

ISIS plays key role in efforts to revolutionize military manufacturing

January 21 2013, by David Salisbury



An infantry fighting vehicle is an armored vehicle used to carry infantry into battle. Credit: DARPA

Inventors from across the country can enter a national competition to design a new amphibious infantry fighting vehicle for the U.S. Marine Corps and Vanderbilt University's [Institute for Software Integrated Systems \(ISIS\)](#) is playing a key role in the development of the

engineering software that makes the challenge possible.

The [Defense Advanced Research Project Agency \(DARPA\)](#) commissioned the development of the open source software, released it to the public this week and challenged all comers to enter the first stage of a \$4-million dollar competition to design the new military vehicle.

The [open-source software](#) and the competition are both part of [DARPA's Adaptive Vehicle Make \(AVM\) program](#), which has the goal of dramatically reducing the costs and lead times involved in developing new [military vehicles](#) by radically transforming the existing design and manufacturing process.

Vanderbilt University's multiple key roles in the AVM program include lead developer of [VehicleFORGE](#), a cloud-based collaboration hub where designers can organize project teams. ISIS is also the lead integrator and developer for the META-X project that provides the open-source tool used in creating, testing and validating those designs. The META-X tool, known as CyPhy, includes software that analyzes interactions between individual design components to determine how well they work together.

The program also includes a model library that holds the digital designs of a number of basic components, like wheels, bearings and transmissions. The library was developed by Ricardo, a Detroit-based engineering and technical consulting company, and its components are tested, readied for the competition and provided to competing teams by Vanderbilt through VehicleFORGE.

The Foundry is another part of AVM, which uses the latest tools to turn digital models into actual vehicles, and is located at the Advanced Research Laboratory at Penn State University.



The website where inventors can enter the FANG competition. Credit: DARPA

The DARPA challenge is titled FANG, which stands for Fast, Adaptive, Next-Generation Ground Vehicle. The challenge consists of three competitions of increasing complexity. The first challenge – which began Jan. 14 and runs through April 22 and has a \$1 million prize – is to design a suitable power train, including engine, drive train, suspension and wheels or treads. The second challenge, which carries another \$1 million prize, will be to design the chassis, armored hull, personnel space and related subsystems. The final challenge has a \$2 million prize for the best design for an entire vehicle. The agency is inviting individuals, small teams and businesses and major defense contractors to compete.

The first challenge already has attracted more than 850 competitors organized in more than 200 teams.

In the past, fighter aircraft, tanks and other complex military systems have been built in a craftsmen-like process by a small number of highly specialized contractors. A new design is broken down into subsystems designed by different teams. These preliminary designs are integrated, prototyped and tested. The integrated systems rarely meet the

requirements so the process is repeated until they do.

This is a costly approach and DARPA is attempting to replace it with the more efficient "correct by construction" process similar to that practiced by the semiconductor industry, which has an impressive track record in getting systems right in the first place.

"This is the kind of innovation that allows separation of design from fabrication. Right now, the design can only be done by a shop that has the integrated capability to do a complete production run. The idea is to detangle design from production and make the entire process more open, innovative and competitive," said Sandeep Neema, research associate professor and ISIS senior research scientist and principal investigator for the META-X project.

ISIS computer scientists and engineers also view this effort in a wider context. They are convinced that it represents the next generation of engineering design where computer modeling, simulation, model verification and automated synthesis become the dominant paradigm.

"We're right on the cusp of really big changes and DARPA's investment in open source tooling for AVM can really help democratize these changes for both current and future generations of engineers," said Larry Howard, ISIS senior research scientist and principal investigator for VehicleFORGE.

For such a paradigm shift to occur, it must be adopted by the younger generation. One part of the AVM program is an undergraduate [design](#) contest called the Model-Based Amphibious Racing Challenge (MBARC), which is being held on the Camp Pendleton Marine Corps Base in southern California on Jan. 19.

The first competition has participants from three universities –

Vanderbilt, MIT and the University of California, Berkeley. Using the AVM software, the students were challenged to come up with truly novel designs that can be fabricated quickly.

The Vanderbilt entry was created in a class where undergraduate students learn about the computer modeling and simulation tools being created at ISIS.

"With Vanderbilt-ISIS a key player in the whole AVM project, we are uniquely positioned to demonstrate these tools to other institutions and ultimately increase their adoption in practice," said Tom Withrow, assistant professor of the practice of mechanical engineering.

Provided by Vanderbilt University

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