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Modern Technology and Its Impact on the Control Panel Manufacturing Industry

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Abstract

This paper will explore emerging technologies and their effect within the control panel manufacturing industry. A control panel is defined by Automation Ready Panels as, “a metallic box that allows the person to control all electric equipment, appliances, and circuits mechanically by using electric energy” (*What is an Electrical Control Panel?*, 2022; Refer to Appendix A for a visual on what a control panel looks like). These are most commonly seen in large industrial equipment, such as assembly lines, rock crushers, etc. The innovations studied in this paper include 2D and 3D drawing, augmented reality, computer assisted manufacturing, computer assisted drawing, and computer assisted engineering. To gain a better understanding, the use of secondary research and interviews with professionals in the industry were conducted.

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I. Introduction

Industries are constantly in a state of change. This is most often the result of technological innovations that force companies to either propel themselves forward or risk falling behind. One specific industry that is currently experiencing this is the control panel manufacturing industry. In this industry, they create control panels which are the equipment that runs different heavy machinery, such as rock crushers, sifters, or assembly lines. Technological change in this industry is occurring on two fronts. The first is the components of control panels in general, such as new drive models that have better power efficiency and, as a result, are greener to run than older models. But we also see numerous examples of technological innovation within the manufacturing process.

In this paper, we are going to be exploring a new type of technology that is currently playing an influential role in changing the control panel manufacturing industry. We will begin by developing an understanding of some of the most prominent types of newly emerging technology, including everything from 2D and 3D modeling to Computer Assisted Manufacturing (CAM). Once we understand what these latest technological innovations are and their effect on the industry, we will see how two major suppliers package them into a usable product. Then, to create a clear picture of the impact, we will explore a local manufacturer's operation to see how the technology has changed his own personal business. Within this section we hope to clearly see the impact these new technologies can have on a particular business and visualize the benefits of adding them to the engineering and design process. Lastly, we will move onto our strategic recommendation, which will include an industry analysis. From this analysis, we will identify the key problem, develop a solution strategy, and discuss its benefits.

II. Modern Technology

To begin, we will discuss the latest innovations that come from modern technology and their effect on the control panel manufacturing industry. The biggest innovation tends to revolve around engineering as it relates to the drawing and designing of control panels, but we also see innovations relating to the manufacturing process as well. The different categories of technology we will cover are 2D design, 3D modeling with Building Information Modeling (BIM), augmented reality, CAD, CAE, and lastly CAM. The significance of these forms of technology is that they are taking away the art of building control panels, meaning that they are simplifying the manufacturing process and lowering the need for workers with technical knowledge. This impact will be seen throughout the exploration of these various innovations.

Modeling and design are integral steps to any manufacturing industry. If there is no model or print to instruct the production employees on how to produce the product, how would anything be made correctly with consistency? There are two schools of thought when it comes to modeling and design: 2D and 3D. These two types of modeling predominantly benefit engineers as they design the control panels, but as we will discuss later, they also tie into other forms of technology, which benefits other parties as well. While both have their use, there is a preferred method of choice for design.

To begin, 2D modeling is the older method of design that involves the creation of objects, drawings, or models in a two-dimensional plane. A two-dimensional plane means the finished product is flat, with no dimensions. This technique is used to design blueprints for manufacturing machines that only know how to read X and Y axes and are incapable of understanding a third dimensional plane. The greatest feature of 2D modeling is its simplicity. It’s quick and easy to create a drawing, as you can use basic shapes such as squares or circles to represent the footprint

of your model. With that, you can get a rough idea of how everything will fit together and where certain items must go. The biggest downfall of this method compared to 3D is that there is no way to check for collision with height parameters, as that data would fall on the Z axis.

The downsides of 2D modeling do not end there. The software that houses this type of technology does not support co-editing properties that are as robust as those of 3D modeling software, and therefore different team members are not able to seamlessly collaborate on a single design. According to an academic article published by Ulteig Engineers, Inc.,

> 2D CAD[1] generates graphical, object level displays of information within sets of drawings that capture and then present information about the design as a series of drawings [1]. With this method design notes and calculations must be manually added to the drawings, and software used to run calculations is often housed within an entirely different application. Additionally, any changes to 2D drawings must be marked up either on hardcopy printouts or via PDF editing software. (Redmond, 2022, pg. 84)

In simpler terms, 2D modeling creates hassle and unnecessary work since no supporting software allows for easy integration for collaboration and information sharing. While 2D does still have some important uses today, such as its easy connection to g-code—the programming language of most machinery—it is overwhelmingly inferior to 3D modeling overall (see Appendix D).

3D modeling is like 2D, but it adds a third dimension: height. This added feature is incredibly beneficial. An article from Laser Design states that, “3D modeling allows your company to conserve those valuable resources by enabling you to catch errors before a design is finalized. As an example, 3D modeling allows you to catch interference issues in an assembly at a point when changes to the design are less costly” (Laser Design, 2020). In an interview with

[1] CAD is “Computer Assisted Design”, which is software that has both 2D and 3D properties. It is used to create drawings and provides tools to assist in the designing process (Woo, 2016).

Brenden Fritz, the owner of a control panel manufacturing firm known as Automated Drive Systems, he stated that interference issues within the control panel box itself were a common problem within the industry. Specifically, he described how problems would arise from the components inside the control panel colliding with the circuits on the back of its door, resulting in it being unable to close. The ability to see the full picture with all the dimensions has allowed for this defect to be prevented within the design process, which has saved both time and money on the production floor.

3D software is also more receptive of software add-ons that allow for easier data communication and sharing. The old ways of doing things were to finish a drawing or model, save the model and send it as an attachment to the people who need to review. They would then mark up the file with any necessary changes or edits and, once completed, send it back to the engineer's ever-filling inbox. And then, that engineer would have to review the new information and physically make the edits to the model. Overall, there was a ton of waste and potential defects that could occur throughout the process. For example, what if the reviewer's comment is illegible or if someone misses the email and doesn't complete their edits before the deadline? Luckily, with 3D modeling add-ons, a lot of this waste can be avoided. An example of add on software could be Building Information Modeling (BIM), which is a "nongraphical software modeling solution that guides design and construction" (Redmond 2022, pg. 84). As is described in a journal by J. Redmond, BIM software has three characteristics:

(1) Models are created and operated on digital databases for collaboration.

(2) Models manage change throughout the databases so that any changes are updated throughout the databases.

(3) Information is captured and preserved for re-use in other applications. (Redmond, 2022)

With the aid of this add on, communication channels can be streamlined to be done within the schematic or design file. This enables for easier collaboration, as it limits the communication pathways within an organization and allows the engineer to be able to see all required information while working on the design. This new way of sharing information allows easier communication between production workers, customers, and engineers. The ease of communication allows companies to fulfill customer needs and solve problems more easily and at a much faster rate than before. Overall, we are seeing the industry shift towards a preference of 3D modeling over the original 2D electrical schematics. This is mainly because it allows for better understanding of spatial requirements and a more complete picture of the final product.

The next emerging technological innovation in the industry is augmented reality. This technology is enabling manufacturers to share complete models of their products to see how they will fit in the actual space and provides a new way to train employees on new processes. As defined in the article titled *Augmented Reality Applications in Design and Manufacturing*, "AR-based systems support information visualization through augmenting virtual objects onto the real world." (Nee et al., 2012, pg. 661) This allows engineers to upload a 3D model of the final product that give external users the ability to interact with it to gain insight. This technology has multiple applications within the control panel manufacturing industry. A significant one is the ability for the manufacturer to allow the customer to see how the control panel will fit within the rest of the space before they actually transport the physical control panel. This allows for easier detection of potential issues regarding the layout of the assembly line where the product may be going (see Appendix B). Overall, the implementation of this technology results in a higher level

of customer satisfaction and adds value because potential defects are prevented before the installation of the panel.

The other way in which augmented reality is beneficial is within the manufacturing process itself. According to an article written by Tuhin Bhatt titled, *How Augmented Reality is Changing the Manufacturing Industry*, "Augmented Reality makes the steep learning curve at the manufacturing unit easier for the new joiners" (Bhatt, 2023). Not only does augmented reality allow you to create a virtual model of the control panel being built, but you can also add features that guide the employee on how to complete each step of the process. At Automated Drive Systems, Brenden has developed a step-by-step tutorial on how to operate their NC Cut machine. Within this tutorial, there are not only written steps and notes, but also visualization ques on certain tools or levers that need to be pulled. For example, the lever the operator needs to pull to cut the machine will highlight when you are ready to cut (see Appendix B). This training method allows for a more hands on approach to learning, which has significant impact on training time. In the same article written by Tuhin Bhatt, he states, "Post adopting AR, the company has witnessed a massive 50% reduction in training time, null human errors, and a 30% improvement in productivity" (Bhatt, 2023). This is a prime example of technology simplifying processes and allowing less technical employees to accomplish the same end result.

Computer Aided Manufacturing (CAM) primarily deals with automation. Which is the use of machinery or other tools to increase efficiency. According to an article from letsdive.io titled, *The Ultimate Guide to Improve Workflow Efficiency*, "Automating repetitive tasks is a key strategy to improve your workflow efficiency. Workflow automation tools help you create standardized processes that automatically handle routine tasks, reducing manual effort and human error." (Dive, 2023). Within the control panel industry, the most common tasks to automate are wire

processing and metal fabrication, as these are very time-consuming tasks. Automation provides a way to increase efficiency and eliminate waste. Brenden from Automated Drive System states in an interview that cutting metal and doing metal fabrication is very tedious and time consuming. Because of this, finding a way to simplify the process proves to have substantial benefits (see Appendix B). Patrick from Nvent says the use of a CNC machine can increase accuracy to $1/10^{th}$ of a millimeter, which results in less defects and wasted materials. He also mentions the benefit of labor savings, which over time can amount to some pretty serious savings (see Appendix D). Overall, it is clear that many professionals within the manufacturing industry have noticed the benefits of Computer Aided Manufacturing. Additionally, software can also tie into CAM. The use of software as a training tool or guide while producing products can prove to be quite beneficial. This type of software can include software packages which create visual aids that simplify more complicated instructions. This results in more streamlined manufacturing and increased efficiency.

The next section will talk about Computer Aided Design (CAD) and Computer Aided Engineering (CAE). There is some overlap between the two, as CAE often has CAD properties, but the biggest difference is the level of support provided throughout the designing process. Author Tracy Woo defines CAD and CAE in her article titled *The Different Software in Computer-Aided Development*, "CAD, computer-aided design, is the use of computers to design 2D and 3D models. CAE, computer-aided engineering, are mostly software tools that provide engineering analysis (i.e. thermal, stress, physics, etc.) of a design" (Woo, 2016). The difference becomes clearer when we look at what Kim Schroeder with Eplan said in an interview, which is that CAD is a build-up system, or an analog system. Essentially, CAD has no data behind its drawings, its merely a drawing that has to be manually made every time. Whereas CAE is drawings with data behind it. Kim states that when a drawing is done through Eplan—a CAE

software—choosing a specific part will display all the information and data associated with it. These can include things like size of the part, temperature controls, speed parameters, etc. On the other hand, a CAD system is limited in that it is only a drawing and the drawing doesn't have any logic or data behind it (see Appendix C).

So, if CAE has more data and logic integrated into the system, why do control panel manufacturers continue using CAD? A big reason is simplicity. It ties back to the benefit of 2D where you are able to simply draw the shape or picture needed, without having to worry about finding and adding all the logic and data needed in a CAE system. Thus, if there is a time crunch, it is very beneficial to have the CAD capability to simply draw the image quickly. Despite CAD's benefits, in the long run, CAE proves to be more beneficial since, once all the data and logic is built into its system, it allows for more assistance with drawing—whether it be a click-and-drag feature to add components to the control panel, or automatically laying out the path wires will take from component to component. Additionally, CAE has the added benefit of automatically including important information related to the different parts and components. Overall, while both types of software have their pros and cons, a fully implemented CAE software will always out-perform a CAD-based system.

In general, there are many types of technology that are currently emerging in the control panel manufacturing industry. From the increased spatial awareness of 3D modeling to the automated benefits of CAE, each of these innovations come with their own set of benefits that greatly affect the companies that implement them. In order to fully understand how these technologies are combined to form a usable product, we must turn to the perspective of two prominent suppliers that work within this industry.

III. Technology as a Product

The technologies listed above fall into two categories: machinery and software. Most of the CAM features are related to machinery, but software can also play a role in that as well. And then 2D, 3D, CAD, and CAE fall within software. But they all do connect in a harmonious way, as the software feeds the machines information that is required for them to operate. And so, within the control panel industry there are two large suppliers, Nvnet and Friedhelm Loh.

Nvnent offers advanced automation machinery, which would fall under the CAM umbrella. In the interview with Patrick, he states this is really what they are good at. Their automation is broken up into three categories: the mod center, NC Cut, and wire processing. They also have some products that are designed to help with streamlining the human workflow, like tilt tables—which help to position the panel into the most comfortable position for the operator to work. Within the mod center, they have the CNC machine, which drills all the holes into the back panel and enclosure. Then the NC Cut will cut the din rail and wire duct for the panel. These are used to mount components and house the wires on the back panel. Finally, there is the wire processing machine, which is a huge time saver, as wire processing is very tedious and wasteful. The benefit of this machine is cutting down on the waste since it will cut the wire exactly to length (see Appendix D).

Although most of Nvent's focus lies with CAM technologies, they have also started to develop CAE-like software which they call Direct to Manufacturing (DTM) software. There is some similarity between Eplan and Nvent's DTM software, but Nvent's is not as robust as Eplan (see Appendix D). The simplicity can be beneficial to some customers though because it is easier to implement and use. The features of this software include a click-and-drag feature for design and automatic wiring layouts. The drawings or designs are done with elements of CAD software

and have 2D and 3D options. The software is often the most important part, as it feeds the information to the machines (see Appendix D). During the interview with Patrick, we learned that the communication between the machines done through the software is much more complex than what appears on the surface. If we start with the CNC, a 2D drawing is required to tell the machine where to drill the holes. But this same drawing, when uploaded into the CNC, is imported to the NC Cut for the measurements to precisely cut the wire duct and din rail for the panel. And then the DTM software will figure out the wire paths and required wire lengths and export the information to the wire processing machine (see Appendix D). Overall, between their use of both CAM and CAE, Nvent has been able to effectively combine these types of technologies to create useable products.

Moving onto the other supplier, Friedhelm Loh owns both Rittal and Eplan. Rittal is their CAM manufacturer, meaning they specialize in machinery to assist control panel production and they manufacture enclosures. On the other hand, Eplan is more software based and is the most robust package on the market. Eplan is CAE based, meaning the design process is highly automated and backed by logic and data. They have features like click-and-drag to put parts onto the drawing easily, and the part database within Eplan provides information such as torque values and amperage. They are also developing a feature of Eplan called Ebuild, which will allow users to create a database of macros to automatically create skeleton circuits by selecting the features of the panel. Essentially, this feature will allow the engineer to input data and then produce an output that is mostly complete other than any additional components or circuits required. When fully implemented, this will offer tremendous time savings for the engineering process (see Appendix C). Overall, all of these implementations represent the various ways that Eplan is utilizing CAE technology.

Eplan is also accompanied by CAM features, including Smart Wiring and Smart Mounting (see Appendix E and F). These two features simplify the building of control panels tremendously because they eliminate the need for the technical knowledge to read an electrical schematic. Schematics require loads of technical knowledge to be able to read and understand (see Appendix E for an example of an electrical print). Often, wire routes can span across multiple pages which makes it difficult for an untrained eye to keep track of. Smart Wiring and Smart Mounting eliminate the need for a schematic altogether and drastically simplify the information. For example, within Smart Mounting, the user will select the part within the software, and it will show them in a full 3D model where the part is located by highlighting it (see Appendix F). In Smart Wiring, if a user selects a wire, it will show the route the wire is supposed to take as well (see Appendix G). Both of these features greatly simplify the instructions on how to assemble control panels, which enables a company to hire for culture, and not for knowledge.

In closing, these suppliers have been able to implement features in the form of both software and machinery into their final products. As a result, the control panel manufacturing companies that purchase these machines and software packages are able to benefit from many types of technology.

IV. The Benefits of These Technologies

Choosing to implement these technologies into a control panel manufacturing business has substantial benefits. But to put it simply, the main benefit is simplicity. Technology streamlines processes by automating, making things clearer, and replacing multiple steps or tools with one robust tool.

One of the biggest benefits of Eplan is that it greatly simplifies the building process. According to Brenden, in the old days he would have to hire people for knowledge. He needed someone who could look at an electrical print and know what the specific components were and how to flip through multiple pages to run the wire, both of which required a high level of technical understanding. Whereas now, with the use of Eplan and CAM software such as Smart Mounting and Smart Wiring, he is able to hire for culture (see Appendix B). This is because with software that can easily instruct people through the steps, the need for knowledge decreases drastically. It also has the added benefit of increasing the speed of training and, because now there is less of a need for high technical skills, he can afford to hire cheaper labor and still maintain that high quality. Overall, when discussing with Brenden Fritz about time savings, they have seen a 50%-time reduction on average for their control panels. Accompanying the time savings is a 15% reduction on labor rates for employees. And so, ultimately, on an average panel we can see the total savings are roughly $1,242 per panel (see Appendix H). If you were to build 500 panels in a year, that amounts to more than half a million dollars in savings, which is significant in the grand scheme of things.

The other benefit of the technology is that it simplifies communication between an organization and with customers. A strong CAE platform allows manufacturers to send the file and co-edit projects seamlessly with customers. That, in addition to an augmented reality feature, adds tremendous value to customers because now they have a way to understand what they are getting before it is even built. Additionally, communication within an organization is greatly simplified between departments. In the interview with Kim Schroeder, a CAE and CAM software package like Eplan allows for production workers to communicate directly to the engineer through the software, which eliminates the need for additional communication

pathways like teams, email, or in person (see Appendix C). Overall, these technologies have many benefits in the modern control panel manufacturing industry.

V. Strategic Recommendations

It is clear to see that these new emerging technologies are going to greatly impact the control panel manufacturing industry. According to Brenden, technology is allowing the industry to change from an art form to a more simple, less technical skill (see Appendix B). This will shift the position of the industry from having the goal of differentiation – or selling their product as being more valuable than competitors - to more of a cost leadership style goal. Or focusing on lower costs than competitors. Technology will also help companies increase the value provided to customers as it will lead to higher quality, faster lead times, and being more able to fit customer needs (see Appendix I). As a result of these impacts, it is important that manufacturing companies adopt these technologies sooner rather than later, as implementation will take a good amount of time to see the full benefit and waiting too long may result in becoming obsolete compared to competitors. Overall, it is imperative for control panel manufacturers to embrace technology in order to stay competitive within the industry.

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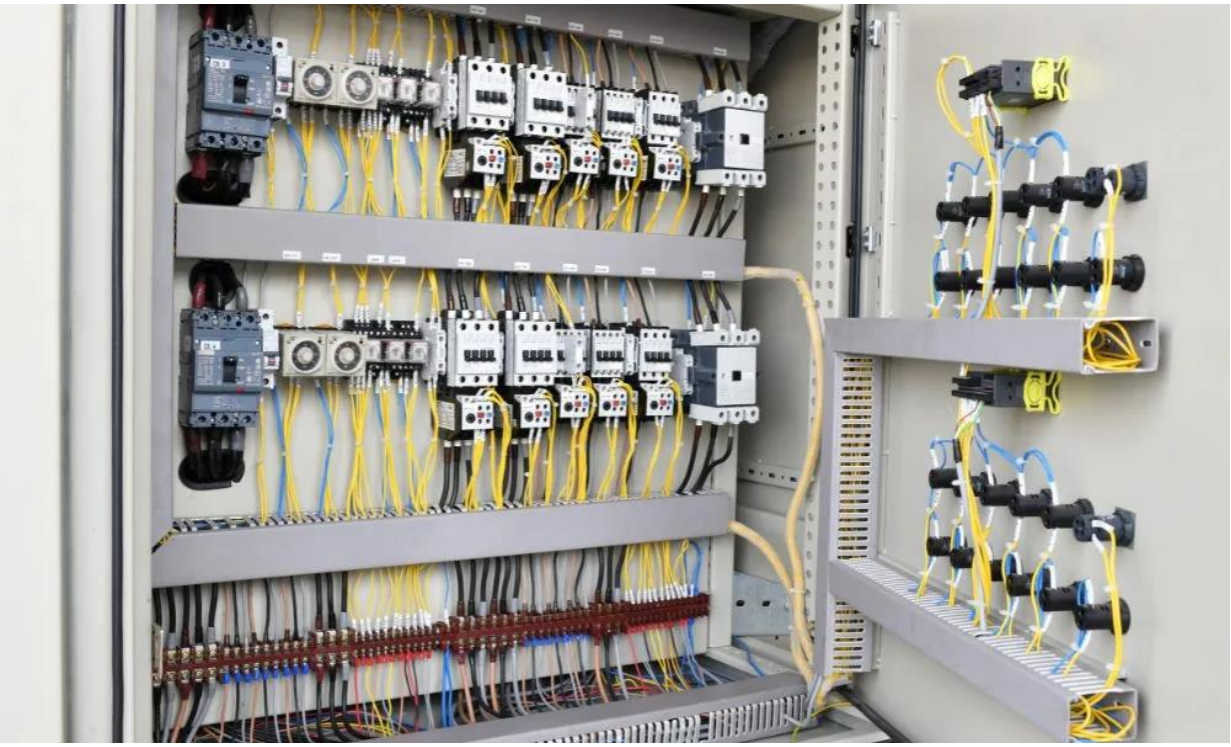
VII. Appendices

A. Picture of Electrical Control Panel



B. Transcript: Interview with Brenden Fritz

Keegan

If you would like to start with introducing yourself, telling us who you are and what your company does.

Brenden

Sure, Brendan Fritz, owner of Automated Drive Systems in Omaha, NE. We're a custom engineered to order, electrical control panel manufacturing company. We've been practicing lean and trying to use technology and systems to make us better for about the last four years.

Keegan

Sounds good. So, the first question, can you describe what production was like before the adoption of Eplan and automation through machinery? And then describe how adoption has changed the way your business operates?

Brenden

So, the way that we used to do it is very common in the industry overall. Every single product that we've built would have a full electrical schematic built. That electrical schematic would have embedded in it 2D layouts, you know, as far as the physical product that needs to be assembled, where things need to be mounted on to the different components that make up the final product. Again very. Literally just electrical schematic based in the overall production. We follow… you basically would have to have one highly skilled technician. That technician had to know basically how to take what was on a printed piece of paper or series of papers and turn it into a real-world product. So, there was a massive amount of knowledge that needed to be had because that one person would literally do every single step of the build by hand manually. So, they had to not only understand how to read the prints or any print that we got from any different customer that may have variation to it. They would have to know how to do, you know, metal, light metal fabrication, drilling, tapping, you know, cutting, grinding. Then they would have to know how to interpret the actual physical model layouts in 2D. How to find and cross reference those parts all the way to you know, running screwdrivers and things like that to mount everything. Then they would have to know, you know basically how to select the wire by size, how to make and apply physical wrap around labels or heat shrink labels we used over time. They would have to know…. Basically, how to read that electrical print to correlate, “Hey, this line means it's a wire. Go search the wire.” For us, it wasn't until we adopted more advanced technology. But what we would do is basically operate in an intentionally so we would put the

bare bones into the drawing. These the drawings took a long time to make. And so, what? Every time we had to go, we were intentionally doing, you know, essentially in process QC of the design which required technicians that were very skilled to be able to look and see you know, oh hey, this this is this is wired to the wrong side of this you know of contacts on a component or you know hey this can't really mount here, because there's a clearance issue. And so it was, you know, at the time we kind of prided ourselves you know, while we have really smart people on the floor building and that allows us to have more bare bones drawings because the drawings took a tremendous amount of time. and it was really just extremely labor intensive from having to have an extremely high skilled person doing the assembly. So that was kind of the way that it was before.

Keegan

And then what technology have you adopted over time that has changed the business and how has? It changed business.

Brenden

By category or product. Like do you want me to use the actual names of the software and the machinery, or do you just say, hey, this type of machinery or this type of information?

Keegan

You can go into… I guess let’s do category.

Brenden

So high, high level broad categories. Different technology that we put in obviously was the moving from CAD to you know more of a CA, a full CAE, so a computer assisted in engineering type of a platform instead of just, hey, how do we draw what's in somebody's head and put it into a physical form. So, we've invested heavily in software. With that software it led to technology

that was computer assistance for the shop floor, you know more literally wire by wire, component by component assembly instructions that pretty much anybody can follow very easily with minimal training. We've invested in CNC technology so that like I mentioned before it was very, very, very manual. As far as drilling, tapping, cutting the steel enclosures and the steel back panels. So, we invested in CNC technology that basically how we do that drawing, we could import that drawing and have the machine perform those functions. We've been invested in, you know, it's just a hybrid CNC. It's just a single axis, but semi-automated duct and din cutting. So, for like the wire way and the mounting components and things that we have a semi-automated machine that assists with getting those highly accurate. We've invested in a wire machine that takes the wire out of barrels, automatically cuts it to length, can apply the electrical fitting, and can inkjet print. So automated wire processing. We've switched from outsourcing. There's a lot of plastic phenolic engraving that's involved in our industry. So, we purchased a machine to be able to laser cut those in house instead of having to farm that out and be reliant on a third party. so, it allows us to be faster and more nimble. If there's a change in text or even sometimes the customer will drop by, “Hey, can I get a tag remade for this?” We can have no problem with it and make it in two or three minutes. So, we've invested in laser technology. We've invested in wearable devices to use some of the more sophisticated technology. Running tests on things of augmented reality and even just pairing augmented reality headsets with web browser capability. I have a lot of tests and I'm trying to figure out how to make that a bigger part of the organization. And I would say it's a technology of people would be our lean transformation.

Keegan

And then what kind of physical changes has that made to business operations overall? So, you know, for instance, before you mentioned it's kind of one person, one panel. And I know

nowadays that's changed to more cell-based manufacturing. Could you have made that change without investing in the technology and software you just mentioned? Or.

Brenden

Not without having the exact inverse response than that we did now. So, through the use of the technology and the systems, we were able to adapt cell based manufacturing principles and see a reduction in the amount of labor per unit. Had we tried to make that change, using the old systems, we would have seen an increase. And an example of that is with the cell base in the high computer assistance of technology, we actually just did it this week. We swapped one job. Three different people had their hands in it just for the core production. There was a fourth who did a door and a fifth who ran the CNC machine. And even though at one point we had one guy working on it. We switched priorities, so we moved two guys into different cell. Then later that week we switched them back and there was next to no handoff needed because the computer system already knows exactly where in the sequence that that panel was getting built. And so, as a result of that, there's not, you know, incredible handoff. If we were trying to do that from a manual print, that person would have to have the print. They'd have to sit down with the person, “Hey, these here's the check boxes. This is what's been done. This is what happened. Oh, hey, I put this wire aside because I had to ask a question on it.” With the benefit of the computer software is not only does the software know exactly where it is in the production, what has or hasn't been put in or assembled or connected so far, it also has things like the commenting feature. So, they can be on the shop floor, and ask questions of the engineers without having to ever leave the work site. And then the biggest thing is let's say there's 10 questions that were asked of engineering that they're waiting for an answer for. If we switched person or it switched from 1 cell to the other. All those questions would have to manually be transferred so that person

know who asked what. Go in this with the technology in hand. They just one person did it one day. The next morning the next guy just picks up. If a question comes back through, it's right in the software. If they want to review questions that were asked, all they got to do is remove the filter and scroll down. There's a little icon that shows whether a question has been asked. So again, anything's possible, but I really, truly believe that without the technology and software, a move to cell base would have increased our [production] times. Not significantly reduce them like it has.

Keegan

And the software you're mentioning, is Eplan correct? … How does 2D and 3D software affect your business? You kind of mentioned it before. How 2D kind of seems to be. I guess the dynasty and 3D is kind of the new and better version, but what are the benefits and drawbacks of each?

Brenden

I would say really the only drawback that I can see to 3D is if you don't have the part, or you know, if you can't download the step file or the 3D model from the vendor, which happens from time to time, especially in the industry we're in. When we first switched to 3D, we spent a lot of time building the 3D models for things that weren't available. So that's probably really the only drawback if it's not available quickly. Where in 2D you know you can just draw, you can get the dimensions off of a 2D print. And just draw yourself a square in the model on the flat and then figure out where your holes are and it's fairly quick. So, it's a little faster if you don't have, you know, a good starting place with a 3D model. Other than that, there's really not any benefit to 2D, in my opinion. Some of the huge benefits we see with 3D is being able to see things in full 3D. So, for an example of that would be, we put selector switches on the door of enclosures. On the

backside of that switch, inside the enclosure is one or more series of electrical contacts. And those are designed to be able to be stacked on top of each other. Well that basically changes how far that component protrudes through the front of the door. So, we had numerous times in the company's history where we had a box, and we had a very deep device mounted on the back panel. So that device was very close to where the door closed, and we had interference where when we went to add two or three contact blocks to the back to make the circuits work. Then, when we went to close the door, it wouldn't close because the two components were hitting each other. Well, when you can place those components in full 3D, all we got to do is spin the model around to the side, grab a measuring tool and we can pre-calculate exactly how far away that is. So, to my knowledge, since we've switched to 3D, we haven't had a single instance of that happening. And it wasn't huge, but you know it… it's just… it's different in 2D. It requires significantly more patience. Another example of 3D would be circuit breakers. We use a lot of which for it is a rotary mechanism. So, the operator for the circuit breaker is a series of parts that attach inside the panel. There's a rod or a shaft that extends to the door. Then there's a hole in the door and a component that mounts on the outside that allows you to turn that circuit breaker or that electrical power on and off. From that, without having to open the door. To do that in 2D, we had tried numerous times, even though early on we had a CNC machine and on 3D we've tried numerous times to get all the overlays and everything to really position that accurately. And we ran numerous tests. It didn't work, so we stopped doing it. I think we had maybe two products that we had dialed close enough that we could predrill that. So, an example of that is to do that by hand. It's about a 20-minute process. The advantage of 3D is all the components are there. They're all embedded so that the software is smart enough that you can change the opacity. You can literally see right through the door. So, for that, now we have all of those components in 3D,

so they're all highly accurate, which is impossible to do with 2D drawings. We can embed a mounting hook or a placement area. Match that to the 3D of the part that goes on the door, and literally as they drag it in from the catalog they hover, it says, “Hey, there's a snap point here, do you want to go down, you know, into the cabinet and attach it where that is down in the device? Or do you want to be aligned with that?” But all the way back on the surface of the exterior surface of the door with this component. So, all we do is click, yes, we want the door. And it's placed and now we can have our CNC machine drill those holes. And I don’t think we have had to do a single one. And that saves us, you know, 20 to 30 minutes plus just a lot of running around. There's actually when the ADS goes lean YouTube, there's one on there specifically about that function. And you know the guy who put the before and after video together aptly put the background music as the chicken dance when they're doing it the old way. Because it was back and forth between the shops, they had to go grab all these different tools. So, to do that manually was probably 7 to 10 tools. And like I said, 20 to 30 minutes. Where, now the machine does it, it already has all the tools, it only needs a screwdriver. They cut the shaft. They built a jig to drill the hole on it. So now it's maybe three or four tools and. 5 minutes to put the handle on so it's things like that, that the 3D really stands out in that arena because you can see it, you can feel that a lot less calculations are required to end up with a product that's accurate.

Keegan

Interesting. You mentioned augmented reality earlier. How do you interact with that in your business, and does it provide much benefit for you and or your customers? Because I know the concept or benefit of augmented reality just in manufacturing in general is it gives you the spatial footprint of how big something is going to be. So do you share models with customers at all so they can get an idea of how a panel is going to fit into their production line.

Brenden

Yeah. So, we do have a couple of customers that we do share the augmented reality functionality. You know, some of it actually spills back to your previous question of the power of 3D. So, because we have that full 3D, we're actually also able to export that and send it to customers. so, customers that are more advanced, just as the world is moving to 3D, customers who have a full 3D of whatever their product that our…. What we're building is going to control. They're able to take our step file, embed it right into their machine, and perfectly accurately represent the size, the arrangement. We do have one customer that's used our 3D models to help make harness lengths and things on their machine. So it is, it is pretty, pretty powerful there. as far as augmented reality specifically. So, our… when we saw the feature come available through E plan, the software that we use, my instant thought was, "Hey, this can help us with exactly that, right." that the spatial we can put a headset on, we can see the product next to it. With the particular software they were using, you had the ability to click on any component and it would give you the part number. So, at the time their production software did not have a mounting capability. So, it could step by step guide us through the wiring, but when it came to mounting all the components on the back panel it was still very manual. Now they have a whole software embedded in the production system that handles this. So, we don't need augmented reality for it. That was one of the first use cases that I saw of it was, hey, now we can have that spatial. It shows exactly where it is. We could, you know, if they turn their head slightly to the right, they see the one they touch and now they should know right to the left. We have used it on a couple of field retrofit projects where hey we can do the enclosure lineup, we can take it out to the customer, pull it up on the phone, the thing you have to have… previously you have to have a known measurement. So, you have to have some way to scale that augmented reality to what the

real world would be in order to really see it. But we found you, we just taken no measurement from point to point. We put a tape measure or something on the door. You can pinch zoom it to get it where it's accurate. You know, fiddle with it a little bit to get it into position, but then we can see things like hey, you know what this this cord drop that's coming out of the ceiling… You know it's going to go right through the middle of this panel. It's not headed behind it, so changes in depth, changes in height. We can look at conduit entrances we can…. see, you know, hey, if we put this here, you know, we got to come this far forward to avoid this beam. Well, the depth of this enclosure is, you know, you can instantly see what was there and what's new. So, you can see, hey, you know what it it's a little bit deeper than the other one. And then now it's, hey, it's going to come out to here. You can take live measurements. Hey, do we still have enough clearance in the walkways and things like that. Uh. Right now, because the technology is evolving, there's a huge cool factor to it. So, we use that, you know, in our sales and marketing side of things. If hey, we have this capability and it again, it's just something that sets us apart at this point. And I could rabbit hole for about an hour of potential use cases that I've come up with for it. It's just incredibly powerful. And like you said in your question it's that spatial Orientation. You're seeing the digital right over top of and embedded as if it was really there. And there's just, there's a lot of a lot of opportunity for that one another one that we've used for that is for one of our machines, we built out a full augmented reality step by step training guide for it. So, if we put a QR, we add a QR code. It would put a new person underneath the Microsoft HoloLens. Use its Microsoft Dynamics guides as a software we use, but literally the headset picks up that QR code on the surface and then literally step by step points them. Click here, move here puts holograms on the handle and they need to pull a certain handle. and we've successfully had three or four people that I know of have no idea how to run that machine. And We put them under the

headset, stand back and observe and within an hour or so, they're able to produce from the machine because it's literally step by step guidance and training. Another use case we've had for the same thing as you know, maintenance of machines. So, because the headsets are spatially aware as you move around. You can have instructions. You can have it where a person has to put their hand in a certain area, so you know the tool went there or that they actually took the step for it to augment to the next and again. It it it's. Instead of having to have somebody stand there and show it, you can build the journey out and then the person can go experience it and mixed reality and perform the task correctly, which is pretty impressive.

Keegan

Yeah, sounds like a lot of value is created within that specific set of technology. So, I guess the next kind of portion is more so kind of industry analysis to just kind of get your perspective on certain factors that affect your industry. So, the first one is, what political factors do you feel affect your industry the most? Could you provide any examples? This could be factors such as mainly just government influence, so government funding for certain like infrastructure projects and or government relationships. I guess abroad or across seas or anything where you can't ship product to or anything like that.

Brenden

Yeah, I think definitely all the above apply to the industry. You know, yes, there are certain types of technologies that are only allowed to be sold in certain areas. So, we do have a few customers that ship internationally. So, we do occasionally have to stay aware of that. You know that there's people in the same industry and all they do is export. so obviously they're much more in depth with that. for us particularly, we've built product that's ended up on every continent at this point, including the South Pole. So yeah, it's out there, but again, it's, there's more of a due diligence

process type to it than I would say hugely economically changing our business. You know, yeah, we see certain industries. You know that you kind of mentioned road bills and things like that you know. we do a lot in aggregates and mining. So right now, there's a road bill in place from the government that has multiyear funding for projects that are related to that. So yeah, we see those industries get strengthened by that. I don't know. I guess I would say I'm sure there's an effect to it. That there's not a tremendous, you know, we don't see the government, you know, really regulating crazy of the stuff that we get into. You know, the again the industry as a whole is affected by all kinds of different ones. You know, if you're selling a lot of products into food and beverage, there's a lot of requirements that you have to make that that frankly are politically influenced. You know, same thing. You know, same thing, if you're selling a lot of controls and you're doing a lot with power plants. There's a lot of extra power, you know, paperwork and systems and, you know, due diligence requirements. So, I would say a lot of those are sub industry specific more so than necessarily applying broadly to everybody across the board. But yeah, I mean there's certain. I don't know. My personal belief is somewhat unfortunate, but you know, lobbyists are lobbyists, and they get what they want, most of the time. But I guess I can't really see a lot of, you know, hey, this has been done and it was to the detriment of the industry. It's more just, hey, yeah from time to time there's different things that get a little bit of a boon from something like that. And I think that's most of what I see in terms of political influence.

Keegan

At least makes sense. The next one kind of ties into socio cultural, but basically, it's mainly just based on customer preferences. Do you see a lot of variability in those to change year to year or is there reasons for that change or?

Brenden

So, I guess I just want to clarify to make sure that I'm understanding and answering the right question. So, what you're asking is, do we see, you know, wholesale changes in what customers proactively come to us for is?

Keegan

Yeah, I think that could fit. It's mainly just kind of tied to lifestyle changes or societal values. So, I know a big portion is there's a desire of people to be more energy efficient. And so, there's a lot of new technology coming out within the industry with different drives and stuff that are more energy efficient.

Brenden

Right, so, so less customer preference, change more of? You know socioeconomical pressures that get applied, yes. So, it's actually, again, I'll go back to the aggregates industry because we're pretty heavy in that. Even here in the last year, we've seen a big uptick of quotes. centered around repowering aggregate equipment that's currently diesel powered, to convert it to electric to Get rid of emissions and things like that. So, I would say more of those environmental. Here in the Midwest at least, you know the power rates are pretty cheap. Honestly, that was originally why I moved out here was for energy efficiency tracking, you know, and to go after energy efficiency projects with the variable frequency drive technology. and really the power, it's a concern, but it's .06 to .08 cent power is cheap compared to… either you go to either coast or down South into Texas and you know you're going to be $0.18 plus per kWh. So, you're two to three times in some cases the power cost of what we have here in the Midwest. that that drives a lot of that right. And so, while there's a push in, you know, people like to be green and like to save and like to conserve, it's just the way the world's going. You know that they're in that case, there's typically also financial motivation to that as well. Not always. But, you know, I look at, like,

repower, right. I see that as much more of that. That that socio. You know it's. It's. The mindset that hey, we need to get better, we need to stop polluting the environment, we need… right. And a lot of the projects that we've quoted or been a part of for those, you know that the cost savings isn't even necessarily on the radar of the goal of it. The goal is to, hey, how do we get rid of this diesel? How do? We quit pumping this into the environment. You know, in some cases there's… Electric can be more efficient, so it's cheaper than diesel, but at least the feedback that we hear from the customers that we've been around is it's, hey, that there's pressure on the larger global companies that is, hey, we, you need to follow these mandates, you need to get better, you need to be a good corporate citizen. You know, so we see a lot of those that it's really not you know the money savings it's hey, you know we're repowering this device we're getting rid of this you know this pollutant or this headache. or you know a lot of even comes to you know the risk to the environment even not necessarily from the pollution from the diesel. but you know if this diesel is on a dredge it's floating in a pond. There's a hole in the supply fuel line. Well, now we've contaminated this whole water supply with diesel. So, there's again it's not necessarily a direct operational efficiency. So much is more social pressure.

Keegan

And it's one more question related to industry analysis, are there any regulations or legal requirements that affect your industry? I know there's UL LLC, I think they do some regulations. So maybe dive into that more or any other particular regulate regulatory bodies that come to mind.

Brenden

Yeah, there's a lot of them. and it's hard to name them just so the way that it's set up, you know everybody follows NEC. So, the National Electric Code applies to what we're building. So, part

of that is you, there's a requirement from that has been adopted through. So, each local jurisdiction. So, the phrase that's used as the authority having jurisdiction. So that can be a town that could be a county. So again, back to the aggregates. They're regulated by MSHA, which is basically the mining safety health. You know the mining version of OSHA, the government. And so there can be a hierarchy of hey, who really, truly has jurisdiction. So that plays into it because there can be subtle things that are different, you know, just depending on what version of code they have that local authority has adopted. can change you know, what the requirements in that local area are. So as far as UL, they're more of a standard than an authority having jurisdiction, but it's the language that gets used in, like National electric code. And M Shaw is. You know, electrical control panels must carry a certification from a national, nationally recognized testing laboratories or NRTL. And currently, at least for our industry, the two primary players in that are U LLC and a company called InterTech. So again, they're there not Necessarily a regulating body. But there are bodies that have inspection programs. You know that that really makes it UL underwriters laboratories. So, the original reason why it was set up was for insurance underwriters, right? So, if I'm going to go insure the building, I want to make sure that the electrical stuff that's in that building isn't going to catch fire or kill somebody. So, you well adopted and started doing testing and creating procedures for all kinds of electrical equipment and it was really to satisfy the insurance industry of hey, you know what, if you do it according to these codes, you know it really in most cases has nothing to do with whether the product actually performs. It's literally just this product going to create a safety risk to either life or equipment., so you know, like for our control panels that we do under UL, they don't care whether it functions or not. all they care about is it going to kill somebody or is it going to start

fire if it's assembled in a way that makes it not likely to do either of those. That's really what they're after.

Keegan

I guess to kind of wrap up here and now we've kind of gone over some of the technological advantages, maybe some threats or opportunities within the industry. What would you say is your competitive advantage or the most key important skill to have? because when I guess when I look at it from an outside view is I think adaptability is quite important. I think there's a lot of high customization stuff that can come through your door at any time. So having the resources available to support you in order to fit all your different customer Needs. In my opinion, seems important. Maybe elaborate on that of what you think is the most important skill to have in this industry.

Brenden

Yeah, probably adaptability or willingness to embrace the fact that the industry is changing. Actually, recently did a LinkedIn post on this that just to cement the thing that you utilize ChatGPT to help force it through, right? Just to show hey, I put the things in, I gave it certain prompts. I told it to include certain things and then I let it write the whole thing for me, you know and not was it just hey here's a blog post that was put out. Also, what the substance of the blog post was. You know, the reality is this industry, and a lot of other manufacturing is moving from your craft style. You know, you need a highly skilled person. That person typically views their job as almost an art form. You know, they're very, very passionate about, “Hey, I've, I've put my, my heart and soul into building each one.” That's great, right? That's. When you have to build the hardware, those are the people you want. Now that technology and systems and automation and you combine it with culture, you really don't need any of that to still produce an

equivalent or an often case is a better. Product. Now we're in more mass production and so now it, you need a different set of skill sets. You need a different set of people. You need a different set. Your manufacturing operation has to be very different. and I really feel that the people who don't see that and who hang on to, hey, this this is really craft and it's an art form and we need to keep the art form still. unfortunately, on a commercial side, unless you get a crazy product, you get a crazy margin on that type of production is going away. and it's driven by technology and the systems and the machines. And it's really… You know, even for us, like I mentioned at the very beginning, right, we're an engineered to order company. We do build some things more than once, but there's a huge variability both in parts count and function in size to everything we build. and the systems and technology allow us to do that in a plant that's flexible, but it doesn't matter whether it's, you know, a 12 inch by 12 inches by 8-inch cube or it's a 72x72x18 cube, right? It goes through the same process; the same technology can be used from tip to tail, and the benefits are still there. In my opinion that the people that hold on to hey, I need to protect this. I need to, you know, this is an art form. I'm not going to embrace this technology because it's going to. I've had a few people come and talk to me and they're like, “Oh, don't You worry it's killing the industry?” I really don't, it's changing it. For us, we have a product that we've documented 58% labor savings as a sum of everything we've done. There is no possible way in a competitive environment you're going to overcome the guy down the street who can do it 58% less labor than you. There is no way you will compete and stay in business. And I think right now it gives us a huge competitive advantage because we're doing it up to 58% faster. and we can still get the price point of the product is still quite high because it's still viewed as a craft. You know we have way better flexibility when it comes to price competitiveness. You know, I'm not aware of ever losing a job to price, if we get into a thing and we really need to tighten the

belt, we have way more margin to play with than somebody who has 15% more labor and you know at some point it's, you know. Through the lean learning we've done, we've learned that you know the level of quality is really as hey, does this product meet the demand of the customer? And so, the example we use through that is, you know, a plastic fork, right? There are all kinds of grades of plastic fork. You go to a real quick Chinese food restaurant, they're not selling you the fork, they're selling you the food. That's the flimsiest, flimsiest plastic fork. We got well, now I want to go have a wedding and I still want to use plastic cutlery because I don't want to deal with the dishes, and I want something that's going to look like I would want at my wedding. Right? There're companies out there who make plastic forks that are chrome plated and all kinds of stuff. functional equivalent to eating one meal. It's the same as if you were using steel, right? Both of those are. Quality for the demand of what's needed, right, that the Chinese food restaurant isn't going to spend $1.50 on a fork. Well, hey, when you're looking at a wedding, $1.50 is a lot better than $10. Right to have a metal or a silver one for one-time use. And so, when the technology is allowing hey that that that acceptable minimum quality or the acceptable performance quality… It's not the art form. And again, yeah, there's all kinds of subtle ways. Depends on how you implement the technology. There's, you know, nothing's a free, nothing's perfect, there's trade-offs in everything you do. But again, for us, we're producing what I feel in my opinion is I'm significantly more high value product. way faster, way less expense and the companies that don't participate at some point are going to be left going, "Man it, it sucks where all my customers left."

Keegan

Makes sense. I think that about wraps up the interview. Thank you very much for your time.

C. Transcript of Interview with Kim Schroeder (EPlan)

Keegan

If you would like to start by stating what you do and talking about what your company does to start?

Kim

Absolutely. My name is Kim Schroeder, I am the sales manager for Midwest. I have been with EPlan for five years. Eplan is the global leader of electrical engineering design software. Now, what that means is we provide software to engineering groups. We probably have close above 80% market share in the European market and we are growing like crazy here in the China and & Pack APAC and the US market.

Keegan

Thank you. First question, how does your company believe their technology is changing the industry?

Kim

This is a very loaded question, but you are working with the right company because there is no doubt that Eplan is changing the industry. Currently, the marketplace for electrical engineering is designed in what we call a CAD system. And when I'm talking, I'm talking specifically about the United States. A CAD system is a manual, mechanical tool. CAD stands for Computer Automated Design. Now, what is funny about this is that it is not automated at all. Eplan is a CAE system or a Computer Aided Engineering software tool. So now when we are building things, the main goal is to produce and make money doing it. How can I make it less? How can I make it of the highest quality? How can I make it faster? And how can I make it less expensive for me? So, two things here, time and money. Kind of the same thing because time is money. So,

I believe & here at Eplan and I would say Brenden Fritz believes that Eplan is absolutely changing the market. because when you go to bid on a job, and I'm going to use very generic examples here. Let's say Betty Crocker wants to make a new mix, new pancake mix or they have an increase in how much pancake mix they're selling because nobody's making it from scratch anymore. So, they need to put a new line in to make pancake mix that… You know, they can essentially box up and put in a grocery store. They need to hire a, you know, an engineering firm to engineer.,. to look at their plant floor, where we are going to put this line. They need to hire what we call an OEM, an original equipment manufacturer. To say who's going to make this machine to bring all of these powders and we'll call them materials together. And then they also need to hire possibly a panel shop like ADS. And then they will also need to hire a system integrator. A system integrator is the person who says, OK, you've found the space on your floor to put the new machine, you found the person who's going to build them at new machine. You found the panel shop who's going to build the controls so that the machine mixes and pours powders and does everything together that it needs to do and then has a conveyor to put all of the new pancake mix into a plastic bag and then box it and package it up. The system integrator is going to say OK, how do I have this machine on my network? Umm, so those are, let's call the operator, Betty Crocker. Let's call them the OEM, the person who's making the machine, the panel shop who is building control panels for the controls and the system integrator who is making sure that the system works on the floor. Eplan is valuable at every single step of the way. One the system integrator, we automate things like programming PLC's. This tells… this is just a smart computer that says, hey, pour this much powder into this mix these five powders together and mix them up and that's how we make our pancake mix. So, the system integrator is programming, PLCs like at all day long. They're also going to have programming of level

switches to say I need to make sure I have this many ounces in this bag because that's how much I'm selling this for. The OEM's going to use us because they want to standardize their electrical schematics to make sure that every machine that they build like this, whether it's different or not, they're bringing power in the same way. the panel manufacturer is going to love us for things that you've probably seen at ADS like smart wiring and automatically feeding machines, or what we call capital equipment information so that they could build the panel quicker and more efficiently and less time and for less money. and with less skilled labor. Then the operator, let's say Betty Crocker of this is going to like us because what do they care about? They just care about that. The machine works. It does what it's supposed to. It's on their network and then if there's a failure, they can easily fix the failure so they can keep making pancake mix. Umm EPlan is a digitalized system, a CAD system like AutoCAD is an analog system. So Eplan is data driven. It has logic in it. We build from the top down; CAD systems build from the bottom up where there… it's like a paint tool. Umm, I'm sure you use Microsoft paint in your life where they're just dropping electrical symbols, drawing lines, and creating a picture of what electrical schematics should look like. Eplan is not doing that. Yes, the outcome is going to be a similar picture. But behind that picture is all the logic of everything we're doing. So, I know every circuit breaker, the electrical properties of it. I know every drill pattern for everything that goes inside my back panel. I know the length of every wire when I'm connecting a device to terminal, so the reason that we're changing the market is we're offering people a way to bring automation into their business. Umm, so you know, just like a car wash, you know, can I drive through the car wash where I have machines do it all for me or do I have five people scrubbing down my car tires? What's going to be cheaper? Well, in the beginning it's probably cheaper to hire five people, but if you want to be in business for a long time, investing the money for the automated

system and letting it run by yourself, now you have no people and you have robots doing your work. And that's essentially what E plan is doing. It is a big computer database that does your work for you. So, did that kind of answer your question?

Keegan

Yeah, for sure. I just want to get a little clarification on one thing. You said CAD is an analog system, could you maybe describe what an analog system is?

Kim Schroeder

Yes. So, an analog system is going to be something that does not have logics behind it. Umm, as opposed to so, think of your phone as a digital system, cause it's a smart phone. When I make a call from my phone, I can go to my call history and see that call and then think of a pay phone as an analog system. When I make a call from that pay phone, I don't have any record of that on the machine. You know, I would have to go to the phone company and even then, you know, that might live in a cloud that might not. So that's what I'm going to mean by the difference between an analog versus a database driven.

Keegan

Makes sense, I guess just for clarification too. So, when you say E plan is more of a CAE tool, could you also say that it does have CAD features into it with the 3D modeling? And, I believe in 2D modeling.

Kim Schroeder

Yeah. So, it does allow you for 2D layout. Modeling by nature is a 3D word. When we're talking about this, umm, what? I say that it has CAD features in it. Of course, yes. Can I grab a symbol and draw a line absolutely? Is that where you're going to find the power behind the system? No, you want to use the system in every way that you could to automate your prop process. But yes,

it is still going to offer you everything that AutoCAD electrical offers you now AutoCAD as a whole is made up of a bunch of companies, Autodesk, they call them. So, it is a very good mechanical tool where it does have 3D modeling and a program called Inventor and Plant 3D. Uh, we do not displace them. We do not interrupt their marketplace whatsoever. Those are mechanical tools, and we only are in electrical tool. But yes, we do have CAD, umm capabilities as well.

Keegan

Umm yeah, I just know through the research I've defined CAD as mainly just being the ability just to do the design and some features to help with design. And so, I guess high level view, when I look at Eplan, it seems like both. But even Brenden called it CAE and the different CAC and CAD and kind of like what you said, they're kind of they're two different animals. But I think CAE builds off a CAD, but it just has a lot more features to actually automate it more.

Kim Schroeder

Umm yes. Although CAD again is a design up approach, so you're placing symbols and lines and then maybe you can add logics as ECE or a database driven software is top down. Where I already have the logics coming from the part and I'm just representing that with a symbol. OK.

Keegan

So, I guess the second question is, how easy is it to implement your software into the manufacturing process? What does the timeline look like from beginning to full implementation and kind of a follow up question to that is what resources are available for training?

Kim Schroeder

So, implementation we like to do within 90 days now. You asked me something a little specific towards manufacturing before we can talk to the manufacturing floor, we have to learn how to

design engineering within the program itself. This could take up to 90 days to learn how to do a project. Now, once we have a project inside of Eplan, in order to push it to manufacturing, I think your learning curve is much less. So, let's call it another 60 days. 30 to 60 days let's say now like anything you use that is new to you. That effort and time you put into it is going to be a direct result of what you get out of it. So, if you go into training and then don't touch the software for two months, you know this isn't a good implementation. But typically, we like to say that we wanna make you as efficient as the day before you bought E plan within the 1st 90 days. Brenden might not agree with that, he had a different implementation, but we have since, umm, moved our implementation. We have design, we have created packages and created consulting packages that really help mature your environment and in a quick way. So, umm, we do not sell this software without a training period. So, every person who buys E plan is also purchasing training, and then we typically do not soft sell the software without consulting.

Keegan

The next question is trying to achieve max efficiency in a control panel shop. Can you do it by only implementing software or does it help to have the software and the automation work together and support each other?

Kim Schroeder

OK, so the keyword there is Max efficiency to have max efficiency. It is the best practice to implement both. Umm, you don't want to umm, because now you think, OK, great. I have this great software tool and it helps me cut down my design time so much. Umm, but I'm still manually producing things like making holes and back panels. Umm, that's not going to give you Max efficiency, so anytime you can replace a manual process with an automated process is where you're going to create Max efficiency. So, I would say for Max efficiency both. But on our

website, just by buying E plan, we can increase your efficiency 40%. In engineering and production. Now that is not to say 40% in engineering and 40% in production. Just if it takes it takes you 100 hours to engineer and produce. Then we say you could do it in 60 by using just our software.

Keegan Kenney

How would you say your technology affects the ability to share data across the organization, both on an individual human to human level? But I guess also from a computer to machine level.

Kim Schroeder

Sure. So, I think we've disrupted that process in a in a lot of ways we offer what we call Eplan cloud solutions. Typically, when a project is umm, you win a project, and you are tasked to engineer and then produce. There are many tools being used to get that process done. You're using word, excel, PDF, uh, step files. You may be using a mechanical tool, a DXF or a DWG, and you're also using email because you have to communicate all of these things to say, hey, this is how I'm engineering. Is this what you wanted? Nope. Changed. It's changed this. People change their mind like crazy, and the Eplan solution. It's all one platform. You can upload it onto the cloud. Your bill of materials there, so that eliminates excel. There's no DWG's because everything lives on the cloud. You could run line. You can do all of that. So, I would say we are disrupting that market. But the end of your question, what was it again? Because it was a little different than the beginning.

Keegan Kenney

Umm. Communication between person to person and then also from the engineer to machine. Yep.

Kim

Person to machine. OK, so the communication between person to person because of an automated system and we can offer that level of automation, we can eliminate the communication between person to person and just communicate with the machine and we can have a direct communication. So, I can send right to the machine. Hey, these are where I need my holes cut out in this back panel. All I need is that person to put that piece of metal into the machine and the machine takes care of the rest. So, I would say we're changing it by minimizing the communication between person to person and maximizing the communication between software to machine. Or we're eliminating the communication between person to person. In addition, we're not using six different tools to get the job done. You're just using one platform.

Keegan Kenney

Makes sense. Uh, how does computer, how does CAD, CAE and computer assisted manufacturing tie into your software package?

Kim

Computer assisted manufacturing, so I would say computer assisted manufacturing is just the output that CAE allows you to give. So that ties into our system because again, what we just spoke about, you can eliminate person-to-person communication and now you can have software, or the computer talk to the machine directly. And then if we're talking about smart wiring, this eliminates expert level tribal knowledge on the plant floor because it gives you a a full proof system where you don't have to be an expert. You don't have to have a ton of experience and you can wire a panel and there's two technologies for this. There's smart wiring and smart mounting. One is wiring a panel, and one is mounting products on a back panel. You also mentioned Ebuild. Ebuild is a tool that once you create your environment within an E plan system, you can create a Configurator. Simply how you can configure you know anything and

just click buttons and it will actually draw all of the macros and all of these schematics and create them for you just by hitting buttons.

Keegan Kenney

Uh, the next question is what are the benefits of implementing your software? These could include minimization of defects, time savings for production, efficiency rates, etc.

Kim

So, the benefit of implementing the software is you will be more profitable. Uh, you can go to production quicker. You can produce quicker; therefore, you can take on more work without hiring more labor. So, your time to manufacturing is decreased.

Keegan Kenney

And then the last question is a bit of an open ended, just kind of your best guess for the future. What is your best guess for the future of the industry?

Kim Schroeder

Uh, the future of the industry? There is no chance that the industry is not going to a database driven software. CAD will be eliminated because as people become more automated, they'll be able to quote jobs cheaper and make them faster. And then other people will start losing their jobs. And then when they lose jobs, they can no longer stay in business. So, the sooner you get on board, the sooner you protect your business as we see this market shift in the US happening.

Keegan Kenney

Make sense. Those are all the questions I have. I have to really commend you because you explain things and I've been working with Brenden for a year and just even just your definition for the control panel process and really how it fits in, you painted it in such a simple way. That's like the first time I could easily understand it, like fully understand what a control panel is and

how it fits into the process. And so just a lot of the data you gave or the answers you gave were very great and throw and simple, which I appreciate because then I found out the industry is a bit more complex than I originally anticipated and understand.

Kim

Yeah. And I'm a salesperson. So anytime you talk to sales, we're going to take it down a notch. And when you talk to engineers, sometimes they get in the weeds on things, but I appreciate the feedback.

Keegan

Yeah. Thank you very much for your time. Hope you have a good rest of your day and yeah, it was greatly appreciated. I greatly appreciate the insight.

Kim Schroeder

Alright, thank you, Keegan. Good luck with your paper. Let me know how it goes.

Keegan Kenney

Thank you. Will do.

D. Transcript of Interview with Patrick Stepanek (nVent)

Keegan

Alright, so just to formally introduce myself, my name is Keegan Kenney. I've been working at ADS for little over a year now. I'm a senior at the University of Nebraska at Omaha and for Honors paper we get kind of pick and choose what our final big project is. And uh, just seeing some of the technology we use at the shop and everything, I thought it'd be really cool and fun to do some more exploration into it. And so that's kind of the whole inspiration kind of the gimmick and kind of the whole main point of the paper at the moment. How is technology changing the industry? And because there's a lot of new innovation emerging, and yeah, it's really taking it from, I guess, an art is kind of a parent. And I talked about in our interview how it was perceived to be an art and how it's more kind of a manufacturing just because there's so many things that make it way easier and eliminates a lot of the, you got to really know what you're going to do it. Umm so I guess to kind of begin, do you mind introducing yourself kind of telling me a little about what you do, the company you work for?

Patrick

Absolutely. Patrick Stepanek. I am the business development manager for Nvent, Hoffman. Well, used to be called our Steinhauer division. For I'm kind of the expert on all the machines and the sales guy for North America. So, my territory is United States, Mexico and Canada. Ah yeah, I kind of handle all the panel shop automation as it sits in our company. And then, like I said, the machines also handle the logistics of getting the machines here because we shipped these guys from Germany.

So logistics of all of that and you know everything else as well.

Keegan

Very cool. So, first question is can maybe go into a little more better detail of the automation and software you guys provide in terms of for control panel manufacturing?

Patrick

Absolutely. How much information do you want? We can get pretty in depth. We can get umm set up. So let me pull this presentation up for you might help a little bit to walk us through it.

Keegan

Sounds good.

Patrick

Can you see my screen? And I don't know if this is recording this as well. I would assume it is ohm if the if you need this as well. I assume it records the whole thing as it sets up, so let me see share share share. Hold on a second. Let sharing properly. Am I sharing the screen and then put the screen up there? Is that showing you my minute? There you go.

Keegan

Yep.

Patrick

Is that showing the screen? Everything's good. OK. OK, let me step through. This is our portfolio of machines that we've got out there. So, we've got a CNC control device by the way, you got all three of these at your shop, or at least a portion of all three of these setups at your shop. So, we have a mod center, and we have four different sizes of the mod center. Depending on the size of enclosures, you guys need to cut. This is made for cutting your enclosures, cutting your back panels, cutting bus bar, din and duct. You can also actually DIN and duct gets exported into the

NC cut, but you can also cut those things on it as well. A lot of our customers, I don't know, I think you guys do cut a lot, a lot of other things on the NC cut besides that, they cut prototypes out of it would sometimes all kinds of different things. I've got a customer actually doing tempered glass. If you can believe it. The machines precise enough to cut that. Umm, the second part of our machines, our NC cut, which is our den industrial, you also have another one of these guys. Umm Brendan said something about you are interested in the software as well. Maybe a little bit.

Patrick

Basically, the input on the Mod Center takes and you cut all your back panels and that's all your your holes and your cut outs for your back panels. If you're familiar with what I'm talking about, that relationship, that data is exported directly to the NC cut. That particular thing the NC cut takes that information. It nests it is what we call it, which means it combine jobs. It can do single jobs and then where the NC cut helps you is actually it kills the waste off on your din and duct rail. Most of the shops that you see out there and you guys were in that category have a manual cutter and typically the guys cutting off 18 inches, 20 inches, 25 inches and there's a lot of waste involved in that typically missed cuts, the wrong range of cuts. And then not the exact cuts. This automation piece eliminates all that and it saves you money cutting those things precisely. Then we also have wire machines, couple of different wire machines. We have a manual wire machine which is basically made to set next to the operator. We have a semi auto which basically prefer provides the wire and everything there and then it prints on a label and then we have the PWA 6000 which is the one you guys have got in the back of your shop on the 6000 prints on wire it bundles. It's basically a set and get set and forget machine and it gives you the ability to basically pump you out a wiring harness for your wires to be able to land them inside your inside your

panel.

Keegan

Very cool. And are you currently developing a software package that is similar to Eplan?

Patrick

Yeah, we have a direct to manufacturing software which provides that same information, same thing as you've got in your E plan software. Ohh, there's a few caveats with a few differences and all the machines have a software based to them as well, so the Mod center is more of a 2D cut, so that usually typically a DXF or DWG file inputted into it. But if you have those parameters out of your E plan, you can also import those out. There's a bunch of different software you've got. EPLAN is a big one. You've got one called XAO, which is another company called Snyder Electric. Our version is called direct to manufacturing software and I could show you a little bit of that. Bear with me a second. Ohh, I don't actually sell the software package. We have another expert that does the software, so when you do the software… OK for like a wire machine, you have the ability when it inputs in to be able to show routing on your on your wire itself. You guys have a version of this kind of, I think you guys do virtual goggles which teach your operator where to land the wires and then your software package. Let me get to it. Bear with me a second. Ohh looks like this. That's actually Eplan here. This is our direct to manufacturing software. This one here is a Schneider software. Umm. And then that's actually bear with me a second. Sorry, that's the different software packages. So you got a bunch of ecad ones. IGE, Schneider E Plan Pro panels which you guys use. That's from a tall we are DTM software which is our engine is actually called ZUKEN E3, which has been out for a while, and we just adapted it. Zuken was really big in the in the wire harness world, so I don't think you guys mess around as much with the wire harnesses, but if you have a manufacturer that does stuff for like General

Motors, those type of guys, they make big giant wire harnesses for the trucks for the different cars. And that's where Zuken was big. In fact, the last F-150 was designed on the Zuken software, which is our new DTM software. So, and then there's other ones called like WS CAD. They're kind of their stand alone and there's just a bunch of different ones. And then, like I said, they provide all the information that inputs. So, you've got source destination, what type of wire you're using, what type of print you're printing on the wire, what color print you're printing on the wire, how you're terminating the two sides of the wire. So, you have different terminations for that. Again, what the length of the wire is, and then also how often because that's a new feature on your machine. You want it to print our machine features. Now a print all the way along the wire which you guys like because it you know when you go through the manufacturing process, when you land the wire or have to find the wire after the fact the the the better the printing on it or the labeling on it is better makes it better for the panel shop to refine it. If you have a, if you have an issue on it. Also, in the landing of the wire.

Keegan

Very cool. Thank you very much.

Patrick

No problem.

Keegan

Uh, next question is how does your company believe that they're automation and software development is changing the industry?

Patrick

Well, the problem that you've got out there now and we it's something we've caught up with, this has been a big deal in Europe for a while, is that we have very little labor and right in anymore.

So, it seems to be a big problem with labor. Like I said, you guys have gone through and figured out through E plan that not only can you load the wires and put them into the machine quicker, but you can also train people quicker. So that's something Brenden always states that he had taken his average time to to bring a guy into the panel shop and actually wired the panels was about two years with the software added package. We can usually make somebody dangerous in two weeks. So, you can see the difference in not only, you know, supplying different things. Our machines also help with the labor help with the accuracy, because now there's specific projects that Amazon is a big one that have specific projects for accuracy even on the cutouts and the whole cutouts for it. So, to be able to achieve those cutouts, it's very difficult to do that with manual tools, but our machine is 1/10 of a millimeter accuracy, so it's able to do that three pretty accurately. So, but again, waste is a big thing. Labor a lot of guys have issues sometimes cutting the… cutting the enclosures, the safety part of that where you are cutting enclosure and it's very sharp and guys would cut yourself on the enclosure. All these things kind of play into it, but like I said, the cost of waiver is going way, way up. You have to pay the employees a lot more. Wow, this these machines really help with that, but it's just really lack of lack of total labor. You really can't find people. Most panel shops will tell you it's very difficult to find good quality people. To put it in the shop and then to be able to train them or have that skill set is kind of a dying breed, unfortunately.

Keegan

Yeah.

Patrick

So Europe is even worse, where they even have, like engineers wiring panels. And these guys are making a lot of money, a very big salary. And then, of course, if they're wiring panels, that's kind

of, you know what I mean, that's a big waste of of money in some aspects, so.

Keegan

Yeah.

Cool did not know that.

How easy is it to implement your software and automation into the manufacturing process? What's kind of the timeline look like from beginning to full implementation?

Patrick

OK, two different things. So, you're looking at if you're looking at our software that we do, you're pretty much moving right into it. So, for like the mod Center, the Mod Center only needs a DXF or DWG and if you already have those files drawn which a lot of shops do, you would just be actually putting a layer on to it a layer onto that would take you probably 10 or 15 minutes to be able to load that into it. Ohh same with the wiring machines with the wiring machines can be manually processed so you can actually dial all the things in, or you can actually use an Excel or a or a CSV file or you can use your routing software. Now routing software implementation and usefulness is varied EPLAN. From what I've understood, is very very difficult to work with, so it takes a lot of time to do it. You're talking… I've had guys that say it's a month to six months to implement that our DTM software because we've simplified the features and things on it. It's not quite as it's not quite as, uh, robust as your E plan, but it's easier to use. So, we claim that it's gonna be anywhere from 2 weeks to about a month and 1/2 to get the customer up and running on it to be able to draw on the software and be able to do it. And then the software. If you know anything about the software provides all the symbols, all the pieces, all the parts, and it becomes a drag and drop. The software can't even at some level, route the wires for you. So, if you put it in there and you tell it the wires and the pieces that goes to it, it can self-wire it for you. That's a

feature that we have on our machine. I believe you’re; I believe Eplan has that feature as well to be able to cycle. Software based on your pack fill right or left. If you want wires, if you're familiar with that.

Keegan

Yeah, very cool.

do you think to achieve Max efficiency you can do it by only implementing software or technology automation or is it kind of you gotta have both to really see the full benefit.

Patrick

Well, it depends on the machines. If you're talking machine related for the Mod Center and NC cut, that's a 2D file and it's really designed to work with CAD. So it really is not necessary to run the E plan. It is a great or you know the others routing software. It's a great addition. Now when you get into the wiring program and the wire machine, that's a different animal. You almost need the software because the software itself gives you the ability to be able to cut your time in half and cut your labor, and also cut your cost in half. There was a couple of things you need to factor when you do a wire machine. You'll notice that when you did as I actually got pictures from your shop, you've got different things like this where you're pulling from your wires. Typically, when a guy is doing basic wiring, he has a rack that looks like this and he's only using small amounts of wire. When you go into the bigger machines, you're going to use bigger bundles of wire and then the cost of this wire is roughly about 1/4 of what it would cost for these fools because they're very expensive to buy them. Small quantity. You buy them a large quantity to become a lot less expensive. OK, so I also even offer an ROI to my customers. I could give it to you, which actually factors in your amount of jobs, and then if you use routing software, regular pieces, or if you're using just manual input on it and it gives you kind of a labor rate and how much money

savings you've got.

And I've got ROI's for the mod center.

And then also for the PWA, I could share with you if you're interested in that and that information like I said, gives you a lot of a lot of good information because what we're looking for when we're selling the machine is you have to justify the cost of it to the customer. And then typically the ROI, how long will it take for me to get my money back when I put one of these machines in place, the typical time frame on an NC cuts about three to six months. Mod Center is about 6 to 9 months and then the wire machine is kind of a mixed bag because if you utilize it a lot you could probably get your Roy out in six months if you don't use it, it might take you two years.

It just depends because the IT has the capabilities, but a lot of our customers don't use the full capabilities of the machines even when they buy the machine that way.

If that makes any sense so.

Keegan

Yeah. Umm, how would you say your technology and software affects the ability to share data across the organization?

Patrick

Uh, it's, uh. They're all designed for that. It’s really good. We basically network these machines for a couple of different reasons for also share data because we have a lot of customers, caterpillars, a good example, one of the guys that we've sold where they have a facility in Georgia, they also have two facilities in Tennessee, and they share the data between the facilities. So, they might build a prototype in Georgia and then ship it over to another facility. And so, they're doing that all off the Internet.

The machines can work with that. We also network the machines as well for troubleshooting, so our troubleshooting guys. You might even been involved or seen this at your shop if you have an issue. Our guy will dial into your machine. Check your software, make sure it's not a software issue. Check some of the problems with it. Make sure it's not a hardware issue based on what the machines kicking back to us and work it that way, so the networking really is a is a really valuable thing for our machines. It also backs up your files, so if you're doing different jobs, you can back them up on a cloud that we provide to be able to back up all your data to use it for different jobs. Most customers have their own cloud, but we do offer our cloud as well for them. So, they can dump in their files and go that route. Most customers don't use our cloud because it's more of a how do you want to say a proprietary thing? They're kind of worried that we'd share, and although it's their own private system of ours, but still, they're more worried about that particular thing, if that makes any sense.

Keegan

Yeah, I mean sense.

So we kind of touched base with the machine specifically like the the CNC machine, how it's CAD software 2D and then within the DTM look like there was some 3D modeling, but is there any computer assisted engineering and then computer assisted manufacturing at ties into your DTM software?

Patrick

Uh, the DTM software does give you. Yeah, your your chance to route, go through everything and then put it through the machines are more basic software because you're taking that routing software and then extrapolating it. The Mod Center is a is a different animal and let me go back to that presentation. Bear with me just a second. When you get into the software on the Mod

Center. And this also varies too, because you guys have got a bit of a legacy machine. So, you may not see all the pieces and parts on your machine. If you were messing with it, but basically, we have a CAD software built into it called Ares Commander. OK. I believe you guys use your E plan and import it in, but you can use the software on it and then you're just importing a DXF or DWG and then we also put a full symbol library that has about 12,000 drawings on it so that symbol library has Allan, Bradley, Hoffman, Rittal, Siemens.

But all your drill holes, thread holes, ducks, all that stuff. So, you can do a drop of a drag. Like I said, I don't think you guys use it for that, unless you're doing a basic cut out and you wanna do it quickly because you guys go back to basically the routing version of it and then it exports that into this software that we have called CE4, which is our, we call it our customizing expert, that is the software part where it tells you how to how to mount it in the machine, exactly where to put it. And then this also is the software that calculates all the speed and feeds feed rates for your machine. That's another really big caveat with our machines. Instead of just buying a CNC cut device, this machine gives you all that information and then your operator does not need to be a, you know, a typical CNC operator who has to calculate all the speed and feed rates. They're automatically calculated. This is also the software that kicks out to the DIN and duct rail and self calculates for the DIN and duct rail. Your software package kind of looks like this. And this is actually your speed and feed rates. If you look at your machine, you can go to steel stainless and then everything is precalculated. You can't change that, but it's precalculated, so the operator does not have to calculate all those things, which is really huge in the manufacturing facility. The software also has an error checking device in it where you put all your different pieces that you got to cut. So, this is all your your drills, your threads, your Millers, and then it compares your software in the software. It compares your whole cut outs to the tool and then it'll kick back and

say this tool is not properly set up. That software also has an importing device and this is where you can import your different files. You see your Eplan P8. That's the stuff you guys use. You can dump it right in the E3 panel is our zuken and then we have a basically a piece to handle anybody software built into it all that converts it back to a 2D file. So, let's say you're doing a 3D file in EPLAN. It will convert it back to a 2D to be able to export and onto that and and be able to put it in the machine language and then that figures out all your machine language to do your holes and cut outs.

Keegan

Very cool.

Umm 2 more questions.

The next one is kind of flurry with it throughout, but it's one of the benefits of implementing your software.

These include minimization of defects, times, savings for production, cost reduction, uh short ROI too would be another great example of it.

Patrick

Uh, I would have to say based on your question, it's doing all those things.

Obviously it's doing your ROI back, it's doing it's cutting down labor because of the fact of, you know, you're being able to cut these things in a 15th of the time and you guys, I think you guys cut holes currently or did them yourself. This gives you a little chart on the speed difference, and this is usually in the in the software where I asked the guys, well, how long does it take you to cut 1 hole and then if you did a full panel door, typically a guy that would be cutting a panel like this say on a stainless steel, this would take an operator or a shop typically three or four days to cut it out. And this machine can do it in 66 minutes, depending on your speed. If you're doing

this in mild steel, this may take your guys 3-4 hours, maybe more, and it's about 11 minutes. So, you can see the speed really is huge. Now the accuracy this machine as we talked about before is 1/10 of a millimeter and there's no way unless you are Rembrandt with a, with a cutter to be able to do it anywhere close to that, the holes are armish machines so well that actually they don't have sharp points on them. And when we cut, if we have paint on the outside, we don't disturb the paint, even cutting it. So it's kind of a, it's kind of an amazing cut the way the machine works and the and the accuracy that the machine gives you with that on an NC cut, it's really saving all your materials. That's where the NC cut helps you there and then on the wire machine. It's kind of 6 of 1 back to the other. It's usually labor for pulling the wires because that's very labor intensive, and then it's also the materials as we talked about the materials, whether you're supplying the materials and getting it cheaper and then putting it to the machine. And then it's a set and forget machine. So basically, you set it, load it, have enough wire to it. It runs till it stops running. Basically, till you run out of anchor anything else so you can imagine the labor savings with that particular thing implementing that.

Keegan

Yeah.

So the last question is kind of more open-ended kind of just get your opinion, what is your best guess for the future of the industry, any challenges that could be become prominent and or opportunities?

Patrick

I think that every small to medium panel shop should have our machines and that is a lot of panel shops out there. I don't remember the exact number. You could probably get that from Brenden. I think Brendan had the exact number we were talking the other day, but there's a lot of different

panel shops that need these particular things. And then as we go, as we evolve as a company, we bring in more stuff. So as an example, the direct to manufacturing software came about when we realized that most of these companies didn't have the ability to be able to push the data in and really do it economically because that DTM software not only same as E plan, it not only gives you the ability to dump it in these machines, but it saves you the labor of putting it together. You can also export a file that goes right to purchasing so they can order the stuff. You can get exact in that, so you know the exact amount of wires and it really saves you a lot of money. Well, I see the automation industry going crazy. And then, like I said, as we go, we add a lot more information. So, we're looking at tilt tables. If you're familiar with the Tilt Table now, looking at different machines, looking at bigger machines, more powerful machines that can do more wires. Ohm, you're seeing a lot of Times Now that some of the bigger shops have gone to a second mod center. I've talked to Brendan about that. So, you get into the second one and maybe a second wiring machine to be able to process more wires. But yeah, I see us getting more and more automated. I also see the wiring part of it going to robotics eventually, so you won't have a guy actually landing the wires anymore. We've already got a couple of those if you want to Google them, they're out there where they've done a couple of things. We actually are working with a university and Germany's. That's where Home Office is at working with some of the robotics on the thing to be able to do some of that. Uh as well and some of our competitors have done that as well. We're all some of those guys are working on the robotic side of it. So I see it evolving into possibly having robots building. You know you've got articulating robots that can move arms and do basically everything we can do to enhance degree. I see it going there and then as our company goes there just automating more and more, I think our our company was bought the Steinhauer side of it. The machine build side was built to augment the the panels, but then as the

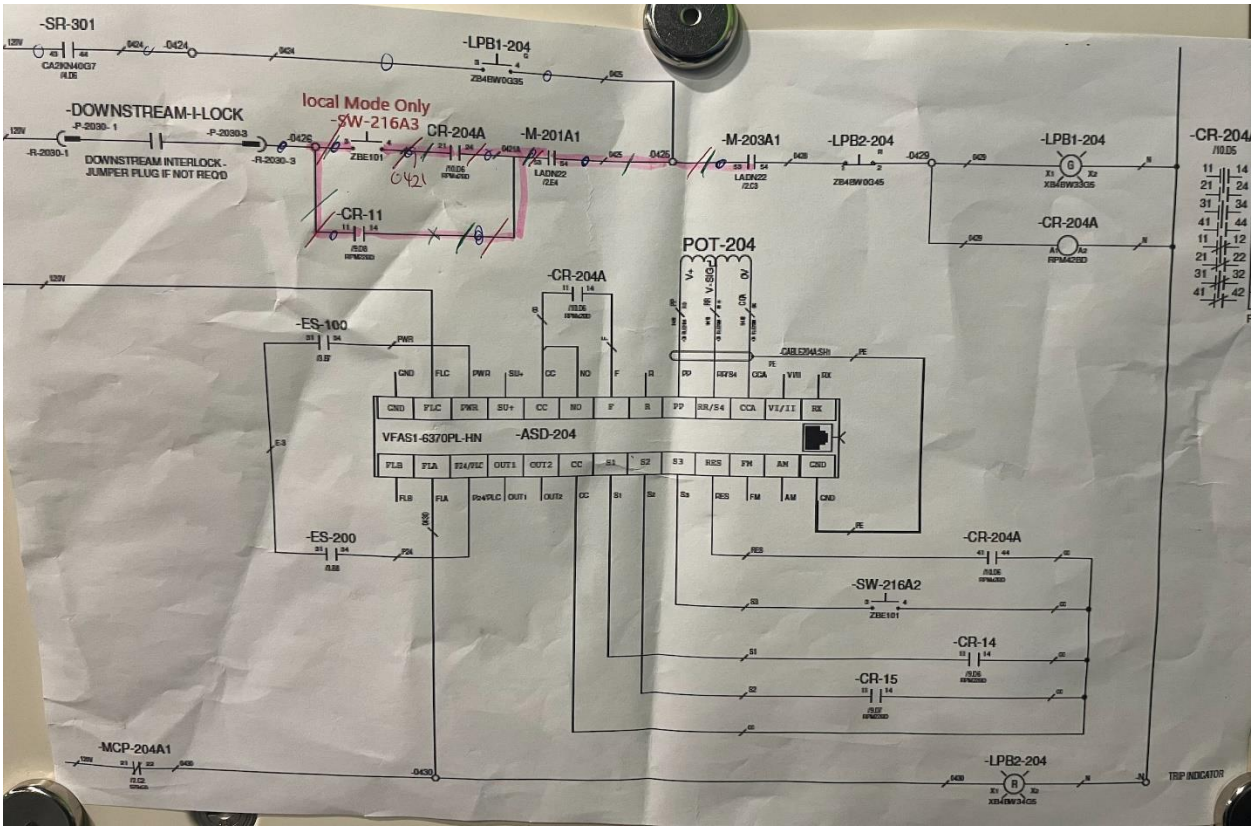
company realized we've even hired a new VP of Engineering for some of these products because they just keep evolving and we keep getting more and more pieces and parts because the industry needs it and we'd rather be the leader looking at that. And we feel like you are look at us and say, OK, they're the leader in this and because of that we want to buy their enclosures and then all their different pieces and parts because of that.

So it's kind of a big tight up Ball, if it makes any sense.

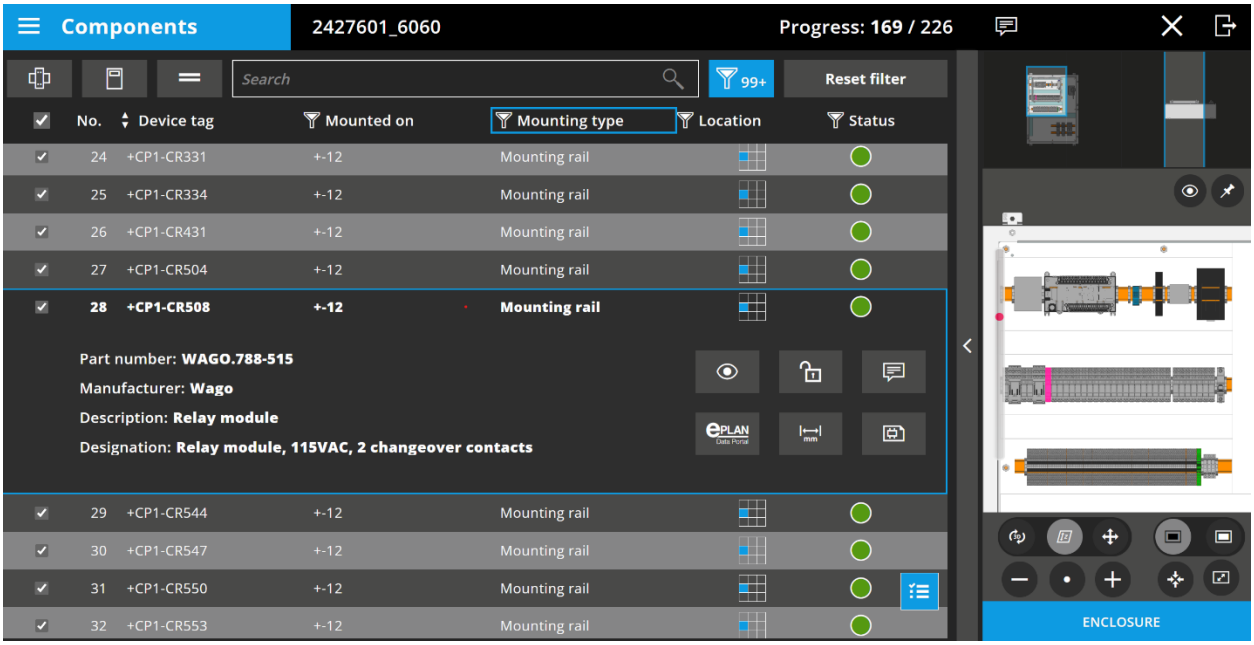
Keegan

Yeah, I know it makes sense. Well, that's all I got for my questions. Thank you so much for your time. I greatly appreciate the insight.

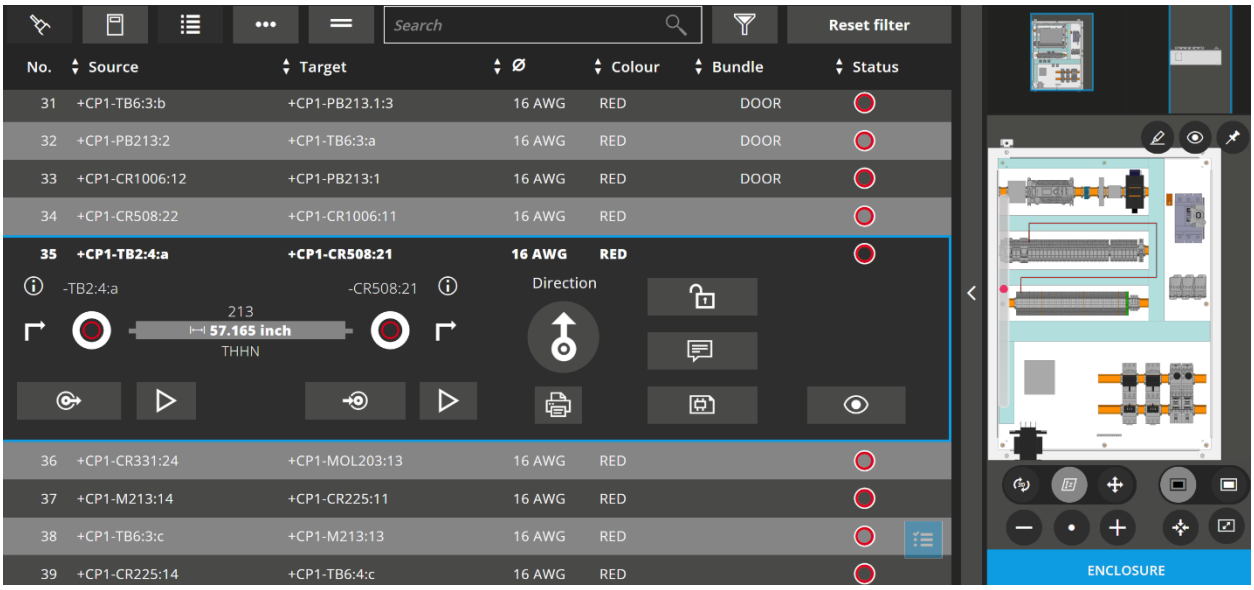
E. Electrical Print



F. Smart Mounting

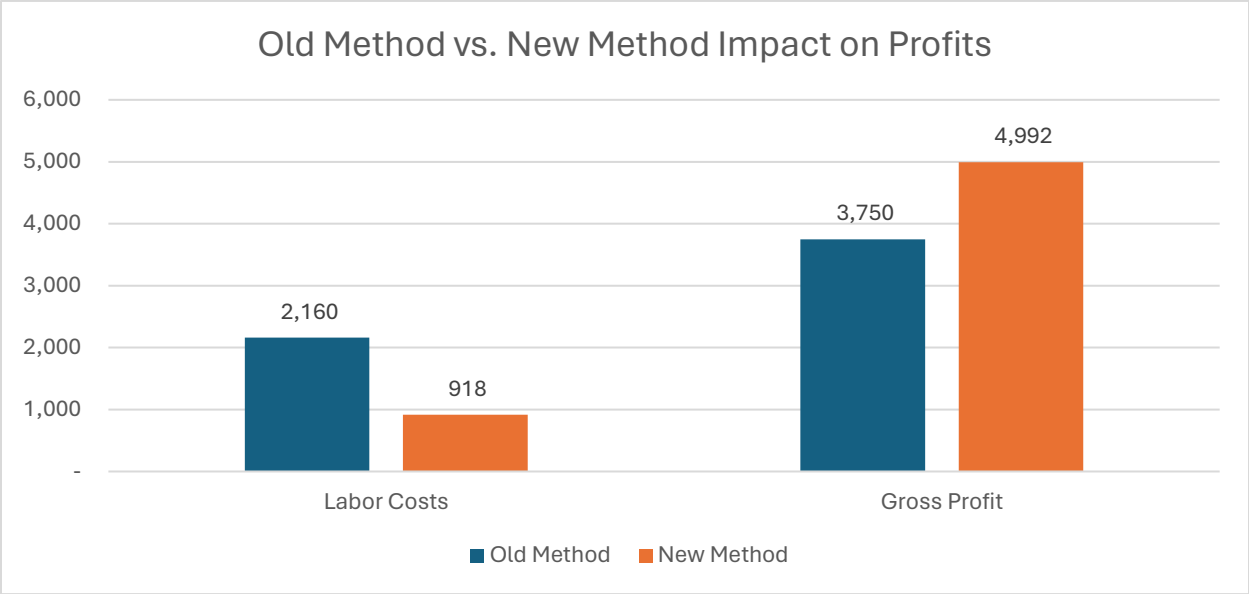


G. Smart Wiring



H. Average Panel Savings

- Price: $15,000
- Old Method Hours to Produce: 72
- Old Method Hourly Rate: $30
- Time Reduction: 50%
- Hourly Rate Reduction: 15%
- Total Additional Income Generated per Panel: $1,242



I. PESTEL Analysis (See Appendix B for more information as well as citations listed after specific bullet points):

Political:

- Infrastructure Bills passed that increase funding for infrastructure.
- Relationships with other countries can impact the pool of customers or projects you can undertake

Economical:

- In expansionary times, it can promote a lot of infrastructure projects to improve things. The opposite is true for times of recession which can impact the potential demand in the industry.
- High inflation can result in lower demand since it causes component costs to increase for electrical control panels.
- "The United States industrial control panel builders' market is expected to grow at a CAGR of nearly 8% during the next 6 years." (c3controls, n.d.)

Sociocultural

- As consumers become more focused on their environmental impact, this will be beneficial to the control panel manufacturing industry. It will lead to increase demand for newer products that have more efficient components.
- Serving numerous industries, so you need to be able to adapt to customer needs and wants for their specific industry.

Technological

- "The main issue affecting their longevity today is when their components become obsolete because panels are changing at a faster rate now than they have in the past 60

years. Technology is evolving so quickly, some of our panels become outmoded before they run any more." (UCEC, 2018)

- Emerging technology that will change the industry from a "Differentiator" mindset to a "Cost Leadership" mindset.

Environmental

- "The most common reason a plant may choose to switch to a newer model is due to power efficiency." (UCEC, 2018)
    - There is an increase importance to focus on businesses' environmental impact. So as components get more efficient it will increase demand of control panel manufacturers to replace outdated control panels. As well as offer the more efficient components.

Legal

- Regulations that enforce standards of component specifications.