innovation in its education and research. This concentration is most apparent in the Robotics & Mechanisms Laboratory (RoMeLa), where undergraduate students, graduate students, and a faculty advisor work together to research and develop the advanced robotics systems of tomorrow.

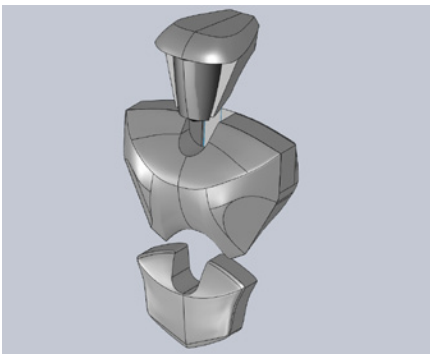
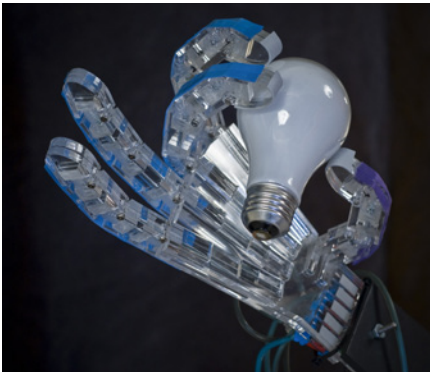
At RoMeLa, student teams work on challenging robotics projects ranging from one-of-a-kind senior design projects to ambitious breakthroughs in cutting-edge robotics research. RoMeLa researchers were once limited in their choice of CAD software. However, as the complexity and sophistication of RoMeLa's research grew, so did the need for a more advanced design solution. Virginia Tech made SolidWorks® Education Edition CAD software available to its student researchers in 2008, acquiring 60 licenses at RoMeLa.

According to Dr. Dennis Hong, an associate professor in the Mechanical Engineering Department and director of RoMeLa, the opportunity to use SolidWorks software not only exposed students to a design solution with a broad, established presence in industry, but also helped them advance research. "Everyone uses the CAD system that they choose," Hong explains. "But SolidWorks has become the solution of choice for many teams.

"SolidWorks was the CAD system used by three of our most successful teams. One team is responding to the Blind Driver Challenge issued by the National Federation of the Blind, another is developing the first humanoid robot in the United States, and a third won two first-place design innovation awards – from the American Society of Mechanical Engineers (ASME) and the Compressed Air and Gas Institute – for the RAPHaEL compressed air robotic hand," Hong adds.

*“SolidWorks is a lot more user-friendly and makes it easier to understand what the software is doing in terms of real-world applications. When it came to generating concepts and ideas, everyone used SolidWorks to quickly gain a visual understanding of the design.”*

**Kimberly Wenger**  
Senior Mechanical Engineering Major



RoMeLa student researchers used SolidWorks software to create the award-winning RAPHaEL robotic hand and CHARLI, the first full-sized, fully autonomous, bipedal humanoid robot developed in the United States.

## Working to help the blind drive

RoMeLa is the only university research organization to undertake the Blind Driver Challenge issued by the National Federation of the Blind. The challenge involves developing an automotive system that enables the blind to drive a car with the same freedom as those who can see.

RoMeLa's system uses a single-plane, sighting laser, audio prompts, a tactile-response vest, a graduated steering wheel, and a computer. The laser sights traffic cones on the course and relays that information to the computer. Then the system instructs the driver how to turn the wheel – such as two clicks to the left or one click to the right – to negotiate the course. If the driver exceeds the preset speed limit, the tactile vest vibrates.

According to Team Leader Kimberly Wenger, a senior mechanical engineering major, the team decided to use SolidWorks software on the “click wheel” and dashboard mount designs because they believed the software would save time and facilitate manufacturing. “SolidWorks is a lot more user-friendly and makes it easier to understand what the software is doing in terms of real-world applications,” Wenger notes. “When it came to generating concepts and ideas, everyone used SolidWorks to quickly gain a visual understanding of the design.”

## The first American humanoid robot

RoMeLa tackled another first – the first American university to develop a full-sized, fully autonomous, bipedal humanoid robot – when the lab began the Cognitive Humanoid Autonomous Robot with Learning Intelligence, or CHARLI, project. The 1.3-meter-tall humanoid robot will be the first of its kind in the United States.

The CHARLI team chose SolidWorks design software because of the importance of simulating parts and assemblies in 3D to pinpoint potential interferences. “SolidWorks is a superior product,” stresses Taylor Pesek, a sophomore mechanical and electrical engineering major. “It is much faster and easier to design and build individual parts and assemblies in SolidWorks, and the motion simulation helped us reduce mistakes and the number of prototypes required.”

Doctoral candidate Jeakweon Han, who oversees the CHARLI project, says the team plans to add enough intelligence to the humanoid so that it can operate as an autonomous soccer player.

“Ultimately, we would like to have CHARLI walk around campus and give campus tours,” Director Hong says.

## An award-winning robotic hand

An offshoot of the CHARLI research, the Robotic Air Powered Hand with Elastic Ligaments, or RAPHaEL project, has won first-place cash prizes in an international design award competition and a national design competition. RAPHaEL employs a novel air-powered actuator to utilize passive compliance and achieve a high-grasping force while keeping the system compact and inexpensive. This approach gives the hand a high level of dexterity, enabling it to pick up and manipulate a variety of objects.

Team Leader Kyle Cothorn, a senior mechanical engineering major, says integrated SolidWorks Simulation and Routing tools were particularly helpful on the RAPHaEL project. “The tube routing capabilities were great for laying out the pneumatic system, and the FEA (finite element analysis) tools helped us identify weak points and smooth out stress risers.”



Dassault Systèmes SolidWorks Corp.  
300 Baker Avenue  
Concord, MA 01742 USA  
Phone: 1 800 693 9000  
Outside the US: +1 978 371 5011  
Email: [info@solidworks.com](mailto:info@solidworks.com)  
[www.solidworks.com](http://www.solidworks.com)



RoMeLa  
Mechanical Engineering Department  
Virginia Tech  
Blacksburg, VA 24061 USA  
Phone: +1 540 231 7195  
[www.me.vt.edu/romela/](http://www.me.vt.edu/romela/)