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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 people who are actually on the front line of the future of work and hear what they have to say. That means interviews with industry, interviews with working technicians, and forward thinkers in the field. We'll do some background research and we'll curate that research to make sure you have the most up-to-date and relevant information. And in every episode we'll suggest action that you can take. We want to inspire you to take that action.

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Joining us today on the podcast are two colleagues from the Association for Manufacturing Technology. Let me start by introducing you to Ben Moses. Ben's the Director of Manufacturing Technology at the Association. Hello, Ben. I believe your background's in engineering, isn't it Ben?

Ben: Yeah, that's right Mike. I'm happy to be on the podcast. And yeah, I've done 16 years in Aerospace. Doing bleeder systems for airplane engines. I did design and manufacturing. And then when I left Eaton Corporation, I was the Engineering Manufacturing Manager of Assembly. So, we did welding and forming and for sheet metal fabrications.

Mike: Great. Great background there. Thanks for joining today, Ben. And also: Stephen LaMarca. Stephen, you're the Manufacturing Technology Analyst at the Association. What do you do? And tell us a little bit about your background.

Stephen: Oh man. So, this is actually my first job out of college. And I went to college and got my degree in Physics. And then I came here, to start as a temp. But fortunately I got taken on full time. And now I wear a good amount of hats, actually. I am a writer for AMT News. I get to sit on some meetings on Capitol Hill with the Department of Commerce, the Bureau of Industry Securities, the METAC, which is the Materials and Equipment Technical Advisory Committee that gets to update the government on the latest manufacturing technologies and materials, and suggest how they should be controlled in terms of exports. So, we do a lot in Export Controls.

I think I have one of the best jobs at AMT, in my humble opinion, which is I'm in charge of our Manufacturing Test Bed. We have a huge metal table over in one corner of our floor that has a desktop 5-axis CNC mill. And also has our latest addition, which is a 7-joint collaborative robot. And all of that stuff on the Test Bed is actually hooked up and using one of AMT's primary products, MTConnect, which is a industrial communication standard for manufacturing technology.

Ben: Hey guys, I want to mention one quick thing about the Test Bed. I am really excited for it because it's... it is literally a—what?—Five foot long table that we're representing...

Stephen: 6 by 3!

Ben: Thank you, Stephen. We want to represent the entire manufacturing facility in this test bed. And we're basically an office in Virginia. And we want to understand the needs and challenges of the industry. And our test bed app is designed to represent that.

Stephen: It's a huge proof of concept. We have a lot of multiple proofs of concept on that one single test bed. One of the first things is we have an entire manufacturing technology test bed and it's at a relatively low cost. It's around $20,000-$25,000 for the whole thing. And we've got pretty high-tech stuff on there.

Secondly, not only is it a proof of concept in that, this really doesn't cost that much (Everybody should have a technology test bed to test the latest and greatest technologies), but also it's a test bed for testing MTConnect. We're going to help our customers use this industry standard. And getting it running to help them save

money in the long run. We should know how to use it ourselves. So, that was one of the first reasons we actually invested in the test bed. So, we could actually get some hands on experience with the standard.

And lastly, the test bed is, as of today, full on Industry 4.0. I can actually hook up my computer to the testbed's network wirelessly. And through my computer alone, I can control both the robot and the CNC machine off of one laptop with their 8 respective HMI's and control them simultaneously—with no wires attached.

Mike: You know, Stephen, it's so exciting, 'cause you're talking our language. I mean that's one of the reasons why I wanted to chat with you and Ben today because you're right up on the top there. What are the trends that are driving manufacturing today? And that's really the focus of today's cast: is to think about what those trends are. And if you don't mind, I'm going to go right to the first question, and throw this one to you. So, remember, our focus is technicians. So, think about that. Instead of programming machines today, do you see technicians instead helping machines learn?

Stephen: Absolutely. 100%. Not only is this machine learning becoming more commonplace... For example, if you have a Google phone, like Ben and I both have Google Pixels. And every time you take a picture with that camera on a Google Pixel, let's say you take three pictures, and of those, three essentially to you, they're the same picture. You delete two of them to save the best one. Your phone, the Google Pixel, will actually keep the two pictures that you deleted in its temporary folder and study them to determine what it was that you liked about the third picture that made it better than the first two. So, in a way that's the most consumer-based version of machine learning.

The first one, I would like to touch on for technicians—and my personal favorite transformative technology—is robotics and automation. In this industry, since equipment is so expensive, really expensive... An industrial robot arm or even a collaborative robot arm two years ago used to be on average about a $100,000 apiece. And now they're getting as low as around $20,000. And we still need them to get lower. But with them getting lower in price, at the $100,000 price point, when a factory manager invests in a collaborative robot or an industrial robot for a particular technician's cell, they expect that technician to take that very

expensive piece of robot and hit the ground running with it. It needs to be doing tool changes. It needs to be doing work piece changes.

When that robot costs less, and they can buy more of them, and just issue out robots to their technicians... Be like, "Here's a robot. Just play with it. Get it to do anything." Something like picking up a pencil. Or, you're wrenching on the table vice, and you hand the wrench to the robot, and the robot puts it back for you. Just something as simple as that. Or opening and closing the enclosure to a CNC machine—is enough to get started. And that's where the learning should begin for both the technician and the robot itself.

The other beauty of automation, where its current state now, is really evolutionary because it's getting really easy to teach robots to do something simple and move on from there.

Ben: Yeah. The business in general and manufacturing has a need to continually grow and produce more. Right? Producing more and make it more profitable. In the end, we're a business. The manufacturers are in the end to producing of goods and service for revenue.

But to your question, Mike, I think the goal of these tools—machine learning and either software or physical automation, that Stephen mentioned with the robotics—is to help the company be more efficient. So, when you talk about technicians helping machines learn, yes, if the business is ready to do that. To support an application, as you mentioned, we've got to collect a fair amount of things before we look at executing. So, Steve's example of teaching Google about what pictures I like and what I don't like, they're learning as you're doing. And that's one of the fundamental things that we have to look for. In the short term, that the business can really harvest, is collecting the data as the manufacturing process is going through, and connecting that data to problems that are being seen. So that you can create that correlation later. And then allow the tools to make decisions for you. So that's pretty foundational now.

Mike: You know, I think there are some important messages there. We have a number of technical educators that listen to this podcast. And they're thinking about how can they make this happen in their classrooms. So, that's good advice.

Ben, let me stay with you, and talk about another trend or two big trends really. You hear a lot about 5G, and AI, and the resulting explosion of data that's coming now, and it's going to come. What's your sense of that, Ben? What does it mean for a technician—this big 5G and AI push?

Ben: Yeah, that's a good question. So 5G and AI are kind of in two different spots in the world right now. For 5G, it's still on the "hype curve." There's not a lot of information about what we can do with that right now. But the big takeaway is they want an industry looking to pass more information through connected systems. That's the current model that a lot of companies are looking for in 5G. But that can be done right now. So, the problem statement that's being proposed can be done now—except through wires.

And I think the main takeaway from the big push for 5G is being able to connect to machines quicker for low latency controls and being able to collect large volumes of data. And that data will feed into kind of artificial intelligence where that's needed, where there's a business need.

AI still has a lot of buzz behind it, a lot of hype behind it, also. Partly because a lot of the applications that we see are more in the consumer space because there's a large volume of information that can be used for training models. And there's two main things we should take away about artificial intelligence, or machine learning, that's needed. One is: large amounts of data to help train the model, and an actual application on the business case.

We're seeing a lot of people asking questions like, "I want artificial intelligence." What is your business case? What is your thing that you want to solve? Therefore, artificial intelligence is a tool that can help you do it. Or just use basic statistical tools. They'll solve most of your problems.

But there are still a lot of applications. So, if you're doing something on object recognition, text translation—there are different tools within AI.

So, just taking another step back, "What is AI?" We have a kinda working definition: a device that perceives its environment and takes action, that maximizes the chance of success at some goal. So, it's an agent working for you. Right? So you've trained this agent to do something for you and that requires your basic math, software, and domain

knowledge to solve the very, very specific goal. So, when we hear the thoughts of, "Everyone should be doing AI!" Hmmm...hold on a second. Let's pump the brakes a little bit. What is the true need? And then, is AI an actual tool to help you solve that need?

Mike: Stephen, do you agree with Ben there? Or is this just a buzz term?

Stephen: Just a buzz term. I think there's a huge lack of clarity behind AI. I like to think of AI as a "technological infinity." It's something that we're constantly striving for, but we're never going to get there because AI is constantly evolving. As we achieve machine learning, as we achieve cognitive automation, AI will then become something else. Something greater. When I got into video games back in the 90s, when you played against a computer player, people call that an "AI." These days, if you called a computer player on a computer game, an AI, you're going to get laughed at. And probably scolded as well, because "That's an NPC" (non-player character). What we call an NPC now is by no means, by today's definition, AI (artificial intelligence). So artificial intelligence is the "real longterm infinity."

To get to AI, you need a lot of data. And to transfer mass amounts of data, you need 5G. And I would even go a bit bolder and harsher than Ben, and say "5G" is still a huge hype word. Our current state right now, 4G LTE ("LTE" stands for "longterm evolution"). 4G LTE is what we need, and what we have, and it's going to be relevant for a very long time. It's still got some life left in it. And the reason why I say that is because, yeah, to have AI work effectively, whichever sub-genre of AI you want, you're going to need a lot of data. A huge bandwidth of a lot of data. But that's another huge problem.

We see a lot of people come to us all the time with wanting to implement something like MTConnect. And they say something like, "Oh, I want MTConnect on our machines and our entire factory." And we ask them, "Well, okay, what are you trying to solve? What data do you need?" And they say, "We want all of the data. Give us every single data value you can get." And it's like, "Okay. What are you trying to do with all of this data? What is the problem you're trying to solve?" And then they say, "Well, I don't know." That's a huge problem.

Even if they have a better idea of what they want. Let's say they do take just a handful of data points for one particular machine. At the end of a six-month trial period, they might find out that, "Oh, we're just using this digital thread to determine whether or not our spindle is running right or not." It's something usually as simple as that. So, they don't need all of that. But at least the infrastructure's there.

So, to go back to where I was going at AI is the longterm. The "Hail Mary." 5G is going to be needed after you realize you need all of this data. Well, let's figure out exactly what data we need right now. As long as we have the foundation for future data streams we may need to collect, if you start with only collecting the exact data you need, then you don't need to waste energy and effort on data scrubbing. So, yes, to some degree, I do agree with Ben.

Ben: We're talking about manufacturers. There are a lot of other products that manufacturers have available that do apply machine learning. So, I just want to be clear that it is existing in manufacturing. And one of the things that gets hyped up a lot is the consumer side of it versus the manufacturing side of it. 5G and AI have strong consumer products.

Well, in manufacturing—if you're doing robotics, if you're doing optical recognition for device inspection—that exists. That is a very thorough product. You can buy some stuff off the shelf where you can have your robot look at an assembly and verify that things are there. You can have artificial intelligence or machine learning applied to problem solving and the manufacturing floor supply chain. There are lots of products, a lot of companies applying those things. But in terms of a manufacturer sitting there, trying to produce 10 parts in a week, these are things that he's going to look for other companies to provide, not necessarily provide in house.

Stephen: When you talk about 5G, you're talking about wireless networking, that's all wireless. A lot of companies, whether it's our industry or something else, they're not even utilizing full 10 GHz wired. So, they don't even have infrastructure. I mean, it's expensive: the infrastructure for 10 GHz. But you can probably accomplish most of what you need or what you think you need with 5G, if you use actual RJ45 CAT6e ethernet cables and upgrade your network to at least 2.5 GHz wired network. If you need more from

there, like if you're doing a lot of 4K video editing, then you may find out—you may touch your network router and find out it's a "little warm"—and then you'd be, like, okay. So, we do need more infrastructure." But like, why jump to (5G)? 5G on the "hype train," in my opinion, because it's wireless right now. A factory for example, is not "on the move." Machine tools aren't moving every week to a different corner of the factory. There's no need to have that wireless. The technology is already there. Right now, today, you could go to Micro Center and get all the equipment you need to wire up a 10 GHz network. So, I think 5G is a bit over-hyped right now.

Mike: All right, let's stay on that technology side. You're just talking about connections, interconnections, things like that. You deal with so many industries in your work at your Association there. Give us a sense of the cybersecurity issues that they're facing. You know, we hear these terms like "edge computing," and all the issues associated with data security. Give us a sense of the trends that you've seen there. Remember again, our focus is on technicians, what they need to know and be able to do.

Stephen: I'll start, because Ben probably can speak more on this than I can. So, I'll start. And I'll say that from the factories that I've had the privilege and the pleasure of touring, there's a huge issue with cyber physical security. And probably the largest bottleneck is a bit of paranoia. And I say that because you look at a lot of these machine tools that you can find in some shops and factories. And their CNC control, for example. Their background operating system is something as old and deprecated as Windows NT or Windows 2000. I haven't seen Windows 98 or 95, but I've definitely seen Windows 2000 and NT. And then on top of that, you take a closer look at some of these controls and you'll see USB ports and ethernet ports that have been, like hot-glued shut.

Mike: Yes!

Stephen: Nobody can put in a flash drive. So, there's no risk of somebody physically by accident uploading some sort of malware on their quarter million dollar or multimillion dollar machine tool. So, there's a bit of paranoia in that.

Now is the risk there of something happening? Should somebody put in a bad flash drive that has the wrong bug on

it? Absolutely! It's absolutely there. But that's a huge problem.

Ben: Yeah, back to previous question: What is...? Getting past the hype of cybersecurity. There's still a little bit of hype around it because there's a lot of paranoia. It's just fear, right?

So, Verizon releases their Breach Report every year. And it's basically this compilation of companies that have been penetrated through their security systems. And it's through different sectors. And manufacturing is one of the sectors that does get breached quite often. And the breaches vary quite a bit. So, some of it is ex-employees that have left, and they're trying to just break into the system to corrupt files and things like that. Actually, one of the higher volume cases are executives within companies that are getting ransomware, lockdown, or laptops, or phishing. Those are still a very, very high population of the breaches. But the key takeaway is they are business interruptions and national security risks. So, the Verizon Breach Report covers a big portion of the business interruption. And I recommend anyone just looking through the Executive Summary on that. And the business interruption cascades to your customer. So, if you're providing a part to defense, aerospace, automotive... Something that shuts down your business, interrupts their workflow, therefore interrupts the rest of the economy. And it cascades pretty quickly.

NIST has a pretty good framework. And there are five sections that everyone should just be aware of. So you start at identifying, protecting, detecting, respond, and recover. So, if you just look up the NIST framework, start there. That's a really, really good starting point of covering those five. And somewhere in the organization, you're going to cover those five. The question is, "How deep do you want to cover those five?"

Stephen: That's a really good framework. And they managed to develop that back in 2013, right?

Ben: It's a very good evolution.

Stephen: And it's still relevant.

Ben: Yep. The reason that it's seen continued evolution is the Department of Defense is looking to use that for cascading

into their supply chain. So, compliance to some type of cybersecurity framework, this will probably support that.

But to your question of, "What does the technician do facing the machine?" Very, very simple stuff. I'm just going to lay out the basics here. Don't plug in a USB device in your half million dollar machine! Don't plug in your phone to charge it in your half million dollar machine! Those are one of the top three carriers of getting viruses and corrupting your machine. So again, that cascades into "business interruptions."

The other side of it is national security risks. There are a few national threats where other countries are trying to get into the Department of Defense supply chain to corrupt parts and disrupt the supply chain going into, say, like an F35 fighter, and things like that. So, the other side of that is to be aware of the criticality of your parts. And be aware of the processes that's your machine is involved. Having the human provide the extra layer of security, of being aware of what the machine is doing, adds a little more confidence. We could have tons of antivirus software, and tons of firewalls, but it doesn't hurt to have a human just verifying, "Yes. This code makes sense." Right? This is what the machine should be doing.

Mike: All right. Good! Those are excellent comments there. Especially your focus on cyber physical systems. You're right, that's often a big issue on the manufacturing floor there. So, thank you.

Stephen, let me turn to you. I want you to get out your crystal ball.

Stephen: All right.

Mike: Look at the near-term evolution of manufacturing. Let's say, 24 months. What do you think that means for the training and education programs that we have around the country that are preparing the technicians to come into that place in the next 24 months? What do you see? What should we be preparing for?

Stephen: Two answers. And they may be different, but one of them, I don't know yet. The first one, I'm going to say, is: "I will have a better answer for you after IMTS 2020." That's an easy way out. Right now my opinion is automation. Robotics and automation. They're getting very cheap.

So, let me go all the way back to actually IMTS 2016, which was my first IMTS. That was my first show. And when I got there, they had the Emerging Technology Center. And in 2016 the Emerging Technology Center (the ETC) was chock full of "additive manufacturing." Every type of additive, every company, large and small, from startup all the way to big companies like Dell and HP. And, come IMTS 2018, additive was no longer in the ETC because it had evolved. It became mainstream. This is back in 2018. Additive was actually on the main floor at IMTS 2018. You as a customer could go into IMTS, walk up to an additive company's booth and be, like, "I want this machine." Get out your checkbook... But at IMTS 2018, the other thing I noticed, other than automation actually being on the main floor, was: you couldn't turn a corner, you couldn't take a picture anywhere in IMTS 2018, without seeing a collaborative robot somewhere on the floor in anybody's booth. There were collaborative robots literally everywhere. Walking into the Student Summit in the C-Hall of the North Building, walking down the escalators, you were greeted right there by a robot arm on the ground, bolted to the floor, not even plugged in, holding a bunch of bags for you! So, you could grab a bag, and just start throwing swag into your bag before you go home. And I saw that. And I thought to myself (again, this is back in 2018), this is a $40,000 coat hanger right here!

Mike: [laugh]

Stephen: And now they're a lot less! But before even getting into "how they're so much cheaper now," there were robots everywhere! So, I thought to myself, this is obviously, like, anybody who's taken, like Economics 101, knows that "This is a surplus. There are robots everywhere. But these things are crazy expensive. The price has to come down. Because they gotta unload them somehow."

So, I think the short term evolution with technology is: all Machinist Technicians will have a robot. And if they don't have a robot, they should have a robot. And that's not on them. It's on their managers. Whoever their boss is, they need to get them a robot right now.

And again, it's doing an operation as simple as picking up a pencil. Or throwing out a soda can, which was one of the first operations that we did here at AMT. Or opening and closing the enclosure to the machine tool. It doesn't need

to be something crazy, but that should be the first step: Get those people robots.

Ben: I got a little different view on that.

Stephen: Oh yeah? [laugh]

Mike: All right. Okay, go ahead Ben.

Ben: I mean, I agree. So, automation is the overall concept that I'm taking from you, Stephen. And I agree with that. So, I agree: I think the future workforce will have more value, and understanding the business needs, and how to solve those problems.

So, to your point, Steve, automation is just a means to an end. The question is "What do you define that end?" Right? So, when you look at physical automation, which you clearly describe, there's also benefits to be earned from software automation. So, if you're a programmer and a operator of that machine, maybe you should automate some of the G code generation or maybe some of the tooling design.

So, in the end, it's a business that needs to be supported. If you're an employee that can help generate more revenue, then everybody wins. So, if we can create tools that future workforce can understand the needs of the business and help solve those problems, or connect a way to solve those problems, I think everyone benefits a little bit more. So, the employee becomes more important to the business, and the business grows from that way.

Stephen: Yeah. You know what? You're absolutely right. I'm not going to back down off of robotics, but I will say that automation is absolutely the next step. Because I've been fortunate to talk with and work with a few companies at AMT who are trying their best to simplify and automate the post-processing software. Because I learned the hard way that, with our test bed, when we first got the desktop CNC mill, "Okay, I've got this milling machine. Let's make some parts!" And I went online, Googled "CAD files," found some awesome CAD files, and like, "All right! I've got some designs! Can I just upload them to the machine tool and click print or something like...?" Wrong! No! Starting from scratch, or even starting from a CAD file that you get online, and editing it to the point where you have your design perfect. Congratulations! You've only done 15% of the work! The next huge chunk, which is hands-down the majority of the manufacturing workflow, is translating your

design into a program file. G-code file in our case. And that is a headache! And I'm fortunate to have talked to some companies that are trying their best to automate that. So, the next big, hopefully near-term evolution in manufacturing will be making that process a lot shorter and easier.

Ben: Yep.

Mike: All right. That's really good. You know, Ben and Stephen today, it was really cool talking about the trends that you're seeing because there's some hype there, there's some buzz there, but there's also some reality. I was listening to you today talking about "cobots are out there" and "every technician ought to have one" and "get started." And I think I see in the education programs I've visited around the country, they're doing that! They've got them set up now in the laboratories at technical colleges. And they are actually doing some of the things that you're saying. So, this give me some faith and some good confidence there.

AI, well, Ben made a good case. You got to have a business case for what you're trying to solve here. And THEN the 5G's going to kick in and help you with some of that data streaming.

Also you mentioned the "cyber physical systems." The awareness there is just critical, especially when you get into the Defense side. I know a lot of our programs around the country that we work with are using NIST frameworks and other frameworks as well for cybersecurity. So, we seem to be pretty well aligned there.

I like what you talked about the future, right? It's robotics. You know, Stephen was shouting about robotics there! And Ben said, "Don't forget, software automation is an important thing, too." So, it was good.

Let me put in a plug: the International Manufacturing Technology Show. It's in September. It's on the website. So, I'll link that in the Show Notes. We'll put a link to that. It should be an interesting opportunity for people who might be listening today to think about going. And I know there's a student section as well, isn't there?

Ben: So, they have a Student Summit, which brings in a variety of local students to prepare them and make them aware of manufacturing technology that are relevant to what they may see. And there's a bunch of hands-on experiences. They get

some really good speeches from other students that have gone through and done some very interesting things in manufacturing.

Mike: I like it. All right. Well gentlemen, it's been just a pleasure today to talk about the trends that are driving manufacturing from your perspective. I appreciate your taking time out of your schedules today to talk with our audience. And also I'll put one more link in the Show Notes to your podcast...

Ben: It's "AMT TechTrends."

Mike: We'll make sure we link that, too, and I know you guys are really on top of this stuff, so that's great.

Stephen: Awesome. Thanks a lot, Mike. We've enjoyed this a lot.

Ben: Hey, It's been a pleasure, Mike. Thank you.

Mike: You're welcome Ben. Thank you, Stephen. And that concludes our section of the podcast today. Thank you very much.

New Speaker: [music]

Mike: That's it for today, listeners. You know, it's not easy to keep pace with emerging trends and industry as we prepare our future workforce. One action is to expand the podcasts you listen to! In the Show Notes I put a link to Ben and Stephen's podcast called "AMT TechTrends." Check it out.

Number two. What about attending an industry trade show? Where you can engage with industry, see what's happening, what the new things are. I also put a link to the International Manufacturing Technology Show that's going to be in Chicago in September. You'll see the link in the Show Notes. There's many other shows like that which you can get right "in there" with industry, see what's going on for yourself.

Now, finally, we talked today about a robot for every technician. How do you make that happen in a learning situation? Where do you get the resources? Where do you get the money? Where do you get the funding to do something like that? Well, I'd like to encourage you to consider the Advanced Technological Education program at the National Science Foundation. They fund technician preparation programs at America's community colleges and technical colleges. The link to the solicitation that describes the opportunity is in the Show Notes.

As always, find our podcast on PreparingTechnicians.org or subscribe on Apple Podcast or Google Play. A rating and review is always appreciated. Our series is produced by John Chamberlain at CORD. Thank you, John. The project is led by the Principal Investigator, Ann-Claire Anderson. Thank you, Ann-Claire. And thank YOU, our listeners, for Preparing Technicians for the Future of Work.

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