Erica: [Japanese 00:00:01].

Sarah McConnell: Meet Erica.

Erica: [Japanese 00:00:08].

Sarah McConnell: Erica's a very lifelike android, designed to look like a 23-year-old woman, and her Japanese creator says she'll soon become a TV news anchor.

Erica: [Japanese 00:00:22].

Sarah McConnell: As robots like Erica take on more and more human jobs, are we gonna trust them or fear them? From Virginia Humanities, this is With Good Reason. I'm Sarah McConnell, and today, When Humans Encounter Robots. Later in the show, a scientist is using satellites to study weather prediction in space.

Scott England: From Mars, we were getting observations at the very top of Mars' atmosphere, and we believe that those are linked to the weather near the surface of Mars.

Sarah McConnell: But first, robots are already taking on jobs previously staffed by humans. James Bliss is a professor of psychology at Old Dominion University. He is studying how humans might interact with robots that are employed as military, or police peacekeepers.

Sarah McConnell: Jim, I understand you're a human factor psychologist. You study how humans interact with technology. I didn't even know that was a field.

James Bliss: It is a little bit nichey. It's been around since the 1940s or so, and becoming more popular as time moves on because technology keeps increasing in capability, and sometimes humans and the way they interact with technology become very complex.

Sarah McConnell: And what are you exploring in particular? Your research is into whether we trust robots?

James Bliss: Right. In the past, robots handled real dangerous jobs. Even NASA has used robots as well, up on the Space Station. For us, we want to know not just how do we interact with them, but how much trust do we have when those automated devices take over certain aspects that used to be controlled by a human? And the particular research that I've been doing lately has to do with peacekeeping, where people need to go in and try to maintain or keep the peace, and sometimes they are in a country or an environment where they're not very familiar with the individuals involved, and it can be a really dangerous task. So about five or six years ago, the military asked, "Can we employ robots that are armed with non-lethal weapons, and use them in a peacekeeping role?

Will people trust those robots? Will they obey them? And how can the robots work as part of a larger team?"

Sarah McConnell: That seems scary to me, to think of robots as peacekeepers. I wouldn't want a robot peacekeeping me.

James Bliss: Yeah. If you look at certainly the media, and movies that have portrayed what can go wrong in that kind of a scenario, it can be maybe a little scary. To be honest, some examples already exist of this. For example, in the United States, there's a robot called Knightscope, and another one in Japan right now called Perseusbot, and they are both passive robots that have face recognition, and they have voice recording capabilities, and all kinds of video recording capabilities, and they essentially roam around and look for danger.

Sarah McConnell: Wait a minute. Where's Knightscope in the US?

James Bliss: There's a Knightscope that had been deployed in Washington, DC, and I believe there's another one in California that they had worked with, so it's kind of a growing thing.

Sarah McConnell: What does Knightscope look like?

James Bliss: It's kind of cylindrical in nature. It's probably about four and a half feet tall, and it's, I believe, on wheels, and rolls around, and essentially is meant to be put into a crowded environment where it can keep track of people and events that happen.

Sarah McConnell: Your research is funded by the Air Force.

James Bliss: Yeah. It's a division of the Air Force called the Air Force Office of Scientific Research.

Sarah McConnell: How does your research work? How are you gaging reaction to whether people will trust and comply with a robot peacekeeper?

James Bliss: We had a three-year project that involved data collection in the United States, as well as Japan and China, and Israel, and for that research, people would essentially play a game on a laptop where they would enter a virtual environment that was a shopping task in a marketplace, and their task was to go from vendor to vendor, and as they did this, buying things, occasionally a robot would approach them and announce itself as a peacekeeper, and then it would demand a personal item of theirs, and so they had an on-screen inventory of items, things like keys, or a telephone, a lighter, things like that. The robot would demand that in the name of peacekeeping, the person relinquish a certain item, and then we would record whether or not the person complied with that, and then we would also give them a questionnaire to fill out about

that interaction. Then we would look at the trust data to see whether they trusted the robot, how much they complied with the request, and so forth.

Sarah McConnell: What did the robot in your simulation look like?

James Bliss: Well, we varied that, actually. In the third year of our research, some of the robots that approach people looked decidedly more human than others, because they had arms and legs, and a distinct face. Others were much more robotic, so in one case it didn't have arms or legs. It really didn't have anything that you could construe as human attributes.

Sarah McConnell: What did you learn about how people responded to a robotic peacekeeper?

James Bliss: Sure. A couple of things stood out. There were cultural differences as far as how people considered robots, whether they trusted them in general, as well as their typical attitudes toward non-lethal weapon and weapon use. We also found that people tended to treat robots in quite a bit the same way as they treat humans, and what I mean by that is, we found that if the robot made an appeal or a request that was more emotional, if it said, for example, "Please relinquish your lighter, because if you don't, then I may get angry, and I may have to do something about it," this kind of thing, people resounded to those emotional appeals much more than if the argument were given analytically.

James Bliss: We also found that people were much more accepting of robots that appeared to be passive, so passively guarding an area, rather than if they were confrontational and came up and actually approached you. Then the third general finding I can point to is that we found that people were much more likely to obey robotic commands if the robot looked like a human. So if there were anthropomorphic features to the robot, then people tended to comply with the demand much more regularly.

Sarah McConnell: Did you find cultural differences in how people responded to robots in these different countries? What were they? The US, China, Japan, and Israel?

James Bliss: Yeah, that's correct. We did notice some differences. For example, we noticed that in our Japanese participants, many of them were very accepting of robots because it is a fairly standard thing, fairly wide in use in Japan. In the United States, we saw quite bit of diversity in terms of what people's opinions were and how they felt about robots. If we took a look at other features like, "What are opinions of weapons?" United States and China actually appeared to be fairly close together in terms of how people thought about weapons, and how they believed that they should be used or not used, and in terms of robots, United States and Israel, there was quite a bit of similarity there. But I think in general, people regard robots in a variety of different ways, and certainly there's gonna be that segment of the population that is uncomfortable with robots in that kind of a role.

Sarah McConnell: How soon is all this coming, do you think? I mean, is it almost here?

James Bliss: I would say it's very, very close. If you remember the Olympics down in Brazil, some years ago, they used robots there to help kind of direct people and so forth. Right now in Japan, the Perseusbot, which is kind of like Knightscope, that's been deployed as part of the 2020 Olympics wrap-up. There are a number of other countries that have robots in development as well for these kinds of purposes.

Sarah McConnell: Are we considering, and are other nations like China considering vast armies of such robots? Is that being envisioned?

James Bliss: I'm not sure we're going in that direction quite yet. I mean, I'm sure people have talked about it, but I don't know of anything on the near horizon that would include that. Of course, I don't know everything about the military and what they desire to do, either. I think ultimately there's gonna be a long distance between where we are now and where that actually happens. I know that many countries have their own set of rules about how much robots can be developed and whether they can be armed and so forth, and that's kind of an evolving situation.

Sarah McConnell: What do you think are the ethical dimensions? As you look into our trust of robots, are you looking at it from an ethical point of view also, or are you mostly looking at it for, "What can we make work here?"

James Bliss: That's a great question. We don't necessarily look at the ethical part of it. That's a little more philosophical than what we do. However, we do from time to time consider it, so for example, if an automated device, be it a robot or be it an automated car, if it were to harm someone or to kill someone, who would be responsible for that? Would it be the designer of the robot or the automation? Would it be the person who was operating it? I mean, at that point, you have to really think about legal and ethical culpability, and so there are researchers, even researchers at ODU right now that are considering the philosophical trolley problem, where, "At what point do you decide whether or not to take a life or take multiple people's lives?" And that's a fairly standard trolley problem with philosophy.

James Bliss: In other situations, we may want to think more ethically about, "What are the limits? What are the capabilities we really don't want to represent? Are there certain tasks where we absolutely don't want robots to be involved?" For example, robots right now have been involved in surgery. They've been involved in [inaudible 00:10:57] driving, and trains, and a whole variety of things. But are there particular things where robots are just flatly unacceptable to the public? One might be counseling, for example. If you go to a counselor, a mental health counselor, much of that involves developing an empathetic relationship with that counselor. And can people develop the same kind of relationship with a robot? I'm not sure.

Sarah McConnell: You think about incidents that are now being filmed, where there are disastrous encounters between police and citizens, maybe after a car stop. You wonder if there were a robotic stop, if there would be less emotion involved. Less fear, less emotion, less hair trigger response?

James Bliss: Sure. That's actually, it's what really motivated a lot of this research. When humans are peacekeeping, or when humans are engaged in that kind of interaction, it's easy to make mistakes. It's easy to say the wrong thing, do the wrong thing. We noticed this many, many years ago, when American war fighters would go over to a foreign country and they would be engaged in peacekeeping, but maybe they would say the wrong thing, or make the wrong gesture, or something like that. With a robot, like you say, it may be that we can essentially package the best in peacekeeping tactics and procedures, and essentially ensure that what gets done by the robot is less liable to offend folks or to cause a problem.

Sarah McConnell: James Bliss is a professor of psychology at Old Dominion University. Coming up next, predicting space weather.

Sarah McConnell: Predicting the weather, let alone long-term climate patterns, is a notoriously tricky business. Our next guest is working on two brand new NASA missions that are already changing our understanding of how the near Earth atmosphere interacts with the uppermost regions near the edge of space. Scott England is a professor of aerospace and ocean engineering at Virginia Tech. He's NASA's project scientist for the new effort called ICON, and a co-investigator for NASA's new mission called GOLD.

Sarah McConnell: Scott, as a scientist for NASA, you and your team won an award for exciting discoveries about the environment of Mars. Help me understand what they were and why that was energizing for you.

Scott England: From Mars, we were getting observations at the very top of Mars' atmosphere, from a NASA satellite called MAVEN, and my portion of this work was looking at signatures of very large scale and very small scale wave motions, and we believe that those are linked to the weather and wind patterns near the surface of Mars, so the upper atmosphere of Mars we think of as starting perhaps around 60 miles above the surface, and maybe extending out to 100, 150 miles above the surface.

Sarah McConnell: What was different about the discovery than what you'd expected when you were looking at this upper atmosphere of Mars? How was this a breakthrough in understanding Mars' atmosphere?

Scott England: As these waves are moving the atmosphere around at high altitudes on Mars, we can actually see them changing the composition of the atmosphere, and it's bringing perhaps more carbon dioxide up and then pushing it down. That was

really profound. It was something that perhaps we would have said we may see in theory, but we'd certainly never seen it before in data.

Scott England: One of the main focuses of the MAVEN mission is trying to look at the conditions at the very top of Mars' atmosphere, in a way to study how Mars can be losing some of its atmosphere to space, and how Mars' atmosphere may have changed over time.

Sarah McConnell: Did that make you look at Earth's atmosphere in a different way?

Scott England: Absolutely. The Earth's upper atmosphere is an extremely changeable and dynamic place. It's very hot. Its temperature changes dramatically day to day, far more than we would ever see near the surface, and extremely high wind speeds, so it can be blowing at very high speed and in a particular direction one moment, and then suddenly change. What I was really interested in studying in this region is, "Hey, how does this portion of the atmosphere really connect to down near the surface? How are these two really part of just one whole atmosphere?"

Scott England: Some of what we're seeing in the upper atmosphere appears to be a consequence of changes in weather systems right down near the surface, and some of what we're seeing is changes in the environment in space that's above this region. It's really where these two come together that make this incredibly dynamic region of the upper atmosphere.

Sarah McConnell: What are you trying to do with these two new NASA projects?

Scott England: Well, there are two new NASA missions. The first is called GOLD, and the second is called ICON. GOLD is a mission that launched last year and is now taking data. ICON, we're just waiting for the launch to come up later this year. What GOLD is able to do is to image this upper atmosphere from geostationary orbit, so that gives GOLD this vantage point that looks like what we would see from a weather satellite, so you see the whole disc of the Earth. So GOLD is able to see the whole of North and South America, the Atlantic, day and night, and that really gives us a completely different perspective on what's going on than from a satellite that is flying in low Earth orbit much closer to the Earth, and is moving very rapidly through this region.

Scott England: ICON, which is the second new mission, is actually going to fly through the very top of this upper atmosphere, and really there's an enormous power by combining that vantage point with this whole planetary scale view that we get from GOLD.

Sarah McConnell: Are these new instruments going to be to your field what the Hubble and subsequent telescopes have been to discovering new planets, for that field?

Scott England: I hope so. It's amazing to be working on this at a time when we're gonna have not one, but two new missions focused on looking at the same region of our atmosphere. When NASA selected both of them for flight at the same point in time, that's when I really started to say, "Hey, we're actually gonna go way beyond what we had originally planned, because we'll be able to piece out in detail what's happening with one view, and in context what's happening with the other view."

Sarah McConnell: I read that GOLD and ICON are using something called airglow to study the ionosphere. What is airglow?

Scott England: Airglow is this amazing phenomena where the atmosphere at very high altitudes is able to emit light, so the aurora is a type of airglow. As the atmosphere is impacted by solar radiation or high energy particles, the atmosphere is then able to emit some of that energy as light. Well, we can observe that light with different instruments, so from the specific colors we can tell what the atmosphere is made of, and if we can see how that frequency of light changes, we're able to see if that gas is moving towards or away from us, which is a way of actually making these measurements of wind at high altitudes. So without actually having to be there, we can see how this region is changing from one moment to the next.

Sarah McConnell: Can the astronauts in the Space Station see airglow?

Scott England: Yes. As the Space Station goes into shadow on the night side of the Earth, what they can see is this green glow over the whole planet, and what that is telling us is it's giving us some information about oxygen in the upper atmosphere.

Sarah McConnell: You've yet to launch ICON, but you do have early results in from GOLD, right?

Scott England: Right. We knew that as this region of the upper atmosphere changes from day into night, that we would sometimes get these very dynamic changes that create these very beautiful, fine scale structures in the upper atmosphere. And we had reason to believe from some previous measurements that the conditions that are present this year, that GOLD wouldn't actually see these instabilities. And practically from the very first day we turned on the GOLD instrument, we just saw a whole range of these structures stretching all the way across from South America, across the Atlantic, around the equatorial region, as far as the coast of Africa. And we really saw just so many of these, and how that we were not even expecting to see any of these. It's really made us stop and rethink what we thought we knew, and say, "Hey, are we seeing more of these because we have a better instrument, or is there something else going on here that we perhaps didn't understand?"

Sarah McConnell: As a thought experiment, if it weren't just that you have better instruments and you're seeing more, if it were, "Oh my gosh. This is changing," what are some possibilities?

Scott England: One thing that's really striking from these images is that these small scale structures perhaps don't seem to be just isolated events. That we see perhaps a whole sequence of them between South America, all the way across the Atlantic to Africa. We see these small scale structures and they're almost regularly spaced across this region, which might suggest that there's some other underlying process here that's determining the spacing between these. That's something that just looking at these images from GOLD, it's hard to not think about.

Sarah McConnell: Put that another way. What are you imagining it might be?

Scott England: We're imagining that this might be another telltale sign of the links between the upper atmosphere and what's happening in the lower atmosphere. At Mars and at Earth, we see this connection throughout the entire atmosphere that energy and information and changes in the lower atmosphere can be communicated hundreds of miles above to the upper atmosphere.

Sarah McConnell: But we would have thought that. We would think that the lower atmosphere affects the upper, and that the upper releases and interacts with the edge of space. How is this such a departure from what we theorize we might have expected?

Scott England: We're still getting these early results, but one possibility is that these same wave processes that we've been studying at Mars and at Earth are being generated in the lower atmosphere perhaps by large scale weather systems, and they're able to move up into the upper atmosphere, just enough to take us over this tipping point where this instability is able to occur. One reason that would be really profound is it really gives us another striking reason to see this connection throughout our whole atmosphere.

Scott England: The idea that the conditions just outside of the International Space Station, so if an astronaut takes a step outside on a space walk, they're flying through this upper atmosphere, and how the conditions are changing there is connected to the same atmosphere we're living in when we step outside our doors here. That's, I think, really profound. That's piecing together what we will need to eventually be able to predict the conditions in the upper atmosphere, so if we want to see a transformation in our understanding to the point where we could have something like a weather forecast for the upper atmosphere, we really need to explore how these basic processes are interacting with one another and shaping the conditions that we see there.

Sarah McConnell: Could this ultimately have implications for people who study climate change, global warming, things of this ilk?

Scott England: It's very early days yet, but one of the things that we do see in the upper atmosphere is a response to the rising levels in carbon dioxide. One of the ways the atmosphere cools itself is through carbon dioxide emitting infrared light, so

as we see rising levels of carbon dioxide throughout the whole atmosphere, eventually that makes it to the upper atmosphere, and one consequence we have there is, over time, we see that region becoming slightly cooler, and as this region cools, it actually becomes even less dense than it currently is.

Scott England: One possible implication is that if this region becomes less dense, that may change space junk, so small pieces of manmade material eventually fall back into the atmosphere, because they slow down as they fly through this very tenuous upper atmosphere. But if that region became even more tenuous, they would spend even longer in space, and this could be a real concern going forwards.

Sarah McConnell: What are the implications of studying this? Where do you want to get from here?

Scott England: There's really two aspects to why we want to study the upper atmosphere of the Earth. There's a practical aspect, in that this is the region where a lot of spacecraft that are in low Earth orbit, they're actually flying through this region, but then there's also a reason to study this and understand the whole atmosphere is one system. That's really fascinating. Those altitudes which are perhaps just 20 or 30 miles above the surface, we see a very obvious connection to large scale weather systems, for example, over the Amazon and other rainforests. We see those communicated up to that altitude around where the ozone layer is happening, and all the way out in this region that we think of as space, we're seeing things change in response to weather systems that we experience here down near the ground.

Sarah McConnell: Scott England, thank you for sharing your insights on this with me on With Good Reason.

Scott England: You're welcome.

Sarah McConnell: Scott England is a professor in the Department of Aerospace and Ocean Engineering at Virginia Tech. He's the project scientist for NASA's ICON. This is With Good Reason. We'll be right back.

Sarah McConnell: From Virginia Humanities, welcome back to With Good Reason. Up next are two interviews, one about welding and becoming a welder, the other about the future of shipbuilding. Here's Andrew the welder.

Andrew Folsom: And so I was out of work for about 12 months, just kind of feeling sorry for myself, and I had to find something to get me going again, and to get my passion back in life, and as soon as I took the welding classes, I just knew.

Sarah McConnell: And here's Jennifer, the shipbuilder.

Jennifer M.: I mean, shipbuilding is nationwide. We have the Gulf Coast region, the Pacific Northwest, California, as well as the Northeast, so shipbuilding really is nationwide for us.

Sarah McConnell: Andrew's joy, discovering how much he loves welding, does have a connection to the sea change we're about to undergo in how we build ships. Both are getting huge infusions of money to educate and retrain the workforce. Let's start with the welder, Andrew Folsom. The art of welding is seeing a resurgence in Virginia thanks to a new workforce grant program. Andrew Folsom fell in love with welding after he took a class at Blue Ridge Community College. Now he's the one teaching welding to construction workers, artists, veterans, men and women old and young, and revealing the power this hands-on craft has to transform their lives as it did his own.

Sarah McConnell: Andrew, you call yourself a welding nerd.

Andrew Folsom: Absolutely.

Sarah McConnell: Why do you say that?

Andrew Folsom: I have such a passion for welding, so when I'm not working at the lab, teaching students, and I'm not working at my own shop at home, I'm on the internet, I'm reading books, I'm talking to people on forums. I'm just 100% committed to welding.

Sarah McConnell: Are you a master welder?

Andrew Folsom: Absolutely not. Nope. Five years into it, I'm not a master welder. I'm just a drop in the bucket.

Sarah McConnell: You started welding when you were 20?

Andrew Folsom: Approximately 20. That's when I first got started just messing around in my dad's garage, nothing doing anything real, and then I actually went to Blue Ridge and took the community college welding program, and I signed up for classes and took the basic, the intermediate, and the pipe level classes, an advanced level class.

Sarah McConnell: Did you know right away you loved it?

Andrew Folsom: From the first minute I struck an arc. It was instant passion, and I just never wanted to do anything else.

Sarah McConnell: Had you gone to college before that?

Andrew Folsom: I did, actually. I went to Blue Ridge and got my criminal justice degree, and I enjoyed it a lot, but it just wasn't grabbing me the way that I needed my career to grab me.

Sarah McConnell: Did you have another profession for a while?

Andrew Folsom: I was actually working in retail, working at a home improvement store, and I just kind of got tired of the retail life.

Sarah McConnell: What was that moment when you thought, "I'm gonna take a course"?

Andrew Folsom: Well, I actually got into a workplace accident that severely hurt my back, and so I was out of work for about 12 months, just kind of feeling sorry for myself, and I had to find something to get me going again and to get my passion back in life, and as soon as I took the welding classes, I just knew.

Sarah McConnell: Do you think the world needs more welders?

Andrew Folsom: Absolutely. Right now we need qualified welders more than ever, whether it be building bridges, or some of the pipelines that are coming through obviously have welders involved. For most of our students coming right out of our program after taking 16 weeks of classes, they can expect to start around the $14 or $15 an hour range, and for a lot of people, that's $3 or $4 an hour more than they ever thought that they could make. We have some students who have been welding for several years now and they're making $26, $27, $28 an hour, which has changed their lives. It's completely turned around their lives when you make that kind of honest money.

Sarah McConnell: Do you ever get inquiries from businesses that are looking for qualified welders?

Andrew Folsom: Absolutely. Our school was founded because the local industry said, "We need more qualified welders that are welding at higher end." I can't tell you how many times, if you go to a local brewery, you will see miles of piping in some cases, and every one of those pipes had to be welded together.

Sarah McConnell: The first course you offer is eight weeks. Students come in, mostly young?

Andrew Folsom: I would say the average age is probably around 25. The first two weeks, we cover oxy acetylene welding, kind of the bare bones, basic, and then after two weeks of oxy acetylene, we do two weeks of TIG welding, and then after the TIG welding, we do stick welding, which is probably the easiest process to get a job with locally, and then we finally finish up with wire feed welding. Then in the second eight weeks, we work on the intermediate class, and that class is all about trying to qualify a welding test. Every time a welder gets a new job, they have to go and show their skills. It's one of those jobs you can't just walk in and say, "Here's my resume. Here's what I can do." No, they want to see you weld. If you have a weld that fails, you can have a building that would collapse. I know a

couple of months ago, I believe it was, they had that huge oil leak out in the west, where millions of gallons of oil came down, and I believe that it might have been down to a bad weld.

Sarah McConnell: Are there any welders in the nation who have such a reputation that most really good welders have heard of them?

Andrew Folsom: Absolutely. I think one of my favorite people, he's kind of a YouTube sensation. His name is Jody Collier, and now that he's getting a little older, his job to himself is to make these YouTube videos to show people what it takes to make a good weld, and to do step by step things. There's tons of Instagram welders now. Instagram has really opened up the sharing of your images. I'll make a weld and I'll say, "Hey, that looks pretty cool," and I'll put it on my Instagram website.

Sarah McConnell: I can't imagine what would be a cool weld. Isn't it just two things coming together at a right angle with some metal there?

Andrew Folsom: A lot of people think of it that way. To simplify, that's what it is, but every weld has a signature. I can look at my weld and tell the difference between my weld and my boss' weld, and you can recognize it. Like I said, it's a signature.

Sarah McConnell: This class that you're teaching comes from a new program called the New Economy Workforce Credentials Grant.

Andrew Folsom: That's correct, and it pays two-thirds of your tuition if you're eligible, so it's really changing people's lives and giving them the opportunity to take these classes, and trying something new, and seeing if they can change their career. A lot of these people are already in the workforce, they're working jobs that they don't particularly like, but they're stuck. They need to make the money, and so with this Workforce Credentials Grant, they're able to take the classes in the evenings and on the weekends, and build up their skill good enough to where they can leave their job that's not their favorite, and move on to a brand new career.

Andrew Folsom: There's a student of mine who came through about a year ago. He was working at a grocery store. I think he was making about $9 an hour as a 30-year-old man. He didn't even have enough money to pay for the one-third of the tuition that the state didn't cover, so he borrowed some money from his brother-in-law, and worked part-time for his brother-in-law, I believe at a construction company, trying to pay that debt off, and now this young man is making $19 an hour, and he's paid off most of his student loans. He's paid off most of his credit card bills, and he's able to go and enjoy life. He can go on vacation. He can afford to have fun.

Sarah McConnell: Did you start out with very few in your classes, but it's grown?

Andrew Folsom: Honestly, it's been almost full from the very beginning. We have an amazing, state of the art laboratory. We just purchased two of the Lincoln Welding VRTEX, the virtual welding simulators. If your angle is wrong, if you're going too fast, if your welding rod is too far away from the plate, when you finish your weld, it tells you that. When they go back into the welding booth, they can see the transfer of the knowledge. They can say, "Well, you know, when I was using the virtual welder, I had to have my elbow up a little higher to get a good angle," and when they move into the booth, they know to put their elbow up.

Sarah McConnell: Do you think you've saturated the market where you live with really great welders and people are having to go far afield to find jobs?

Andrew Folsom: Our goal is to try to saturate the field with good welders, and I think we're starting to get there. We've been around for three years. We've qualified over 300 students and 75 of our students are still locally employed. One of the things that we focus on is soft skills. Everyone thinks about welders as being these rough and tumble guys, getting hot, burning themselves with long, bushy beards, but the reality is, the small things, the soft skill matters. Being able to communicate with the people around you. Showing up on time. Showing up matters. Doing the best job you can matters. Being able to communicate with the people that you work with is very important to do.

Sarah McConnell: You care a lot about the ones you teach. You stay in touch?

Andrew Folsom: I absolutely do. Yes, ma'am. I email, text message, phone calls constantly. I would say at least once a week, I'll hear from somebody. That's my favorite thing about this job that I have is changing people's lives, because it changed my life. It got me from a place I didn't want to be, and it gave me passion. It gave me hope, and so if I can just share a little bit of that with some students, that's my job, is to show them that I care, and give them everything.

Andrew Folsom: I'll have students, first day on the job, they're getting ready to go to work, and they'll call me. "Hey, I can't remember. How many amps do you run if you're burning a 7018 electrode?" And I'll talk to them, and I'll calm them down a little bit. Being able to recommend good companies to work for, good, strong companies that have good values, and that pay their employees fairly is very important.

Sarah McConnell: You've also got another program that you've started doing with people who like to weld for artistic purposes.

Andrew Folsom: Sure. We've started doing a Modern Metal Art Class. This one woman made this beautiful praying mantis out of silverware that she put in her garden, so we work with a lot of people like that. We're working with a War Paints group, which is a group for veterans who can come in and just kind of release some of their creative juices. The gentleman that started the program said that when he came back from one of his deployments, he started painting, and he realized

how much it calmed him, and how much it kind of brought him back to center, and so he started this War Paints program to show other veterans it's okay to need to release, and so they come to this lab, we provide the welding gloves, we provide the jackets, we provide the hoods. You just got to show up with a good pair of leather boots and safety glasses, and we take care of the rest.

Sarah McConnell: Do you have any women who are doing the actual welding, or only the artsy welding?

Andrew Folsom: Oh, we have plenty of women that have come through our classes. It annoys me when people say that women don't belong in this type of workforce. I'll be honest with you, I prefer working with the female students, because it's not about an ego. They don't care what the guy next to them is working on. They care about them, and they want to do the best they can, so I really enjoy it when the females come into our welding program, whether it be on the art side of it, or whether it be on the structural side, and they're trying to make a name for themselves.

Sarah McConnell: Is there some worry in the industry that the robots are gonna come along and wipe out welding?

Andrew Folsom: Technology is definitely encroaching into the welding world, and I personally think it's a great thing. I think you have to embrace technology to move forward, and if you're not moving forward, you're falling behind. A lot of people see these robotic welders and they think, "Oh, great. I'm gonna be out of a job here shortly." But the truth of the matter is, you have to be a qualified welder to program the robotic welders. There's always gonna be welding that can't be done by a robot. That's 300 feet up in the air, inside of a skyscraper. Underwater welding is a lot of things that people talk about. There's always gonna be welding jobs for those people who are willing to embrace the technology and move forward with it.

Sarah McConnell: There's been so much hand-wringing over the loss of the automobile industry, the loss of the iron mining industry, and all of these others, where men and women could work with their hands, be outdoors some of the time. Do you see a possibility that we could have sort of a resurgence in rebuilding America's infrastructure?

Andrew Folsom: I sure hope so. A lot of the jobs now that people work, that they're not happy with, sitting in an office, sitting in a cubicle, I bet there's millions of people who work Monday through Friday, 8 to 5, on a computer, but then when they go home, they're in their garage. They're building simple things, and if we could just push them to try to change your life, which is really hard to tell someone, "We want you to take these classes, see if you like it, see if you're good at it," is another big part of it, "and then drop everything you've ever known and start a new career." And for the people in their mid to early 20s, that's not a big deal. But some students we get are in their 30s, 40s. We've even had some people

who were retired, that just kind of wanted to come in and learn how to weld, but career changers are a lot of the people that we get, that come through our program.

Sarah McConnell: Have you heard from the Virginia governor or the chancellor of the community college system about just how popular this program is, that's a new funding effort by them?

Andrew Folsom: Absolutely. I believe the instructors, myself and all the other instructors put everything we have into this program. With my students, I'm in their booths all the time. I'm watching them weld. My favorite thing to do is to sneak into their booths when they don't know that I'm there, because if you know I'm behind you, you're gonna weld like I asked you to. But if you have no idea that I'm standing right behind you, you're gonna do what you think is right, and that's when I get to say, "Well, you know, I notice you weren't doing the U-shape like I was telling you," or, "You weren't quite holding it long enough on the left side." Almost with every single one of my students, I will grab their hands while they're holding the welding rods, and I will physically weld with them so they can feel the muscles, so they can feel how fast I'm going, and some people just have to be shown in a lot of different ways, so it just varies greatly between each student.

Sarah McConnell: That just sounds wonderful. I would take your class. Andrew, thank you so much for sharing your thoughts on this on With Good Reason.

Andrew Folsom: Absolutely. I very much enjoyed it today.

Sarah McConnell: Andrew Folsom is a welding instructor at Blue Ridge Community College.

Sarah McConnell: Some of the welders trained by Andrew may join the ranks of Newport News Shipbuilding, which is next to the largest Naval base in the world, off the coast of Virginia. Newport News Shipbuilding is investing in augmented reality to more efficiently craft the next generation of Navy ships. Jennifer Michaeli is a professor of engineering at nearby Old Dominion University. She's also a fourth generation builder of ships. Her great-grandfather built ships in England in the 1800s, then immigrated to Newport News Shipbuilding to build ships for the US Navy. His son-in-law also worked there, and so did his grandson, Jennifer's father, who also worked on the first prototype nuclear reactor for the aircraft carrier the USS Enterprise. Jennifer is expert in ship design, production, and testing.

Sarah McConnell: Jennifer, you're helping convert the building of ships from a process that requires tons of paper to one that is all digital.

Jennifer M.: Yes. Yes, we're very excited about this. It's really happening in other industries already, and bringing all kinds of exciting tools, augmented and virtual reality, to 3d scanning, to 3d modeling, into shipbuilding to harness the efficiencies of

those technologies into designing, building, and maintaining ships and submarines.

Jennifer M.: The way we had been designing and building ships was very paper-based. What the industry and the Navy is looking at now is taking all of that to a digital format, to going paperless, to being able to design something on a computer, take that to a tablet, give that to a welder or a pipefitter, or shipfitter, and for him or her to then go and do their work so much more efficiently, and if there's updates to the design, they're getting those in realtime, so everything will be all connected in the near future to achieve these efficiencies and cost savings.

Sarah McConnell: Has the Navy felt sort of behind the times in this regard up to now? Are we playing catch-up with other industries?

Jennifer M.: I believe that in the aerospace industry, in the automotive industry, these advances have been happening, which is wonderful to see. The uniqueness about shipbuilding is that we are not mass producing parts. There is a tremendous amount of complexity in the assembly of ships and submarines, and so we have to try to pull as much as we can from the successes happening in automotive and aerospace and advanced manufacturing sectors, into the ship building and ship repair industry.

Sarah McConnell: What new ships has the Navy commissioned to be built in the near future?

Jennifer M.: Regionally here, with Newport News Shipbuilding, they are currently building the Ford-class, which is the next generation aircraft carriers, and they're also working with Electric Boat in Connecticut on the Ohio replacement class submarine, which is going to be called the Columbia-class submarine. Those are two of the largest programs in the Navy. I mean, shipbuilding is nationwide. We have the Gulf Coast region doing such a wide variety of shipbuilding, the Pacific Northwest, California, as well as the Northeast, so shipbuilding really is nationwide for us, and these changes that are happening at these tier-one shipyards, we would call them, will then be able to be translated to the workforce and the companies of the shipyards nationwide.

Sarah McConnell: Do you think all the shipyards are trying to do this, go digital?

Jennifer M.: Yes. The technology is there, and it's ready, and it's the workforce. Even for me, I have freshmen coming into my class. They are more comfortable doing 3D design than paper-based design. They're more comfortable in an augmented and virtual reality space than not. These are the 18, 19, 20-year-olds, so now I look at my children, for example, my four and six-year-old. I'm having to balance their tablet time, right? You hear about their screen time, and it's a fine line, because so much of their learning process is now based on tablets and technology, so it's not about, "Oh, they're watching cartoons on it." They're truly learning and advancing at such a fast rate, and that's the future of the workforce in shipbuilding and other manufacturing sectors, and so we need to

make these changes now and create these pipelines so that we can attract and retain the best and brightest into these fields.

Sarah McConnell: Haven't the shipyards employed tens of thousands of blue collar and middle class Americans who are getting paid well for great jobs that they work very hard at, but will now not be able to do because they're now digitized beyond their ability to keep up?

Jennifer M.: Oh, no. I don't believe so at all. I mean, this is not about replacing jobs with computers. This is about upscaling the current workforce and preparing the next generation workforce for this. What we're looking to achieve is harnessing the technologies, and driving down the costs, and increasing the efficiency in what we're already doing. That's the best thing for the nation. I mean, we have our large fleet of ships and submarines. We have our large industrial base supporting commercial ships for transporting goods in and out of the country, for supporting commerce, for international trade. I mean, all of these ships and vessels will still need to be designed, built, and maintained, but the technology will allow us to do it quicker and more efficiently, and at a lower cost.

Jennifer M.: We've received what's called a Go Virginia Grant to bring together the K-12, community colleges, higher education, and really create pathways for people to pursue their passion. Whether their passion is welding, or IT and cyber, or design and engineering, or business, there's opportunities for them in the shipbuilding industry so that they can prepare themselves for these exciting careers, and at the same time, stand up a digital shipbuilding lab that will allow us at the university setting to not only do research and education for our students or workforce training for the current workforce, but to do outreach and reaching into the elementary and middle and high schools, and have these young people come into the lab, experience digital shipbuilding, and really see how exciting it is to design and build ships for the US.

Sarah McConnell: It was exciting to hear you talk about the building of a new class of aircraft carrier. Tell me the sorts of changes we might see in the finished product.

Jennifer M.: The Ford-class, which is this next generation aircraft carrier, is so much more technology and war fighting capability. I mean, they're looking at the rail gun, and laser weapons, a much more sophisticated electrical system, so much automation, so they're reducing the crew size on the vessels, so there's so much technology packed into really the same platform that they have built in the past. So many companies across the nation are supporting the shipbuilding industry, and this type of upscaling and training will have to translate to all of those touchpoints in the supply chain, so it's not just about changing how our welders are doing things, or how our shipbuilders are doing things. It's a company in Iowa that's providing critical parts that will go on that aircraft carrier. If that digital thread is truly going to be robust, it will be about training those folks all across the country in order to be able to support the industry.

Sarah McConnell: Well, that's wonderful. Jennifer Michaeli, thank you for talking with me on With Good Reason.

Jennifer M.: Thank you so much. I appreciate it.

Sarah McConnell: Jennifer Michaeli is a professor of engineering technology at Old Dominion University. She's been named an outstanding faculty member by the State Council of Higher Education for Virginia.

Sarah McConnell: Major support for With Good Reason is provided by the law firm of McGuireWoods, and by the University of Virginia Health System, connecting doctors and patients through telemedicine to deliver high-quality care throughout Virginia, the US, and the world. UVAhealth.com.

Sarah McConnell: With Good Reason is produced in Charlottesville by Virginia Humanities. Our production team is Allison Quantz, Elliot Majerczyk, Kelley Libby, Cass Adair, and Alison Byrne. Jeannie Palin handles listener services. We had studio help from Todd Washburn at WHRO, and Bill Foy of Virginia Tech. Additional music this week from Blue Dot Sessions. For the podcast or a transcript of the show, go to withgoodreasonradio.org. I'm Sarah McConnell. Thanks for listening.