# Week of Women STEM Panel: Smart Tech

KAREN WEATHERMON: Since we are at 4:30, I'm going to go ahead and get us started. If you're saying, I don't think your mic is on, it's because it's for the Livestream. So you're not going to hear me amplified. But this is so that folks watching from afar can hear us.

So, good afternoon. I'm Karen Weathermon. I'm the director of the Common Reading Program. And together with the Office of Undergraduate Education, for which I work, and also the planning group for the Women in STEM Week, which we're celebrating this week, I want to welcome you to this event about smart technology.

I'm especially excited about this presentation, because our more normal Common Reading presentations-- and probably more normal, more regular university presentations generally-- are typically a single speaker talking from his or her own perspective from that particular field. And this is such exciting work to me, because it is a way of highlighting how different disciplines can really illuminate questions and problems and bigger and often more exciting ways, fuller ways, to see what questions are the most important to address and what kinds of solutions might present themselves for those questions.

This is part of a year-long look at technology, emerging technologies related to this year's Common Reading book Soonish. This, today's topic, especially connects to the book's section on programmable matter. But as I said, it's also a wonderful example of the power of collaborative thinking.

Looking ahead to upcoming Common Reading events, there will be a talk this Thursday by Sue Paish. She's the director of structures for Boeing. That will be at 4:00 PM in Spark 335. This talk is also part of our week celebrating women in STEM.

And next week, we have, on Monday, the Showcase for Undergraduate Research and Creative Activities, otherwise known as SURCA, from 3:30 to 5:00 in the Cub Senior Ballroom. That's a wonderful opportunity to see the kind of innovative work being done by undergraduates across the university-- in fact, across our different campuses. Students from various campuses will also be traveling to Pullman to show off their work. So it's a great chance to see what undergraduate research can look like and, I hope, inspire you to think about participating yourselves.

And on Tuesday, there will be a talk by a panel of faculty on gene editing and ethics, another hot topic that is sort of on the forefront of technologies. And that's another panel of folks both from philosophy and from our reproductive science programs. So more about those events can be found on the Common Reading website and also on the Common Reading CougSync page.

If you are attending for Common Reading credit, see me at the end of today's event, and I'll card swipe you in. Just to let you know, today's event has a required post-event survey with just

a few questions that help give us some useful information and also the Women in STEM program some useful information for us to be able to program forward. So that survey will come to whatever email you have linked to your CougSync account. So whatever account that is, your WSU account or another one, that survey will arrive there. It's just a few questions. It'll take you just a few moments to fill that out.

And when you have filled it out, then this event will populate into your involvement page. If you have any questions about how to do that, you can't find the survey, you don't know how to do that, there's also instructions for that on our website, which is commonreading@wsu.edu.

So now to introduce today's speakers. Diane Cook is a Regents Professor and the Huie-Rogers Chair Professor in the School of Electrical Engineering and Computer Science here in our Voiland College of Engineering and Architecture. She received her bachelor of science from Wheaton College and her master of science and PhD from the University of Illinois. Before arriving at WSU in 2006, Dr. Cook's experience included research with IBM, NASA, the National Center for Supercomputing, among others.

Her research interests include artificial intelligence, machine learning, data mining, robotics, and smart environments. She is the director of several things here at WSU. She's the director for the WSU Center for Advanced Studies in Adaptive Systems, with the neat acronym CASAS. Very clever, since it involves, often, adaptive technology in homes. And she's also the director for WSU's Artificial Intelligence Laboratory and director for the National Institute of Health's training program in geron-- no, gerontechnology. Did I get that right?

Shelley Fritz is a College of Nursing faculty member at our Vancouver campus. Her nursing background is in public health, emergency nursing, administration, and nursing education. Her research focuses on the application of technology and the delivery of health care and human-computer interactions. She earned her bachelor of science in nursing at Walla Walla University, her master of science at Walden University, and her PhD in nursing from WSU.

The third member of this team, Dr. Maureen Schmitter-Edgecombe, is unable to be with us today because of a death in her family. She is the HL Eastlick professor in psychology, specializing in clinical neuropsychology. And the perspective that she brings to this team will be carried by her team members who are able to be here today.

So together, this trio of researchers bring the lenses of technology, of health care, and of neuropsychology to questions about how our older population and others can live more independently. For their innovative research, they have been awarded recently nearly $3 million in grants from the National Institutes for Nursing Research and the National Institutes of Health. So please help me welcome our speakers this afternoon.

[APPLAUSE]

DIANE COOK: Well, thank you, Karen. Thank you for inviting us. So I mean-- you need me to wear this? Sure. I'm Diane, and this is Shelley. And it's been fun to work in this group, because we are very multidisciplinary. And the smart tech we're going to talk about today centers on smart homes.

So let me first poll the audience to see what background you're coming from. How many of you live or have lived in smart homes or homes that have smart technology in them? Any show of hands? Any smart appliances?

SHELLEY FRITZ: Anybody with Alexa or a Samsung Hub refrigerator? One person?

DIANE COOK: What about a smartwatch or a smartphone? And for those with mobile technologies, how many of you have ever used an activity tracking app? Now, for the same group, how many of you have parents or grandparents that also use smartwatch/smartphone with an activity tracking app?

SHELLEY FRITZ: A couple.

DIANE COOK: There are a couple.

SHELLEY FRITZ: Four or five.

DIANE COOK: All right. So this is our mission-- to understand what data from those sources can do in order to understand and assess somebody's health and to use that information to intervene to help people stay healthy and aging in their own homes and environments. And clearly, there's a need for this because of the aging of America. And while this slide says aging of America, this age wave is global.

But the statistics I have focus on the US. For example, every day, one-- or is it 6,000 Americans celebrate their 65th birthday, 3,000 Americans celebrate their 85th birthday. And I like this stat the best-- American seniors now outnumber the entire population of Canada at about 35 million. And this is a change that we are going to have to respond to.

What this graphic shows is how the distribution of the population in the US has changed over the last 50 years and how it's going to change over the next 30 years. If you look, when it started in the '50s, the biggest category was the 0 to 5 years, and there was a sharp decrease when it got 5 five to 10 years. But then with improvement in medicine, these babies were able to lived through toddlerhood and into adulthood. And then, as you know, with the coming of the baby boomers, life has been extended even further.

So what started out as kind of a triangle shape, as you move forward to-- we're looking at the 1990s. That big, fat part is moving higher and higher into the 65 age group is what I find particularly interesting in this graph. And by the time we go past where we're at in 2019 and on

to 2030, it's going to become one of the largest age groups. And that's going to present some crises that we have to deal with.

So, what kind of crises? Well, if there's an increase in expected age due to benefits of medical technology, then there's a corresponding increase in the cost of care and the need for care. However, the number of people that are available to provide that care is remaining near constant. So there's an ever-increasing gap between what we can provide for older adults who are going to have multiple chronic conditions, who may be failing in terms of their memory and cognitive performance, and the resources that we have to take care of them.

There won't be enough physical resources. There won't be enough caregivers. So what we're hoping is that we can design technology to fill that gap and address this question-- how are we going to keep this aging population functionally independent in their own home? And by functionally independent, we don't mean just alive and existing, but able to perform their daily activities with minimal intervention so that we're not putting the burden on this increasingly small percentage of people that are young and healthy enough to take care of them. But also, so that the costs are kept within reason and people do not need to move to assisted care facilities.

So in terms of the smart home, we are designing technology that acts kind of like a prosthesis, almost like you would think of a prostheses, as an artificial limb. In our case, it's whatever is needed-- a prosthesis to keep older adults mobile. It could be a cognitive prosthetic to help them where they're having some memory gaps, or wherever it's needed in order to keep them functionally independent in their own homes.

And so I first got interested in smart homes because I had done research in machine learning. And maybe like other women who are interested in STEM disciplines, or engineers in general, I wanted to move from looking at just theoretical design of algorithms to using machine learning for an application that had societal impact. And I was talking to my in-laws, and they said, well, are you familiar with smart homes? Because they worked in the real estate industry.

And I said, no, but the Texas State Fair is one city over, and they say they have the home of the future there. So I went and visited the home of the future, and it had a lot of really neat gadgets. It had a washing machine that you could start from your computer. This is a long time ago. It had a refrigerator with a barcode scanner, so when you run out of milk, you scan the bar code for your milk carton, and it would create a grocery list.

And back then, they had a company called homegrocer.com that you could automatically send your grocery list to. And they would assemble the groceries and deliver them at the door, so you never have to leave your home. It's awesome. And I thought, that is certainly a connected home, and it's one that has a lot of neat gadgets in it. But coming from artificial intelligence and machine learning, I wouldn't call it a smart home.

Because when we think of a smart home, we think of one that is able to sense what's going on in the environment, to reason about it in terms of what is its goal maybe in terms of serving the people that live there, and then act in such a way to reach that goal. And even if you have a connected home with a lot of neat gadgets, it's still the resident that has to make all the decisions and decide what is going on inside of the home and what is the need. So I was interested in seeing, can we actually build a home that is smart?

So based on this definition that I just gave, here's what we need to make a home smart. We need for it to be able to sense what's going on in the home and with the residents that live there, to be able to identify specific patterns. And if we're using this for a health goal, then from that, we will assess the health of people that are living there and, finally, intervene.

And the reason this is a cycle is that if we design some intervention. We want to be able to see the impact that it has on what's going on in the home and the health of the people that live there and adjust the intervention correspondingly. So this is our goal for a smart home. And at first, it seems a little like a pipe dream, like a George Jetsons futuristic home. But this is something that the technologies are there to do it.

But we also want them, at the same time, to be subtle. So a lot of times, we will have individuals come to campus and say, show me your smart home. Because we have a test bed smart home in one of the graduate student apartments. And I think that they're hoping that the robot butler will open the door, and there will be flashing lights. But remember, this is a technology that we want to be accepted by older adults and to pervade our homes, and the last thing they want is a big yellow light saying, I have need for assistance.

So what we want is for them to walk into this smart apartment and see an apartment. And the technology just disappears into the home. Now, what we have in this picture is not quite that. It is our smart apartment, but you will see that there are sensors throughout the apartment. So the goal of disappearing into the fabric of the home is still underway.

But it does do these steps of sense, identify, assess, and intervene. So I'll talk just a little bit about what these are. In terms of sensing, we flood homes with sensors, because that provides data that our computer programs can use to identify what's going on in the home, what are patterns. Are there are changes that we need to be aware about? And how can we use this to assess the state of somebody's health and intervene?

This is just a collection of a subset of some of the sensors that we work with. So going from left to right, we see two of the people in our lab that have opened up an infrared motion sensor. And we put them on the ceiling of our homes and apartments, and we just connect them with, like, command strips so that they're connected with adhesive that you can remove when you don't want them anymore.

But these are infrared motion sensors, so they're not cameras. So they don't require lighting, and many people consider them a little bit less invasive in terms of privacy. But they're looking

for heat-based movement, because they're infrared. So you find them, for example, when you're at the airport and you get near the door and it opens. It's because there's an infrared motion sensor that detects that you're walking in that area. So if there's heat-based movement of a certain mass, then it lets us know that there's some movement in the area that it's sensing.

And when we get to the challenges part, we will revisit. This because this heat-based movement can present a challenge for us. It looks for heat-based movement of a certain size. So if you have a cat or dog, this drives us crazy, because the cat kind of teleports through the house. Sometimes it shows up, and sometimes it doesn't.

So infrared motion sensors are really valuable, because they let us know what's going on in that area, is there some movement. The next one to the right is a magnetic door sensor. And you can see that there's two sides of it, because it's actually just forming a magnet. And when the two ends line up and the circuit closes, then the sensor will send our computer a text message saying that the door's closed. When they no longer line up, it sends the message that the door is open.

And you can imagine putting this on external doors if you have a family member who might be prone to wandering and you want to know when they've left the home. It also lets us know when they're performing activities that you really want to track, like accessing the medicine cabinet, because they might be taking their medicine.

Then, further to the right are object sensors. And you can put just little tags on objects that monitor when you're moving an object. So you can see if somebody is actually accessing their medicine bottle, if they're accessing a bottle of water so that they're staying hydrated, have they gotten out of bed, whatever, you could monitor in terms of motion. This is all within the home, but there's no reason that we're limited to the home.

So many of you said that you've used a smartwatch, you've used a phone, you've used an activity tracker. That's another source of information that we use. And finally, in the very lower left is just a floor plan of an apartment. And it shows all these red dots where we will put sensors throughout the home. So we kind of try to cover the whole home and see what's going on.

While we're looking at smart homes, I did put in one video here that shows an example of the kind of data that can be collected. This is my husband, and he and I designed an app to collect sensor data from a smartphone. And we have a little plug in there, because you can actually download this app and put it on your phone, either Android or iOS, and tell it what activity you're doing at any given time. And it starts to learn over time and suggest, oh, are you actually going for a run right now? Are you sleeping? So you might want to turn it off sometimes.

But as he is moving the phone around, you can see that the sensors on the right side of the screen are updating the numbers. And all these numbers can be sent to a central computer, or they can be kept on the phone. And it's our job to make sense of those numbers and see what

you're doing and see if there are changes in your lifestyle patterns that we need to watch out for if we're trying to monitor your health.

So similarly to the previous video that showed what sensor readings might look like as you move a phone around, these sensors in a smart home generate text messages that we have to analyze to determine what's going on in the home. Here, I'm showing a video of one of the students in our lab, Jess, who has entered the home and is just performing a series of activities. She's entered the home. She's putting away groceries, and then she's going to walk in the living room to do something else.

In the lower left, I'm showing all these motion sensors that light up as she moves through the home. And then there are green rectangles that show doors that light up when the door opens. But what the computer program sees are the text messages that are in the upper left. And you see it's just a bunch of numbers. It's just showing the date and the time, a sensor identifier, and an on/off, motion/no motion.

So the question is, given a file of information like this, what can we tell about a person's health? It seems a little bit cryptic, but that's the fun challenge for us in terms of designing computer programs. The first thing we try to do once we have a sequence of those text messages that are sent to our computer is to try to identify what activity a person is performing.

Once you look at enough sensor data-- and Shelly has done this-- you start to recognize what is going on. And I have people who are not trained in engineering and they help us out, provide labels for activities, and they actually start to get emotionally attached to the person that they're labeling. Because you can see what's going on in their life.

For an example, if you were looking at motion sensors and it was 3:00 in the morning and there was a sensor above the bed that was going off probably every 10 minutes-- because it only registers whenever there's movement. And then, suddenly, there's a flurry of activity, followed by motion sensors in the bathroom going off. And then back to bed, and then it goes back to every 10 minutes. You can probably gather-- it's 3:00 in the morning-- that they were sleeping, they got up to use the restroom, and then they went back to sleep.

This is an important thing to identify, because these bathroom trips in the middle of the night are one of the most hazardous times for older adults, a very likely time that they're going to fall. And so being able to identify what activity is going on is kind of the vocabulary for us doing health assessment and intervention. So from this data that you collect on your phone or in the home, we might be able to tell are you sleeping, are you doing house chores, are you working, are you socializing, all those other components that you need in order to stay healthy and functionally independent.

So we sense, we identify, and then we assess. So if we can express your behavior in terms of these activity vocabulary terms, then we have a basis for determining what your health status is. And to provide evidence for that, we ran a study in which we collected data from smart

homes for multiple years-- so in some cases, seven, eight years. And these were for older adults living in retirement communities, and the average starting age was 85.

So we knew, at that age, that they were likely to undergo health changes. And we wanted to see can we pick up on that in terms of changes in their daily behavior? So we collected data non-stop. And this is those text messages from a smart home. There's about 1,000 of those a day. So that's how many data points we're looking at.

And then Maureen's group, Dr. Schmitter-Edgecombe, would visit these individuals twice a year and do a set of standardized tests. So, example of a standardized test. There's the TUG test, the Timed Up and Go test. And that checks for your mobility. So you start sitting in a chair. You get up, walk forward 10 meters--

SHELLEY FRITZ: 10 feet.

DIANE COOK: 10 feet. Turn around and come back and sit down and see how quickly you can do that. So that shows some indication of mobility. And then RBANS is a set of questions that you answer to determine what your cognitive health is. And we were interested in seeing can we actually predict what these standardized scores would be for mobility and for cognition?

And surprisingly, we could. And it wasn't just a question of how well do they sleep, how many times did they go out of the home, how much time did they spend socializing, but it was everything. It was their complete lifestyle. And actually, one of the greatest indicators of change in health were just changes in day-to-day variability of their routine. Once their routine started to kind of crumble, that was an indication that maybe they were undergoing some cognitive changes.

So being able to collect all this data to get a sense of somebody's entire life pattern, identify those patterns, and then look for changes in those patterns was critical for us to discern that there were changes in health status. So that's an indication of kind of slow changes in health status over multiple months or years. The question is, if you're going to design computer programs, can you also identify more immediate changes in health status that are critical, like a fall?

I mean, certainly, if you look at this graph here, which shows movement or activity level, just based on number of motion sensor events within the home on a daily basis-- and it goes from January to March. You might wonder what's going on in this person's life, because clearly, there's a downward trend. They are getting a little more sedentary for some reason. And maybe that's a concern, and you want to look into it.

Can you also detect if there's a break from routine that is only a few minutes long? So this is an area that we are looking at right now. An example of what we can do is we can look for changes from normal and see if they line up with known changes in health. So here's one example, and I think Shelley will talk about falls later.

In this case, this was a resident of one of our smart homes. And we used a time when we knew she was healthy and had normal behavior as a baseline. And then we looked at every week after that to try to determine when there might be a significant change from baseline in her behavior. And the graph at the top shows how much each week changed from that baseline. And whenever it goes above the red line, that means a statistically significant change.

So if we look back at her health history to try to identify what's going on, it turns out that this is an older adult, 86-year-old female, who was diagnosed with lung cancer. And that small blip that you see above the red line is when she received the diagnosis, and that bigger blip is when she started treatment. And then, because we automatically identify activities, we can break it down and look at changes in each of the individual activities.

So the two bottom graphs are what we would call heat maps. And they're showing one rectangle for each hour of the day, and each row is a separate week. So you can see that there's a lot of very dark coloring late at night, early in the morning before that week when she started treatment for the sleep activity, because that's when she was doing a lot of sleep, and it was very regular. After this green vertical line, week 11 when she started treatment, there's very little sleep in the middle of the night, which one would expect.

And if we looked at dozing or sleeping out of bed in the middle of the day, which is another category, we would see a lot more of that during the day. So we can identify and understand what the nature of those changes is. Similarly, this is enter home on the bottom right. Before she started treatment, there's some occasions when it's not perfectly white, indicating that it does happen. But after she started treatment, there's a lot of people entering the home, most likely providing care and support for her.

So this is what we want to do. We want to be able to identify when there are changes, understand the nature of those changes, and then, ultimately, intervene. So here's just two interventions that we have right now going on. And then I will turn this over to Shelley.

The first one is on the left, and it's called a Digital Memory Notebook. And I will show a short video on that. This is Maureen's creation. She wanted to have a tablet interface face that older adults could use. So we designed it with input from older adults, so it used high contrasting colors and large fonts. And it allows them to keep track of appointments and medicine information.

But the other thing it does is it partners with the smart home. And an individual who has some memory difficulties can be very anxious about whether they have performed certain activities each day or not. They just can't remember. So the smart home will actually populate the notebook with what they've done that day to give them some reassurance.

Furthermore, because we are designing machine learning programs, we can anticipate when the person would normally, in their routine, perform their next activity. And it's not just time of day, because taking medicine, if you take it with dinner, it may not always be at 6:00 PM. So we

need the smart home to recognize that they're eating. And then if they're eating but they haven't taken medicine, this tablet will prompt them to take the medicine, kind of acting as that cognitive prosthesis. So I was--

[VIDEO PLAYBACK]

- So this is a digital memory notebook. So it's a task management app. And so what you do is you can schedule different tasks you have throughout the day. It can also remind you to do certain tasks. One of the cool features that it has is it also has a partnership with the smart home.

DIANE COOK: If you were falling asleep, you're not anymore.

- And it can also predict when it thinks you're going to complete activities.

[MUSIC PLAYING]

DIANE COOK: So the notebook recognizes that she's taking medicine, but prompting her to eat food with it.

[MUSIC PLAYING]

- Please go to the notebook app.

DIANE COOK: So it detected medicine. And it--

[COUGHING]

[MUSIC PLAYING]

[END PLAYBACK]

So this is one intervention. And we first tested it with individuals in the on-campus smart apartment, and now we're testing it with older adults in their homes. And it's letting us know what the impact of this technology is. Because as with all research projects, it has bugs.

And so our first pilot participant, when the app crashed on her, as they're likely to do, we needed it back so we could fix it. And she wanted to drive back with a Digital Memory Notebook, because she didn't want to be separated from it. So she wanted to drive two hours back and have us fix it, and she could bring it back with her.

So we're happy that some of this technology is meeting this need and, hopefully, playing this role of a prosthetic to help people stay independent. And the second intervention technology is much more futuristic and much more in progress. That is a robot that partners with the smart

home. Because a robot can provide some physical assistance that a tablet cannot. Eventually, it should be able to automate some actions and retrieve objects.

But in this case, once again, it is partnering with a smart home to recognize what activity a person is doing. And if they're having difficulty completing that activity, the smart home should detect that. The robot will approach the person and ask them if they need help. And if they say they do, then it'll show them a video of what they're supposed to be doing, either step by step or as a whole.

And if they're having continued difficulty, it can actually lead them to the objective that they need in order to complete that activity. And I'll show quick video of this. And it's a neat project. It will have a lot of impact eventually. But you'll see, right now, just what the status of robots is, as well, and why we don't need to be too scared of them.

So this is RAS, our Robotic Activity Support. [? Anisha ?] is taking out some medicine. But once again, she forgot a step. So here comes RAS, asking her does she needs some help. And then she can interact with the tablet to say yes, I don't know what step I'm skipping. And it'll show it to her, and it will be a video of herself having done it or a video of the entire activity.

So as I transition this to Shelley talking about the research that she is doing in nursing as part of this project, you can imagine that there's many challenges to clinical translational of this work. As engineers, we're really interested in seeing what can we develop next. We're not necessarily quite so interested in making them usable or user friendly, because we just think it's really cool to have a robot in our smart home.

But if we're looking at older adults, then we need to think about the fact that this is a very rickety robot. And if a person has mobility difficulties, are they going to grab on to this robot to try to steady themselves, and they're both going to go over? So we need to make technologies acceptable to the user and safe to the user, which is a big gap for people coming from engineering. We need to accurately detect a need. When is there a need, and when is it just a false positive? You know, maybe they're just going out for the day.

Costs and privacy. Privacy sensor data is a huge issue. When you are doing your activity tracking apps, as many of you raised your hand for, that data requires, often, that you're turning on location services. And all that data is captured by your provider-- Apple or any other provider that you have, maybe the app designer. That can be used for other purposes. So how do we provide these services while keeping your identity and your lifestyle private?

Sensor battery life-- when we run studies with watches and we turn on location services, this watch typically will run for four hours before running out of battery. So how can we extend the battery life and still provide all those services and not be asking older adults to constantly replace the watch and charge it, which if they're having cognitive difficulties, is unlikely to be done consistently?

Creating reliable and valid health tech. Even if we have achieved a high enough success level to publish papers, it's going to take a lot more large clinical trials for it to be adopted by the health community. So we are a long way from that. And then, eventually, we need to demonstrate the value added to clinicians. And that's a good point for me to turn it over to you, to see is there a value added.

SHELLEY FRITZ: Well, we're working on that, so thank you for that. I'll add to this list that we do want to augment and assist older adults in the various ways that can help them stay independent longer. But we also have to be careful that we don't over-assist and create dependence. And that's one of the things that we work on in nursing and we pay attention to when we're assisting older adults, is-- or anyone with a disability or children, for that matter.

We don't want to over-assist. We want people to do as much for themselves as they possibly can. And you can imagine, there's a lot of reasons around that. So if you don't mind moving to the next slide.

So I'll start by sharing that I joined this team and this research after 20 years in nursing practice. And as you heard, my background's in emergency nursing and public health, but I've done a wide variety of other things, like start up a home infusion company and do a lot of training of nurses over the years on using technology that becomes available.

And so, let's see, I saw my first patient in 1988. So a lot of technology changes have happened since then. And so I have many years of experience of taking a technology that's been designed by engineers, and it comes to us as this really cool thing, and then figuring out how to actually make it work with the patient. So we use technology with patients to assist with treatments, assist with diagnosing, providing comfort, and then sometimes just plain old saving their lives in a code. So there's quite a bit of technology around that.

So that's where my background comes from. And when we talk about this idea of clinical translation, it's really what I'm interested in. It's also probably a really difficult area to be doing research and studying, because that jump from technology to actually having it be added value to the question clinician is important.

A piece of this that becomes really important is this idea of trust. If nurses don't trust a technology, if it fails them, they're going to back off from use of that and rely on their own judgment and their own clinical skills and any non-technology things that they can do if they've learned to not trust the technology. So those false positives or those failures become super important in translating that into clinical practice.

That also becomes really important for the patients, too, because many patients are being taught to use their own technologies in their home. I have home health patients who are learning to do their own dialysis kidney transfusions at home. And they have the equipment that is attached to their body, and they've learned how to hook up that equipment themselves, push the right buttons. And this is considered smart technology, when you're doing in-home

dialysis. So that piece of having the patient be able to trust the technology, too, is really important.

Pardon me. I'm getting over a URI. That's an Upper Respiratory Infection. So in the environment of smart homes and technology and where nursing plays a role in this and with older adults-- go ahead and push-- one more time. There's three concepts that are really important that we find written about in the literature, but also, I can tell you, is important from my years of clinical practice. And that is, people are really interested in quality of life.

And included in that idea of quality of life is-- go ahead and hit the button-- this idea of health and improving health. So this is one of the things-- as we're looking at identifying people's normal motion patterns, their normal behaviors and activities, and then being able to identify what's abnormal that might be clinically relevant, that's where we can look at providing interventions that can improve health, by either mitigating instances where they might have an event-- like anticipating that there might be a fall or that sometime in the next couple of hours they're really at risk for fall. Because of over a variety of things that, as a nurse on a unit, I might notice that the patient has not had enough fluids today, that instead of standing up in one fell swoop, they do what we call a stand with one or a stand with two. OK?

So there's is a difference in how someone's feeling and their strength level depending on how they move with that. And we might then get extra assistance. So how can we train a computer to be able to understand those kinds of movements so that we could mitigate when we understand a fall might happen?

The other thing is that if we have improved health, we will have extended independence. And what older adults are saying is that what quality of life means to me is that I can live in my home longer independently, not be a burden to anyone, and in order to do that, I need good health. So this is where nursing comes in. Nursing kind of owns the field of the human response to illness.

So you may have heard this before, but they often say that doctors see the broken leg and the nurse sees the person with the broken leg. And that is the difference, really, in the focus on the human response to illness. That's really, really important, to have people who are expert at broken legs. My husband could tell you that after last summer, when a tree fell on his leg. So we do want people who are expert at fixing broken legs.

But we also need people who are expert in understanding how is that broken leg going to impact someone's life. And if that broken leg becomes a broken back and now they're a paraplegic, how does that impact-- how do we still have quality of life, good health, and independence?

So this figure really represents what we call the clinician in the loop. And if you look at the top, there's the smart home with the sensors that Diane has already described to you, a wide variety of them. And following the figure around, the computer labels the activities that it identifies

that are normal. And then the clinician looks at identifying data sets that are abnormal. So this is where nursing really starts to come into play in that any good algorithm has to be annotated by a human for the machine to be trained to identify something as a human would.

So we have a team of nurses who are doing weekly telehealth visits and monthly in-home home health assessment visits. And they are using that information that they gain from actually listening to the heart and lungs of the patient and watching them move and having them do different activities like grip strength, et cetera-- just like we would assess someone in the hospital or as a home health nurse. We use that information to then go into the data sets and find something that we believe represents a change in health state.

And we provide that information, that data set that's annotated with what we believe is going on, to the engineering team, who then trains the computer. From there, we can figure out how to provide interventions, once we understand a clinically relevant abnormal activity. And then we can assess whether the interventions that we provide are effective or whether the patient is being adherent. And those are really important concepts when it comes to cost in health care.

We have one of the highest GDPs in the world for health care. And so our government is very interested, especially with older adults, who are 99% of them on Medicare-- so that's our taxpayer dollars paying for those health care instances. Pardon me. And so CMS, Center for Medicare and Medicaid Services, is saying, we need to see what they're calling value-based care.

Value-based care means that we are providing care that is low cost but high good outcome. And in order to understand whether we're doing that or not, we have to measure something, right? So this provides us this really good measurement for that.

So next one. So this area that you see highlighted is really the area where nurses are involved. And this is where, even though nursing is not a STEM field-- and certainly not women in STEM. Because I think we have 10% males in our field now. Nurses working in technology and the development of technology is extremely low. I think there's less than 1% of nurses in the nation have a PhD. And I can tell you that way less than that work with technology in the design and development phase.

So kudos to Diane for having the insight to have a nurse at the table. We're excited about that. Next one. So this is an example of the similar data that you saw earlier when Jess was in the smart home and moving around. But this is data from the participant that you saw had fallen in his kitchen earlier. And so what we will do is identify when that fall happened, what were the activities around that, what was the health status around that, based on our nursing assessment. And then go ahead and hit the button. I have a lot of animations in here.

So we'll identify for the engineering team and annotate, basically, when the fall happened. That's called ground truth, providing a ground truth for training the machine. And in nursing,

we're calling that clinical ground truth, because that's exactly what we're providing. So go ahead and hit the button.

Over here, you'll see a data visual that the engineers have created for us to look at. So this is the translation piece. So I tell the engineers that my nurse practitioner team will look at a new kind of data to decide what they're going to do to treat a patient in about 60 seconds. We might review the chart for two to five minutes. If it's a complex chart, we'll probably review it for five minutes before we go in the room. If it's not a very complex chart, we're going to review that chart in less than two minutes.

There's going to be a chief complaint. That's what we're going in there to see them for. And so this kind of data has to be presented to us in a way that we can absorb it very quickly or we're not going to use it in practice. So go ahead and hit the-- here, you can see that the person who fell then had very low activity after the fall. And this is across four days. And so this is a clinically relevant abnormal event.

And so think about if this wasn't a fall. If this was your grandparent and they were moving around their home normally and all of a sudden they weren't hardly moving around their home at all-- which would indicate they're spending most of their time on their bed or on the sofa-- would you be wanting to call your grandparent? Would you be interested in that kind of thing? I think the answer that probably is yes.

Somebody who normally is up and about and then all of a sudden is down for four days-- think about yourself. If you don't move for four days, how do you feel? What is your human response to your illness if you're not moving for four days? Very clinically relevant. So this is an example of a visual that we're working on for providing to nurse practitioners and doctors for around this.

So another thing that nurses need to do in working in this high-tech field is we need to disseminate the information and the knowledge that we're gaining to our own discipline. Because remember what I said-- there's a lot of nurses who don't work in tech, specifically in the design of tech or knowing what's in the pipe. I know that in the 20 years that I was working at the bedside, when a new technology arrived, it arrived. And we were told, you got to use it. You got to learn it. And so that's what we did.

But to have nurses know what's in the pipes so that they can have a voice in the design and development of that will mean that there's a lot less swearing at the bedside. So the other thing that we need to do is we need to express our ideas and what we think is important regarding technology outside of our discipline, as well. So this is an example of an article with the three of us who were here on the panel today with engineering and computer science, neuropsychology and nursing, disseminating that cross-disciplinary idea generation in a computer journal, as a featured article in a computer journal.

So how is this relevant to clinical practice? We talked about some challenges to clinical practice when we transitioned between Diane and I, but this specifically is looking at nursing practice. Currently, a nurse gets her information about the patient from the electronic health record. You might have heard it referred to also as electronic medical record.

In that record, we have a ton of data. We have pictures of the patient. We might have an MRI. We might have a CAT scan. We might have an X-ray of that broken leg. We will also have vital signs. We'll have labs. And we'll have trends that are shown to us on what your blood sugar is or what your blood pressure is. We'll also know your history, all the surgeries you've had, every time you've seen the doctor, all of those kinds of things.

Those are all data points that we currently use to help us know how to treat you when you've come to us with complaint or come to us injured or sick. But I really believe that in the future, we will add a new kind of data to this electronic health record, and that will involve the data that comes from the environmental sensors from a smart home and/or the wearables that we all wear.

I can tell you that the last time-- so I've been in either hospital administration or academia since 2006. But in 2006, when it was my last shift in the ER, we had some people with smart watch stuff starting right about that time. And we had a gentleman come in. I think it was one of the really early Kardia AliveCor ones.

And he was in atrial fibrillation, which if you catch that within a certain period of time, you can shock a person back into a normal heart rhythm. But if it's been too long, you can't do that, because then you run the risk of, when you shock the heart, creating a stroke because of a clot that may have developed inside of one of the chambers of the heart. And so we were able to tell when this person went into afib and know that they were within the safe window to cardiovert them.

And that is an example of how these things can really impact not only care in the emergency department, but certainly care when you come see your doctor or your nurse practitioner or your PA at your typical care points, whether that's every six months or every year, every two years, depending on what your health conditions are. So this kind of data can really help us intervene in all the life and all the illness that happens in between those care points so that we can provide care between the care.

Pardon me. So I show this to you because it's an example of why I believe that this remote monitoring that we're talking about doing with the smart homes can be very clinically relevant. This is a virtual hospital that actually exists in Sioux Falls, South Dakota. It's in an industrial park in an industrial building. And this hospital has employees that are board certified ER physicians, ICU nurses, pharmacists. And they are monitoring patients that are in either hospitals in the urban centers or in rural America and seeing people's live heart rates, their cardiac rhythms, their blood pressures, their lab values, et cetera.

And those people from Sioux Falls might be monitoring somebody at UMass General. They might be monitoring somebody at University of Washington Medical Center. They might be monitoring somebody in Kenya. So interestingly enough, the World Health Organization representatives were at this hospital on this bridge-- they call it a bridge-- the day before I was there, because they're really interested in looking at this as a model for how to provide modern care in third-world countries.

So the idea that we can remote monitor people is very real, and there's a lot of people very interested in it. This is monitoring from hospital to hospital. In this case, some of the people that are boots on the ground are ICU nurses at UMass. Some of the people are boots on the ground paramedics-- not nurses, not doctors, trained paramedics. Because that's the only thing that exists in their community in rural America. And these people with the education and the board certification are backing them up and helping them know what to do.

So we know that remote monitoring works, and we know that our government, as well as other governments across the planet, are interested in this model of care. That's an example of hospital. But you can see, based on all the things that we've talked about, that certainly, environmental and wearable sensor monitoring-- and we didn't even talk about biosensors, because I have a whole other lecture on that. Implantables. How that can really impact how we provide convenient, timely, and effective care.

So I think we transition here, right? We were told we talk a little bit about women in STEM.

DIANE COOK: Yeah, so, women in STEM. This is WiSTEM week, right? And I'm asked often what it's like to be a woman engineer. I have to say, I know many stories of others who have gone through a lot of difficult times being in the minority in engineering, but that's not my story. I've been supported by everybody around me, and I have thoroughly enjoyed being a woman and an engineer.

I think though one point I can make is that I did not start out being an engineer. It's not that I was against it. It just wasn't on my radar. I was going to be a lawyer. And my dad was a professor in a small liberal arts school, and he took me to meet with the law profs. And they said, if you want to go to law school, don't major in psychology or political science. Major in a science and/or math. So I became a math major.

And as a math major, we were required to take a computer science class. And I took it over the summer, and it was so much fun. It was a way to be creative and get the computer to do your bidding. And I never realized how enjoyable it could be to be an engineer, and you could still be creative. And so I immediately switched into computer science. And problem was that by the time I graduated, I only had four computer science classes, so I went on to grad school simply because I didn't know enough to get a job.

And in grad school, then, I got exposed to research, and I have kept going, because this job is like getting paid to do my hobby. So I would say that, for me, being a woman and an engineer

has not been a trial. It's really been just an exposure to an area I hadn't originally considered, but from which I would never go back, because it's a lot of fun. What has it been like for you working with engineers?

SHELLEY FRITZ: Yeah, it's a really unique place to be for nurses, because-- actually, I was trying to think of other nurses who were working in this field who were published in the field, and I know three besides myself. That's what I've encountered since 2012, when I started working with you. I think it was 2012 when I entered the PhD program here at WSU. Graduated in 2015 and immediately was hired on that fall by the university.

It's been a really unique place to be. I think it's been more of a gentle transition for me, because I'm working with an all-woman team, which is super cool. Diane's really proud of that.

DIANE COOK: And super unusual.

SHELLEY FRITZ: Yeah, it's pretty unusual in the field. Like to have that computer journal article, feature article, by all women was a proud moment, I guess we could say.

DIANE COOK: Yeah.

SHELLEY FRITZ: Yeah. Yeah. So for me, the exposure in nursing to technology and being one of the people who are constantly the trainer on the smart equipment, I guess I had probably more exposure with IT and engineering along the way. And I definitely learned-- well, two things I've learned.

Well, one, communicating with engineers is unique. And the second thing I learned is, basically, I've got to learn how to communicate with engineers. They think differently. They communicate-- I don't think they would want to communicate. If they never had to talk to anyone, if they could just text/email people, that's what they would do.

So I think those years of working in the hospital with the IT-- and as the electronic health record emerged, this field of informatics emerged, which was a new field in health care. And some nurses moved into that. And some people who work in informatics and health-- which is considered a pretty high-tech area within health care-- are not nurses at all. They're trained now in informatics and data science.

So I think the other way that I learned how to communicate with engineers was I've been married to one for 33 years. Successfully, which is a feat in and of itself.

DIANE COOK: It is. It is. Well, when we designed this talk with Maureen, we had, like, 15 minutes for Q&A, and I think we talked so much that we have none. But I have been told to include this QR code and ask you to complete the survey for WiSTEM week. And do we have time for questions, or do we need to be done?

KAREN WEATHERMON: Are there any questions to ask?

SHELLEY FRITZ: Any questions about the smart tech or about the careers?

DIANE COOK: All right, well, we will be around afterward--

SHELLEY FRITZ: We will be.

DIANE COOK: --if you do.

KAREN WEATHERMON: And again, if you need Common Reading credit, make sure you come see me. We'll [INAUDIBLE]. There will be that other short survey that we email to you. So you have two surveys happening. This is WiSTEM, and then if you want Common Reading credit, there'll be a second short survey emailed to you.

DIANE COOK: Thanks for coming.

SHELLEY FRITZ: Thank you.

KAREN WEATHERMON: Thank you so much.

[MUSIC PLAYING]