Integrating Emerging and Cross-Cutting Technologies: Vacuum and Automation with Nancy Louwagie and Tom Johnson

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Mike Lesiecki
Our series on the Future of Work is continuing with the focus on integrating emerging and cross cutting technologies. We are hearing from educators on exactly how they are creating changes and new opportunities for learners in partnership with industry. Note that this presentation does not necessarily reflect the views of our sponsor the National Science Foundation. A video version of this presentation is available on our website Preparing Technicians dot org. Now it's time to welcome Nancy and Tom joining us Nancy at Normandale Community College, why don't you introduce yourself to the audience. Tell us a little about yourself and then introduce Tom.

Nancy Louwagie
Thank you, Mike for the introduction. And thank you for inviting Normandale to be one of the presenters in this webinar series. As Mike mentioned, my name is Nancy Louwagie. I'm an instructor in vacuum and thin film technology at Normandale. Community College Normandale is located in Bloomington, Minnesota. I'm also serving as a principal investigator for currently funded NSF ATE project that started in 2022. Part of the inspiration for the current project came out of CORD's, recommendations and shared resources as part of their Preparing Technicians for the Future of Work project. Our project incorporates some of those ideas related to incorporating cross disciplinary learning skills and knowledge as they apply to our core programming technology vacuum and thin film technology. the name of Normandale its current project is flexible technology education to upskill reskill for a vacuum technician career, we call it flex tech ed for short, the PI team consists of the eight individuals who are named on this slide. Before sharing some of the details about the new curriculum, I'd like to provide some background on the core technology discipline that is vacuum technology, and how we arrived at this project that we're currently working on. At this point, I'd like to introduce my colleague, Tom Johnson, Tom is going to provide some background information on where vacuum systems are used in manufacturing research, and why the vacuum condition is a critical process parameter that is considered as part of manufacturing and research operations.

Tom Johnson
Thank you, Nancy. So I'm just gonna give you a little bit of a background of why vacuum technology is important. As you can see pictured here in this this slide, are a number of products that could only be produced with vacuum technology, from a thermos to coatings on glass, whether it's architectural glass, or sunglasses, touchscreens, on cell phones, laptops, lots of different products use vacuum as a critical component in that man manufacturer of those products. So what is vacuum technology? Well, they're vacuum systems that are used to establish and maintain a low pressure condition. So these conditions are created by removing gas from a vacuum chamber and creates a controlled environment with sub atmospheric pressure. So why do we need a vacuum to create these fantastic products? Well, here's an example. Let's say we want to create a thin film coating onto a surface, we have to start with a solid

material, which is called the source. And we want to take that source material and transfer it to our substrate. And a substrate could be architectural glass, sunglasses, all those products that you saw before. And that coating needs to be vaporized from a solid material to a vapor. So in a high vacuum condition or a very low pressure condition, we can transport those atoms from the source to the substrate without them colliding with any intervening molecules of oxygen or nitrogen. So therefore we are ensuring that we're getting the coating that we intend. So in summary, a low pressure condition facilitates the process of coating a surface with a thin film of very pure material,

Nancy Louwagie
What is Normandale's vacuum and thin fill the technology program? Well, this is a program that prepares a student to work as a technician in industries and research organizations which rely on vacuum based processes. Normandale offers three different credential options. One is a two year associate's of applied science degree, which consists of 60 credits worth of coursework. Then there's two certificate options. One certificate is the vacuum technology certificate, and that consists of nine to 11 credits of coursework. The other is the Vacuum Maintenance Technician certificate, which consists of 28 or 29 credits of coursework. I have a question if you don't mind me interrupting you are these these credits are stackable towards the degree or they're independent certificates. How does it work? They are stackable. So a student can earn the vacuum technology certificate. So those first nine to 11 credits, first earn that credential, then proceed to complete additional credits and earn the vacuum Maintenance Technician certificate, and then finish out the final credits to get their AAS degree. Most of the students that come into our program are already employed in industry and are aware of vacuum systems in their in their in their workspace. So they're motivated to come into this program and learn more about vacuum system functions and operations so they can be more effective on their jobs. And some of them their employers are often offering them incentives in the way of like a promotion or a pay increase if they will go and earn the vacuum technology credential. So Normandale is program with vacuum technology does go back to 1996. But since that time, we've been awarded five NSF ATE Project awards. And these projects have really helped us enhance this program. They've helped us develop and refine the curriculum, we've been able to procure and develop some new resources, and they've helped us be able to try new new forms of curriculum delivery. Normandale's current project is an outgrowth of two previous projects. Starting in 2014. We had an NSF ATE project that allowed us to develop custom vacuum equipment trainer systems, there were no commercial off the shelf systems available. So we designed and developed our own trainer system that would support student hands on learning experiences. In 2017, we received another NSF ATE project. And we were looking at creating the vacuum technology certificate curriculum in a fully distance learning mode so that students could do all could do all of the curriculum from outside of Normandale they did not have to attend in person. Part of the initial motivation in the project was to acquire a piece of equipment and material deposition system that could be remotely accessed by students and operated by the students. After the pandemic hit. We received supplemental funding that was in support of undergraduate research experience and the undergraduate research experience. We had our students help us to design and develop, build and test the vacuum equipment trainers that were originally developed as part of the previous project and transform them into an automated system, one that could be remotely accessed and operated by students. As part of that URE experience could actually be its own course where we would integrate the automation or the teaching of automation and and apply it directly to the system operation of those vacuum systems. I want to point out who the person in the picture was. So the person here is of one of

our URE students. His name is Jason Rear, Jason is responsible for the original design of the remotely accessible bet system that you're gonna see demonstrated in a little bit. Jason, when he came to us was employed at a local semiconductor business as a operator. He earned the vacuum technology certificate and then continued on to complete the AAS degree in vacuum and thin film technology. He has since been promoted to a process technician at his employer. At this point, I'd like to give it back to Tom and he's going to talk more specifically about the curriculum we have in mind for this new automation in vacuum technology.

Tom Johnson
Thank you, Nancy. I'd like to talk to you a little bit about how we transform the undergraduate research experience content into a fully functioning course we have three components to this course series, the introduction to vacuum system automation, which primarily focuses on the documentation side of things, what are the pieces of documentation that are important to automation, like schematics, and instruction manuals and, and those types of things. And then we're going to build upon that in the second course in this series with inputs and outputs for vacuum system automation. And in this course, we're going to actually have hands on components that students will be wiring and integrating to their PC at home. And that will give them an introduction to how to collect signals from devices, and how to integrate that to a computer interface. And the third course in this series is we call our capstone which kind of pulls all of those learning experiences from the previous two courses, and has a student have a project. And they would create their own human machine interface, for a simple vacuum system, we had a student actually create a human machine interface for a vacuum equipment trainer. And we'll demonstrate that for you shortly. But here's this, here's a picture of what that vacuum equipment trainer looks like. And we have our vacuum chamber supported by a rough vacuum pump, and some valves for operating gas flow. And we'll be taking these components and automating them and making them remotely accessible. And it will be up to the student to create a human machine interface to incorporate all of these elements. So let's go ahead and take a look at the what that remote access vacuum equipment trainer looks like and operates. Let me demonstrate the system for you. This is what a student might see when they log into the equipment at Normandale campus. So I'm not at Normandale campus right now I'm located remotely. And I have been able to log in over the Internet to this piece of equipment, this vacuum equipment trainer. And I will just quickly demonstrate for you what a student might do as part of their learning activity, start with turning on the rough pump, get that pump going. And as you can hear, you can actually hear the rough pump running in the background. And that's good audio feedback, it makes students feel like they're actually sitting in front of an operating a real piece of machinery, rather than like a simulated experience. But for the purposes of this video, I'm just gonna mute that sound for now and just go through the rest of the demo. Now, a student would want to pump down the system by opening the roughing valve. So by clicking on the roughing valve, you can hear that start to pump gas out of the vacuum chamber. And you can see the pressures dropping on these gauges. Students that put this HMI together did a good job at animating the molecular density inside the vacuum chamber. And you can see it's getting less and less dense in there. Over on the right hand side, we got some trend graphs showing the pressure. As soon as we open that roughing valve the pressure drops over time, we have two representations of that data that's being collected. We have a linear graph showing atmospheric pressure down to zero. But we also have a log representation of that same information. And that's more useful when you start jumping over several orders of magnitude. You lose a lot of detail on that linear graph as it levels off, but you can sit still see that it's continuing to

pump down and then once they got down to the pressure that they want to do their activity at, they would shut that roughing valve and then they would vent the system back up by opening the vent valve and by opening that vent valve they're letting gas back into the system and bringing that back in chamber backup to atmospheric pressure. And you can see that also show up on these linear log graphs. So this is what a student would do. If they were taking one of our vacuum courses they would be interacting with this equipment, getting a sense of how they this equipment is operated, for our automation class. Our capstone project that I referred to Earlier, would actually give the student an opportunity to make their own human machine interface for this same system. So they would wire up all these devices that the valves, the gauges, they would bring that information on to their computer, and then link this to a data acquisition software, and be able to graphically display it in a manner of of their choosing. And we think that this is a very valuable experience for technicians that are working in fields to be able to interact with digital automated components. And that was one of the feedbacks we've got from our program advisory group, that students really needed this type of experience to work in industry today.

Mike Lesiecki
Tom its Mike, I wanted to make a comment here, I really picked up on what you just said, I mean, their ability to work with real time live digital components, and then take that data, do something with it in Excel. And that's the expectation of industry that really resonates with us here. We are looking at it right on the screen. So I'm impressed with this.

Tom Johnson
Yeah, it's really been a game changer for us. As far as delivering this education to students, students can be located anywhere they have access to the internet, can interact with the equipment, they can build their own automated system at home, and test it out on live equipment.

Mike Lesiecki
So they're sitting there at their kitchen table with their computer, logged into the system actually building their own HMI and acquiring data from their home. That is correct. Okay, that's pretty good. Now colleague says we turn to an opportunity to ask questions among our presenters. One of the things I wanted to wind back to Nancy is you mentioned, many of your students are employed. Are the industry sending people to Normandale? Do you go to an industry to engage them? Is it for credit? I know, that's a lot of questions at once. But how are you working with industry? Nancy?

Nancy Louwagie
Well, that's a great question, Mike. We've had great support locally from a few different companies that have fabrication facilities, and employ quite a number of maintenance technicians and process technicians. And the answer is yes, they do refer those individuals to come to Normandale and get this vacuum technology certificate or the AAS degree. We have been expanding our reach because of the distance education components. So we're networked with other businesses across the country now that have sent of their employees are signed up to have their employees up for our courses. So it's a combination of we're still we're still working with our local employer set, and they still have needs to hire more technicians. But also nationally, there's a there's a big need to hire different types of maintenance and process technicians or different businesses. But,

Mike Lesiecki
Tom, a question from our audience. What about troubleshooting? I mean, that's a big demand by industry. Now, people that are skilled at troubleshooting. Does your system help students with that skill?

Tom Johnson
Yes, I think it does. Since you're working with live equipment, anybody who's worked with vacuum equipment knows that it doesn't always work as intended. And these become learning opportunities for our students, we can also build in scenarios into our systems that simulate the problem they might have with the equipment. And then students would have to figure out how to diagnose the problem and then fix the problem. And I think that the automation course actually takes it even one step further, because it really gives students a feel for all of the components behind the scenes, and not just operating the system, but actually, the components that actually are put together to make a whole vacuum system work.

Mike Lesiecki
Good. Good. Excellent. You know today, Nancy and Tom, I wanted to congratulate you because you're right in front of us. We've seen how one integrates things like automation into Nancy, you refer to it as a legacy technology, but vacuum technology is very current today, of course. So integrating automation, Tom, you talked about the data stream and having the students be able to look at that data, do things with it, make decisions on that that basis that is the real Future of Work, right students being able to do those things. So thank you for showing us today how this all actually happens. As we conclude for today, I'd like to remind you again of additional resources that are available at Preparing Technicians all one word dot org, we have a framework for cross disciplinary STEM core that's about a five or six page white paper that will give you the basis for some of the decisions that have been made in integrating these technologies. Also, we have something that are called instructional cards. They are short learning activities that you can download and use right in your class. You can listen to podcasts like this one, featuring cutting edge industry interviews, and you can share recorded webinars like this one today with your colleagues for your own professional development. Here's some examples of those instructional cards that I just mentioned in that first bucket data knowledge and analysis. Data visualization, you saw some data being visualized today, we talked about spreadsheets. instructional activities in the middle column include automation, robotics, integrating Internet of Things type of sensors. So all of these things are available for you at the website podcasts is in the series, including this one. You can see another of the other ones, including the one on the upper left technicians in the new blue economy. That was an interesting one. And finally, in this webinar series, you can share and find them at preparing technicians.org/webinars Nancy and Tom, thank you again for joining us today. We enjoyed hearing about all of your work at Normandale. Now you've expanded this onto the national stage. So thank you both again. Thank you, Mike. colleagues said that concludes our webinar for today. Goodbye.