EPISODE FIFTY-EIGHT OF "ARMED WITH SCIENCE: RESEARCH APPLICATIONS FOR THE MODERN MILITARY," A DEPARTMENT OF DEFENSE WEBCAST HOST: DR. JOHN OHAB GUESTS: SALLY SHOOP, RESEARCH ENGINEER, U.S. ARMY COLD REGIONS RESEARCH AND ENGINEER LAB; BARRY COUTERMARSH, RESEARCH ENGINEER, U.S. ARMY COLD REGIONS RESEARCH AND ENGINEER LAB SUBJECT: THE U.S. ARMY'S SYNTHETIC AUTOMOTIVE VIRTUAL ENVIRONMENTS PROGRAM TIME: 2:00 P.M. EST DATE: WEDNESDAY, MARCH 10, 2010

ANNOUNCER: "Armed with Science: Research and Applications for the Modern Military" is a weekly webcast that discusses cutting-edge science and technology, and how they apply to military operations. Each week we will interview scientists, administrators and operators to educate and inform our listeners about the importance of science and technology to the modern military. DR. OHAB: Good afternoon and welcome to the "Armed with Science" podcast for Wednesday, March 10, 2010. I am Dr. John Ohab at the Office of the Assistant Secretary of Defense for Public Affairs.

Today we're going to explore how the U.S. Army is using science to help save the lives of military and civilian vehicle operators. It's an extremely important issue. One third as many soldiers are killed in vehicle accidents than in combat. We're joined today by Sally Shoop and Barry Coutermarsh, research engineers at the U.S. Army Cold Regions Research and Engineer Lab. They will discuss the SAVE Program. "SAVE" stands for Synthetic Automotive Virtual Environments. And the goal is to build hardware and software that can teach soldiers how to control a vehicle to avoid accidents and rollovers, and ultimately save lives.

Sally, Barry, it's great to have you on the program. How are you?

MS. SHOOP: Fine. Thank you, John.

MR. COUTERMARSH: Fine. Thanks, John.

DR. OHAB: Listeners, if you've got questions there's a good chance that our guests can help you answer those. So send us a Tweet to @armedwscience, or you can post a comment on the blog and we'll try to get you those answers.

Sally, Barry, let's get a stage set before we get into the more specific part of your research. Can you tell us a little bit about the Army Cold Regions Lab and what kind of work goes on there?

MS. SHOOP: I'll take that one. (Laughs.) Hopefully that's the easy one. The Cold Regions Lab is part of the Corps of Engineers Engineering Research and Development Center. The Engineering Research and Development Center has five R&D labs and we're one of those. Our main office is in Hanover, New Hampshire; and we have two offices in Alaska, one in Fairbanks and one in Anchorage.

Our primary mission, we are really multi-disciplinary here, and our primary expertise -- our unique expertise is dealing with cold impacts or seasonal impacts on the terrain, and on the environment, and operations, and, specifically, military operations.

DR. OHAB: Now, you're both working on the SAVE program, which, again, stands for Synthetic Automotive Virtual Environments. Can you tell us about that program, and then some of the research that you're involved in?

MR. COUTERMARSH: Well, the SAVE program is all about saving lives, really. And it's about finding ways to teach soldiers how to avoid motor vehicle accidents. And one of the reasons we're so into this is that, with the recent, the armored requirements of the new vehicles -- there's a lot of high center-of-gravity vehicles out there, and they've been having some rollover accidents. And we'd like to have an impact on reducing those. And also the military operates on unpaved surfaces a lot, and there hasn't been a lot of work out there done on looking at how a vehicle operates on these loose, unpaved surfaces.

DR. OHAB: Has there been a lot of research done on how vehicles behave on various surfaces, in general?

MR. COUTERMARSH: Yeah, there has been a lot of work on how vehicles behave on the paved surfaces. I mean, if you can imagine, that's where most of the automobiles in the world operate. But our work is focused on how wheeled vehicles behave on gravel, loose stones, mud, snow and ice, because these are the types of surfaces where the military vehicles frequently operate.

DR. OHAB: Now, one of the central components of this research is the simulator. And over the last year we've explored on this program a couple of different scientific endeavors that rely on simulations. What makes the SAVE program and your research especially distinctive from other simulation-based work?

MS. SHOOP: We're really trying to get at training that relates to good control of the vehicle. And a lot of the simulators that are out there, both in the commercial world and in the military too, are geared towards situational awareness and what to do in a vehicle if certain things happen.

And this aimed more towards training people to really control a vehicle when it gets in a bad situation. So we can -- we teach them about eye placement, and then to teach some muscle memory so that they learn how to get out of a skid or how to steer around an obstacle without having to actually think about it. So they're trained to do the muscle memory part as well.

And then, as Barry mentioned a few minutes ago, the other really unique thing is that this -- we're dealing with unpaved surfaces, so we're looking at the vehicles on different kinds of surfaces; for this program, primarily gravel roads like they have in-theatre currently, and bad roads, bad surfaces, loose gravel.

Some of the other things too that are unique is we're looking at pretty high-speed operations. We're working with rally drivers. And they actually approached us and said they train military forces already to do high-speed operations on gravel roads. But it's difficult and it's expensive to do live training in vehicles. And they said, well, if we can teach some of these things in a simulator instead, it would save a lot of money.

And we're trying to build a simulator and software that is portable and inexpensive so we can get it into the hands of more people, both military and civilian. DR. OHAB: So this is probably a question you guys have had before, but how do you know that research that takes place in a simulator can actually be helpful to civilians or soldiers in the real world?

MR. COUTERMARSH: Well, there's a lot of evidence out there in the real world about different companies that are using simulators for, again, what Sally said was situational awareness. So we've also done some work here in an accident avoidance test, where we took 11 people and we put them in our simulator for a -- let's see, it was 10 weeks for 30 minutes, and we taught them how to control the vehicle and how to avoid an accident, that was a set-up accident, for the test.

We then took folks that hadn't been trained, and we took both groups out and put them in real vehicles, and we ran them through the accident avoidance test in real vehicles. And we looked at how they did, and the group with the simulator did much better than the group without the simulator training. So, you know, that's why we think this has real promise.

MS. SHOOP: There's some literature out there too for other people that use simulators -- like the police departments and stuff use some vehicle simulation training, and they have some pretty good evidence that it translates to real vehicles pretty well.

DR. OHAB: And for some of these vehicle performance tests you're doing, what kind of vehicles are people driving?

MR. COUTERMARSH: Well, on the accident-avoidance tests we had a specially-instrumented Ford Focus. That's our -- that is one of our test vehicles that we use for the driving end of it. We also have a test

vehicle here, it's a 1970s-era Jeep Cherokee that is a highly-instrumented vehicle. It's got load sensors on all four tires, and we use that to actually evaluate the surface friction.

As Sally said before, what we're trying to do is to get this simulator so that it responds realistically to these loose gravel surfaces, mud, snow or ice. And in order to do that, we have to program in the simulations such that the contact patch -- which is that area of the tire that hits the ground, so that the contact patch actually behaves like it does in a real vehicle on that surface.

So we use our Jeep Cherokee to go out and measure all sorts of specialized forces and measurements, so that we can take that data back in the laboratory and then put those algorithms back into our simulator so it'll behave realistically, like a vehicle would on that type of surface.

MS. SHOOP: And I just want to add to that briefly. The vehicles that we have -- Ford is a partner on this program, and they've allowed us to use the Ford Focus and a Ford Explorer that we then took and instrumented so that we can measure the inputs drivers, as well as the response of the vehicles, when they actually do the live testing. And that's been extremely useful.

Ford's interested in this program because they're interested in more advanced safety for their vehicles as well. So they want to know what -- you know, what we find out, what we learn from this.

DR. OHAB: So, ultimately, will the research have applications in and outside of the military?

MS. SHOOP: Yes. There's a few primary areas we're looking at for spin-off applications, and that's one with the commercial automotive industry, with Ford, looking at advanced safety. And another one is for robotic systems, because we're capturing some of the behaviors of expert drivers, when we work with our rally racers -- or rally drivers, to figure out how we want to train people to drive better. So we want to capture some of those expert behaviors into robotic systems.

And then the other thing we're looking at is, because we look at the forces and -- between the tire and the -- between the tire and the surface, we're hoping that some of that will translate into improvements in gravel roads and how those forces are transmitted, between the road and the vehicle, to improve some road- building techniques in marginal roads.

DR. OHAB: Let's focus specifically on how this could impact the military. If you were able to get this research to translate, you know, into an application for the military, what value would that research have do you think?

MR. COUTERMARSH: Well, one of the areas is obviously -- the obvious one, where if we can teach folks how to use a vehicle and to operate it, and to learn the right muscle memory. I guess that's the

emphasis that I'd like to take to that. When things happen unexpectedly to you, and you react like, you might say, a sharp turn at a high speed. You're obviously in danger of flipping the vehicle over, especially on a high-CG vehicle, center-of-gravity vehicle. So one of the things that the simulation does, is that if the student can learn muscle memory, they can learn how much they can turn, and how fast they can turn, and how to use the throttle and the brake and the steering to make the vehicle do what they want it do, and also to keep it operating in a safe mode.

So if we can get this information out into the military, and this simulator can help to teach them that, so that they don't have to do this in a real vehicle where it's dangerous and it's also pretty expensive, then we think we can save lives.

MS. SHOOP: We're also thinking of, we'd like this to be an objective -- kind of like an objective trainer. So our vision, like in the long term, would be to develop training curriculum that the -- you know, the computer will have all the inputs from the driver, and the vehicle response; and to walk them through different training scenarios, so that they can learn that way and they won't have to have a trainer standing right by them at all times.

And too, because it's in a simulation, it could be really fun. And the guys -- especially the young, our younger soldiers, they're pretty amenable to playing some of these. It's almost like a video game, and it's fun. So, hopefully, we can train them how to control a vehicle better and have a good time at the same time.

DR. OHAB: So the research could be applied in the current conflict as well?

MS. SHOOP: Yeah, particularly because they're doing a lot of maneuvers on surfaced roads and poor roads -- on paved roads, gravel.

MR. COUTERMARSH: Yeah, and, you know, the way that they're armoring the vehicles nowadays, there is a lot of high center-of- gravity as a result of that, and that makes a vehicle rather unstable. So, yes, it has a lot of use now.

MS. SHOOP: I think, and some of the changes in the way that the military operates these days too, they have to do probably more special operations where the Special Forces have to get in and get out in a hurry, and they have to keep the vehicle operating the whole time. But, you know, their lives are at stake while they're driving, so they have to have pretty good vehicle skills to do that.

DR. OHAB: Now, how do you actually connect, you know, this with the military? Do you have a vision for how it could be implemented in the future?

MR. COUTERMARSH: Well, that is one of the challenges that we face here, being a small laboratory. Sometimes we say that we're the Army's best kept secret --

MS. SHOOP: (Laughs.) MR. COUTERMARSH: -- but we try not to be. You know, we see that this technology, and we also see the technology that's already out there in using simulators as being a mobile technology. You could put this in a trailer; you could drive it around to different bases; people could use it to before they're deployed -- they could sit in it and run through various tests.

Like Sally said, it hopefully -- we think that it will be automated eventually, so you don't have to have a human standing there.

That would make it a lot easier for anyone -- to just sit in it, and hop in it, and to use it; that they wouldn't have to make a prior arrangement with an instructor or something like that. It could all be automated.

MS. SHOOP: There are some -- there's some things out there that we are hoping we can link in with too. There's already some vehicle trainers, and things that I think some of -- we're an RD program, so some of our products could spin off into. And we are really looking for help for -- with some of that.

And we still have a little ways to go as well. We have to do some testing on some different kinds of surfaces. We still have to develop some of the training scenarios, and what would work best. We don't know exactly which motion cues or even audio cues are the most important for realistic vehicle control.

The driver spins -- in driving on a gravel road, you can imagine you hear some -- you could hear the gravel spinning, like at the left-rear wheel, and know how you're impacting the weight on that wheel, and you can maneuver the weight to help control it. So audio cues are really important.

We also haven't integrated the eye tracking yet to know if they're looking where they want to drive. One of the really important things in avoiding an accident is to look where you want to go, not the thing that you might hit. So training people to look to their open pathway is really important.

I can't think of anything else on that, right off hand. Can you?

MR. COUTERMARSH: I can't think of anything right off hand.

I know that -- I guess I would like to emphasize that the ongoing research we'll be doing over this next few months will but integrating the eye gaze. And, you know, such as -- the stuff that Sally said also, is that we're also trying to evaluate what is the best way to train this, what cues would be good, because we are using a simulator in rather a unique way, in that we're actually trying to teach how to control a vehicle. So the simulator has to give back certain cues realistically, and we're not sure of what all is necessary yet. We're not through with the research yet.

MS. SHOOP: So we're also looking partnering with the right organization for funding in this area, because we have -- essentially, we started with seed money, through a Congressional (add ?), through Representative Paul Hodes in New Hampshire. So that was just to get going; and then to spin it off to where we can -- (inaudible) -- it, and get it to the hands of the soldiers, so maybe that every unit could have one of those, or every post could have one of these. And that's really our end-goal.

DR. OHAB: And you mentioned the auditory and visual cues. But I was hoping you'd talk a little bit more about where the research is going from here, and maybe some of the next major steps for you guys.

MR. COUTERMARSH: Well, one of the next major steps is to the eye-gaze piece. We're going to be doing some more -- I'm actually doing some sustainment training. One of the things we think the simulator has a value in is that once you learn the skills, how often do you have to use a simulator, or something similar, to keep those skills up, because we're all about building muscle memory for the right inputs for the vehicle.

So this spring we started with five folks that we had trained previously with the simulator in the accident-avoidance tests. And I'm putting them through some sustainment training where they only get a brief stint in the simulator for maybe five minutes for every two weeks, and we're seeing if that will keep their skills up. That'll help to give us some baseline data on how often you have to use these things to keep these skills current.

Along with that, we'll be doing the eye-gaze piece, where we'll actually look and see how important a part does eye gaze play in handling the vehicle well. Most of the research out there says that it's very important, so we're going to try to put some metrics on that, and to see how it does in this loose vehicle control -- (inaudible) --

Do you have anything to add?

MS. SHOOP: Yeah. One of the other ways we wanted to go too is to do -- we've just done really a proof-of-concept study with -- using the simulator, so we'd like to do a little bit more, a larger group to train. And we've talked to the local National Guard units in New Hampshire and Vermont, and they're really interested in trying this out too.

So we're looking for funding to train a larger group of people. The initial group was just the civilians here at the laboratory, but it'd be nice to get some soldiers into the simulator and get their input. And along with that, when we train some more people, we'll be able to develop a little bit better curriculum on knowing exactly what things work best and what things we can drop off.

DR. OHAB: What's your sense for how the program has been received so far?

MS. SHOOP: All the people we've showed it to think it's really great -- a really great program. It's a really -- it's been a nice program. It's a really great team we have. We have a lot of collaboration with universities and industry, with Team O'Neil, who does rally racing, who provides expert drivers and expertise in that area. They have a spin-off company called "Vehicle Control Training," who is -- their expertise is specifically going to be in training vehicle control.

The local folks that we've showed it to -- we've talked to the Marines, and we've talked to the Guard units, we've also showed it to civilians as well, and everybody's been really positive about it. Vehicle accidents are a problem for everyone, so this could have a nice -- good impact.

MR. COUTERMARSH: Yeah, and, you know, one other point here is that we're actually looking at the driver as an integral part of the vehicle accidents, which seems kind of obvious. You know, a lot of the work in the vehicle world has been in making hardware and the anti-skid stuff, well the military vehicles don't have that luxury usually, and also they're put in very stressful situations.

So the driver's a very important part. It seems rather obvious, but I think we need to restate it, that the driver is a very important part in handling the vehicle. And if we can build them up and give them some muscle memory "do to the right thing," if you will, I think we'll make some great strides in reducing accidents.

MS. SHOOP: We've talked to some folks too about putting it into the driver's education curriculum. And I know some states are moving towards that a little bit more. I mean, the statistics are really dire, and it's the -- vehicle accidents are the most likely cause of death for our young people, both soldiers and civilians, and there's 40,000 -- over 40,000 vehicle accidents in the U.S. alone per year. So there's, I think, a lot, hopefully, that we can have an impact on.

DR. OHAB: Now, Barry and Sally, you're both research engineers at the Army Cold Regions Research and Engineering Lab. I was hoping you could tell us a little bit about your backgrounds, and, you know, what would it take for someone to be engaged in this kind of research?

MS. SHOOP: I'm actually a geological engineer, or a civil engineer by training, so my focus came from -- I've been at CRREL for 23 years, and that's been primarily looking at vehicle performance issues, on snow, and ice and mud, and different types of terrain. Because of my background, I'm looking at how the interface, or whatever material is below the vehicle, impacts the performance of the vehicle itself. And you probably have all heard this on TV and on the radio, "it's all about where the tire meets the road" for wheeled vehicles, because that's where the forces transmit from the terrain to the vehicle. So that's my background. Is that in terms that make some sense? (Laughs.)

DR. OHAB: It makes sense to me.

MS. SHOOP: Okay. (Laughs.)

MR. COUTERMARSH: I'm also a research engineer here. I've been here over 34 years.

And if you can imagine, in that time I've done a lot of different work here. But the military end of it, I've been on winter bridging; I've been looking at winter silo investigations for the BMDO project; landmine performance on frozen ground; mortar-base plate modeling, stuff like that. So it's been a very varied background.

I've always had an interest in sports cars and such, so when this opportunity came along I thought it was a perfect fit of physics and driving. And I like to teach -- you know, I like the teaching end of it. So that's basically my background.

DR. OHAB: Where do you teach?

MR. COUTERMARSH: Well, I teach here. From the accident avoidance stuff, I've actually found that I just enjoy teaching the students about this. So that's been my teaching experience.

DR. OHAB: Well, as we wrap up today's program, I'd like to offer you the opportunity to give us any final thoughts or anything that you wanted to add.

MS. SHOOP: (Inaudible.)

MR. COUTERMARSH: Well, I guess just that, again, you know, the focus here is that we're trying to save lives. And in a research laboratory, you know, you don't get that opportunity all the time. So I think that this project has been a really great project. I think all the feedback that we've had on it has been very positive. So we're looking, again, to extend this work, and I just think it's a very -- it's worthwhile work.

MS. SHOOP: Ditto.

DR. OHAB: Well said.

Our guests today are Sally Shoop and Barry Coutermarsh, research engineers at the U.S. Army Cold Regions Research and Engineering Lab. Thank you so much for taking the time to be here with us today. Really appreciate it.

MS. SHOOP: Thanks for having us. MR. COUTERMARSH: Okay, thank you, John.

DR. OHAB: Listeners, please join us next Wednesday, March 17th when Dr. Lynn Smith, at the Department of Defense Education Activity, discusses the Junior Science and Humanities Symposium, also known as JSHS. The program provides high school students the support and resources to design and conduct original research in the areas of science, technology, engineering and math. We'll also bring on several high school students in the program to talk about their experiences.

Thank you again for listening. I am Dr. John Ohab, and you've been scienced.

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