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Mike: From the Center for Occupational Research and Development, welcome to *Preparing Technicians for the Future of Work*. I'm your host, Mike Lesiecki. In each podcast we'll reach out to the people who are actually on the frontline of the future at work, and hear what they have to say. That means interviews with industry leaders, working technicians, and forward thinkers in the field. In every episode we will suggest action that you can take. We want to inspire you to take that action.

This podcast is brought to you by the Center for Occupational Research and Development, known as CORD, with financial support by a grant from the National Science Foundation's Advanced Technological Education program. Opinions expressed in the podcast do not necessarily represent those of the National Science Foundation. You can find out more about our project and our approach at "preparing technicians" (all one word) dot ORG.

Our topic today is *Smarter and More Independent Robots*. Let's get right to the interview. Today we are speaking to Lou Frenzel, the Technology Editor for *Electronic Design* magazine, where he writes articles, columns, blogs, technology reports, and online material on the wireless communications and networking sectors. Lou keeps pace with the current state of all kinds of technologies. Hello, Lou. How long have you been with the magazine? I guess you were there full-time, and now you're working part-time with them? What's the deal, Lou?

Lou: Yes, hi, Mike. And thank you for inviting me to be here. I started with *Electronic Design* in the year 2000. I had been teaching at Austin Community College for quite a while and decided to go be a full-time writer. So, since the year 2000, I worked full-time, and retired—supposedly retired—in 2016. But I still work for the magazine, still do quite a bit of work for them. And it's fun keeping up with technology! It's just too much to know!

Mike: Boy, it sure is. You know, I know you were a professor and department chair at Austin Community College that you mentioned. Do you still teach there?

Lou: I haven't lately, but I work with some of the professors over there. I got one of the professors helping me with a new book, and so, I go over there all the time, and talk with them, and get an update.

Mike: Good, I'm glad to hear it. You mentioned books. Here's a question for you: how many books have you authored, Lou?

Lou: About 27.

Mike: Ha! *About* 27.

Lou: I think that's about right.

Mike: Excellent. Yeah, I was on your Amazon page there, and saw a bunch of your books there. So, well anyhow, let's talk today about our topic: robotics, right? So, the idea is that robots are smarter and more independent. But Lou, robots aren't new. Now you mentioned the big emphasis in robotics is "smarter." What do you mean by smarter?

Lou: Smarter means that the robot has more intelligence and can do work more on its own. In the past robots were primarily programmed by engineers or technicians, and the programming defined very specifically what the robot could do. Since then, it's improved considerably, because now we have much better software. We have things like machine learning and artificial intelligence. And this helps robots become more intelligent, so that they can work on their own.

Mike: You know, you mentioned, Lou, in addition to smarter, "more independent." What does that mean? In what sense are they more independent?

Lou: Some of the new robots can literally work on their own, if they're set up correctly. The newest ones make use of artificial intelligence software, like *machine learning*. But this machine learning requires that the robot have senses. So, the big emphasis today is providing robots with a large mix of sensors that will guide them to do work on their own. So, it's a combination of getting the sensor input and having that interpreted by the software so the robot can do its job.

Mike: What sort of sensors, Lou? I mean, obviously there might be vision sensors. But what other sensors do these robots use to be aware of their environment?

Lou: There are several important ones. One of the ones you mentioned was video cameras. And that is still widely used in industry. The whole video thing has been around in the form of what's called *machine vision*, where video was used in combination with some type of artificial intelligence software to recognize a product that's being worked on, or a particular phase of production. Those are still used. The cameras are better than ever. They're high-res, and color, and they can pick up a lot of information that the robot needs.

Other sensors are ultrasonic sensors, which are used primarily for proximity detection. These use a high frequency in the forty- to seventy-kilohertz range and operate a lot like radar. They radiate the signal outward, pick up the reflection, and make a decision on how far away the object they were pointed to is, and its direction. More recently the sensors that are being incorporated are literally radar sensors. These are single chip radar units that were developed primarily for automotive applications. And they're widely used in automotive ADA Systems for automatic braking, and that sort of thing. And these radars are also used in robotic proximity detection, and just in getting a better view of their surroundings.

What they do is put all this sensor information together and provide that to the machine learning. And the machine learning then makes decisions on what the robot can do next.

Mike: Lou, if you had to describe "machine learning" to a novice, how do you describe machine learning to someone who's not really familiar with the term?

Lou: Boy, that's a tough one, Mike, but I'll have a shot at it here.

Mike: Okay.

Lou: Machine learning comes in many different forms, but most of it is based on software that use neural networks, and probability calculations.

Mike: Yes.

Lou: The idea is to feed as much information to the computer, and to provide it some training. Give it input that it can work with to know what decisions to make. Once the computer gets enough information, it can then make some decisions on

its own, that is largely based on what the sensor information is.

A great example of this these days is the development of the self-driving car. I guess you'd call the self-driving car a "robot," basically. Its whole ability to drive itself safely is dependent upon all of the different sensors that are available—the ones I mentioned, plus some others. And those sensors provide the basic knowledge that the robot gets. And the machine learning interprets it, and then provides action, if required.

Mike: You know, that's an interesting analogy. I hadn't thought of that. Today's industrial robot is somewhat, in many ways, like a self-driving car, isn't it?

Lou: It really is. And I think they're trying to make them more like that. But part of the problem with it has been trying to protect people near the robot. There are a lot of robotic accidents, where people forget that there's a big 400-pound robot swinging its arm around. And I think they've corrected that somewhat, by putting the robot part of production inside walled off areas...

Mike: Sure.

Lou: ...so that humans cannot get in there, or if they get in there, it shuts down the operation automatically.

Mike: You know, this move towards robots that are more smarter, more independent—what's driving it? I mean, ultimately, are we going to replace all of our workforce? Or what's the big drivers for these independent, smarter devices?

Lou: I think the big driver is still to improve productivity in automation and manufacturing. The smarter the robot is, the better that it can replace a human. And in many cases, it's better producing the detailed work than a human could do. It does a better job basically.

Mike: Sure.

Lou: So, these are the main drivers of it. And unfortunately, they are on the path to replacing some workers, yes.

Mike: Some types of workers, maybe?

Lou: Some types of workers, definitely. Yet not everybody.

Mike: You know, Lou, our project focuses on preparing technicians for the future of work. So, what are the implications in the short term for what technicians need to know and be able to do? For example, you mentioned sensors. Maybe there's an area where our education programs need to be more robust. Think to your own experience: how should we change to make technicians better prepared to work in this context?

Lou: Great question, Mike. And I think you're right about the sensors. This is an extremely important part of the whole movement toward more autonomous robots. I don't know how many schools actually teach a sensors course, but there's enough material there to add one. And in a manufacturing program, it might not be a bad idea.

At Austin Community College we had one course that, a large part of the curriculum was involved with sensors, and the sensor signal conditioning, and how that is attached to data acquisition systems, and to computers. So, yes, I would say most definitely: add some instruction in all types of sensors.

The second thing is one that everybody probably already knows, and that is: technicians need to know more software and programming. Everything has moved in that direction. You just need to know computers, and software, and how they work, and in many cases, how to do some special programming on the machines that are being made.

Mike: Yes. Well, you know, Lou, today we wanted to just get your sense, and sort of a broad sweep of what you see as directions in robotics and automation technology. And I think you really helped us emphasize that, in fact, robots are becoming smarter and more independent. And, hopefully, technicians can upskill themselves, including those who are currently employed, right? What if you're an employee technician? You've got to come up to the technological challenges as well, right? In your workplace.

Lou: Yes, most definitely. I think the continuing education of a technician is extremely important, as there's something new coming along all the time. I don't know what the answer to that is in robotics, but something needs to be done. The old way of robot programming, I think, is still implemented in some places as it works in some applications.

Mike: Yes.

Lou: But pretty soon robots are going to be more intelligent, and we're going to turn 'em loose, and let 'em do the work, and make the decisions on their own. And that should improve the productivity. But those robots are going to be more sophisticated and going to require more care from more-advanced technicians, is what I would say.

Mike: Sure! Those technicians got to keep those robots working, right? That's the main thing, I think.

Lou: It's a very complicated machine that requires lots of attention, yes.

Mike: All right. So, we'll turn 'em loose, get out of their way, except when they need our help.

Lou: Yes. [laughing]

Mike: That's good! That's a good way of wrapping this up, Lou. Well, Lou, thanks for your insights on this, your experience that came from over the years of looking at implications of new technologies, and new techniques that come into the workplace. We really appreciate your insights on this, Lou.

Lou: Glad to do it, Mike. And thanks again for asking me for this program.

Mike: All right Lou. That ends our discussion for today. I'll talk to you the next time.

Lou: Okay. Thank you, Mike.

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Mike: Today we discovered the trend towards smarter and more independent robots is driven by their sensory abilities. And robot learning happens via machine learning. One of the references in the *Show Notes* says "Machine learning was born from pattern recognition, and the theory that computers can learn without being programmed to perform specific tasks." Today researchers have discovered that computers can learn from data. And then I realized my "Netflix recommendations" are an everyday application of machine learning! There's your action for today: get yourself more up to speed, at least conceptually, on what "machine learning" is. We have two decent references for you to look at in the *Show Notes*.

As always, find our podcasts on PreparingTechnicians.org, or subscribe on *Apple Podcasts* or *Google Play.* A rating and review are always appreciated.

Our series is produced by John Chamberlain at CORD. Thank you, John. And we want to acknowledge the project leadership by our Principal Investigator, Ann-Claire Anderson at CORD. Thank you, Ann-Claire.

And thank you, our listeners, for *Preparing Technicians for the Future of Work*.

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