The benefits of digitizing your Panel Projects

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Executive summary

A detailed look at the lifecycle of a panel project makes a strong case for digitization. By digitizing the tendering and engineering phases, the customer, tendering office, and engineering office work together to create an exact digital twin of the panel being built. Through data input, customers can mitigate potential risks that can occur in a project's lifecycle, increasing quality and competitiveness. Digitization has been shown to reduce manufacturing time by up to 49% - a necessary reduction given the market's current labor shortage.

What are the benefits of digitizing panel projects?

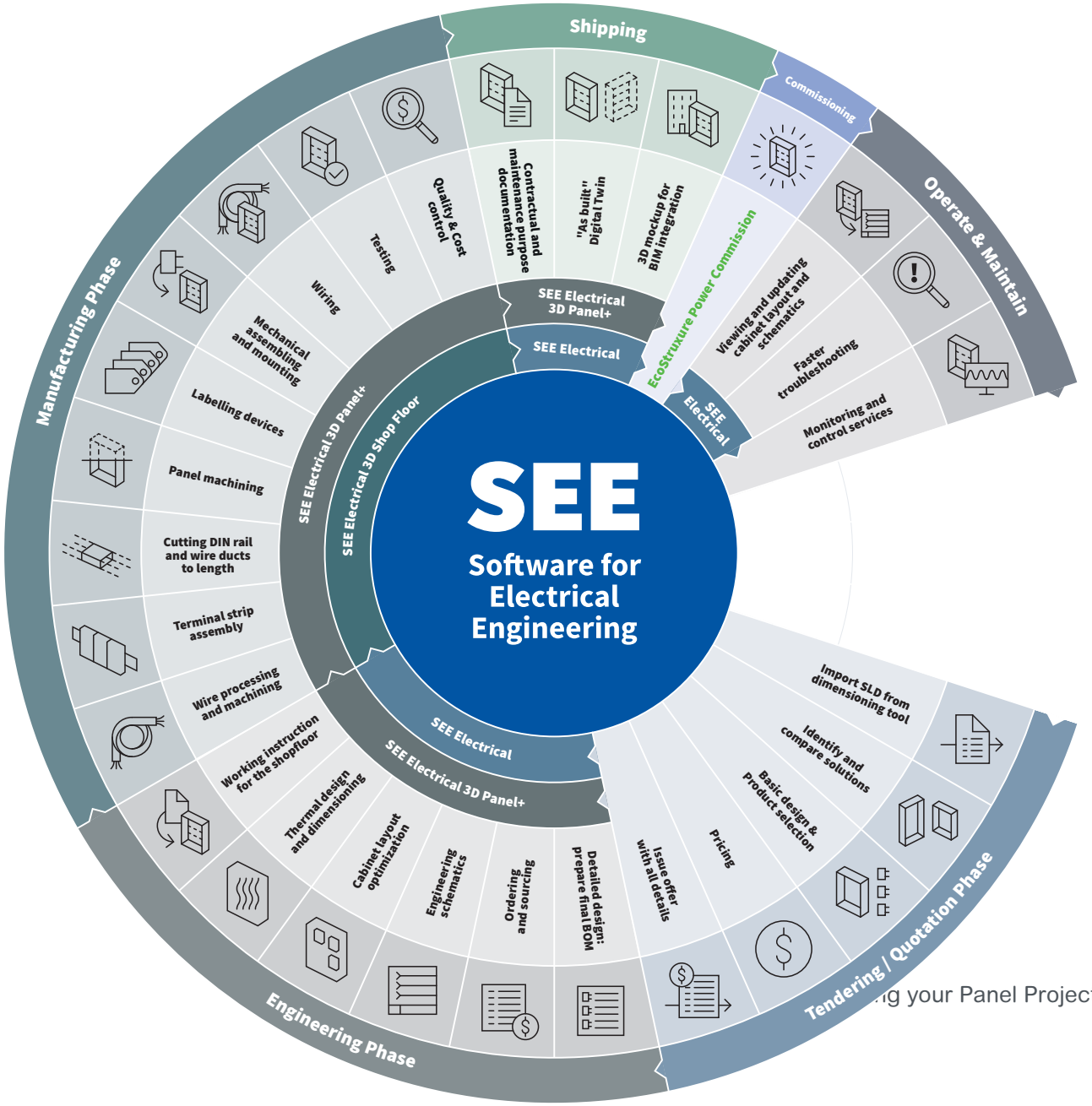
- A consistent product development process means shorter production times, continued reduction of costs, and improved quality.
- Virtual 3D prototyping provides users with a clear spatial perspective within cabinet design, making it easy to optimize space, place and manage system components, calculate wiring and cable routes, and reduce costly waste.
- Manufacturing process automation allows for earlier availability of manufacturing documents, 1:1 drilling templates, wire lists for assembly and mounting, precise component end-fitting and mounting, coupling of marking, wire manufacturing, and NC mechanical processing machines
- Digitization ensures that all departments have access to the same data, eliminating time lost due to redundant data, reverse engineering, manual data transfer, or data syncing. All changes applied throughout the project's spectrum are made in real time.
- A seamlessly integrated workflow offers value beyond manufacturing. Purchase, sales, customer service, and finance departments all benefit from access to consistent, relevant, and real-time data that extends beyond geographical limits and company divisions.

The benefits of digitizing your Panel Projects

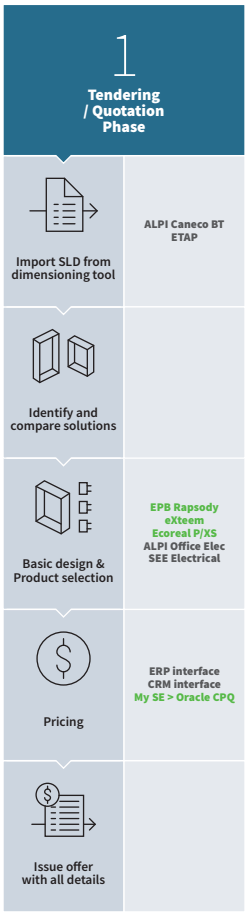
Introduction

Panels may seem like simple products, but they have a complex value chain and are often unique, making standardization difficult. Panel builders are required to build panels that can withstand harsh environments and drive critical assets in their customer's facilities. Additionally, panel requirements impose a high level of specialization and versatility. They require electrical, mechanical and automation expertise. This highly competitive environment puts considerable stress on lead time commitments and margins. The panel builder's job is not an easy one!

This document presents an overview of each phase of a panel design project and shows how the digitization of these phases can improve productivity across the board, allowing panel builders to stay competitive and improve customer satisfaction. The Industry 4.0 approach can also offer opportunities in the tendering, engineering, manufacturing and testing phases.



Tendering phase



Phase outline

"It is not uncommon for the bidding office to receive incomplete requirement"

From a panel builder's point of view, each project's lifecycle begins with the tendering phase. A prospective customer, usually an integrator, sends a high-level description of the system - for example, a sewage treatment plant that needs to be controlled and powered by a panel. This is essentially a specification. In return, the integrator expects the following elements:

- Total project cost at the maximum level of precision
- Preliminary civil drawings or layout for the integrator to validate the proper integration into the facility
- Preliminary bill of materials (BOM)

In addition to cost, the last two points are crucial in the bidding phase, as they allow the integrator to validate that the initial proposal fulfills the system's needs. To achieve this, the bidding office works closely with the design office, as a preliminary design is often required to quickly evaluate the type and quantity of equipment to be integrated in the panel. The specification may only list how many pumps, fans, motors or heaters are involved in this sewage treatment plant project. The design office uses that information to determine what gear is required in the panel to drive every element in a safe manner and the type of panel to store it in.

This step is often not linear, and it is not uncommon for the bidding office to receive incomplete requirements that then trigger exchanges with the integrator. These can be costly in both time and energy.

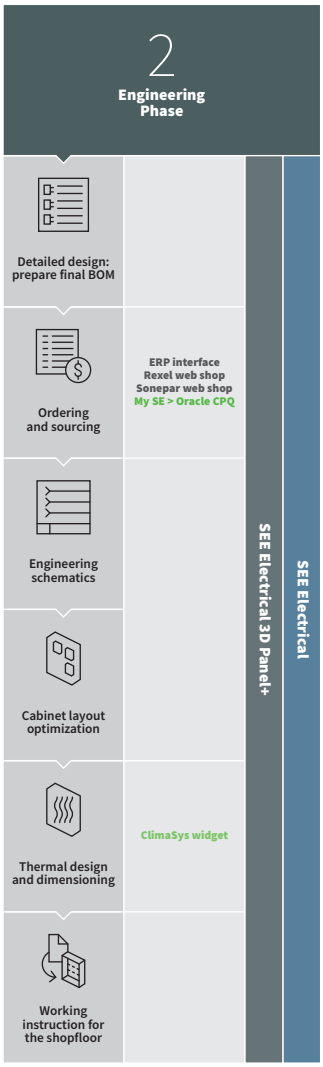
Opportunities offered by digitization

"Tendering and design offices working on the same set of data helps avoid inconsistencies and misunderstandings"

One of the key challenges of digitization is determining the customer's needs. To counter this difficulty, companies can create a standardized exchange flow between the tendering office and the prospective customer. This helps ensure that the correct inputs are shared at the first exchange, thus drastically reducing the time spent gathering missing information and reducing the risk of misinterpreting the end customer's need.

The tendering office works closely with the design office to perform a preliminary analysis to support costing activities. If the customer request is in a standardized digital data format, it can be quickly vetted and passed on to the design office, who will then use the preliminary analysis to upgrade its content and send it back to the tendering office. Having both teams working on the same set of data helps avoid inconsistencies and misunderstandings during this process. This preliminary analysis already includes important information for the design phase and is ready for reuse, thus minimising retyping throughout the whole process.

Engineering phase



Phase outline

“Challenge is to create the RIGHT documentation for the panel”

Once the bid is won by the panel builder, the engineering phase begins. **This phase can account for up to 35%** of the total time spent on a project. This phase has three primary goals:

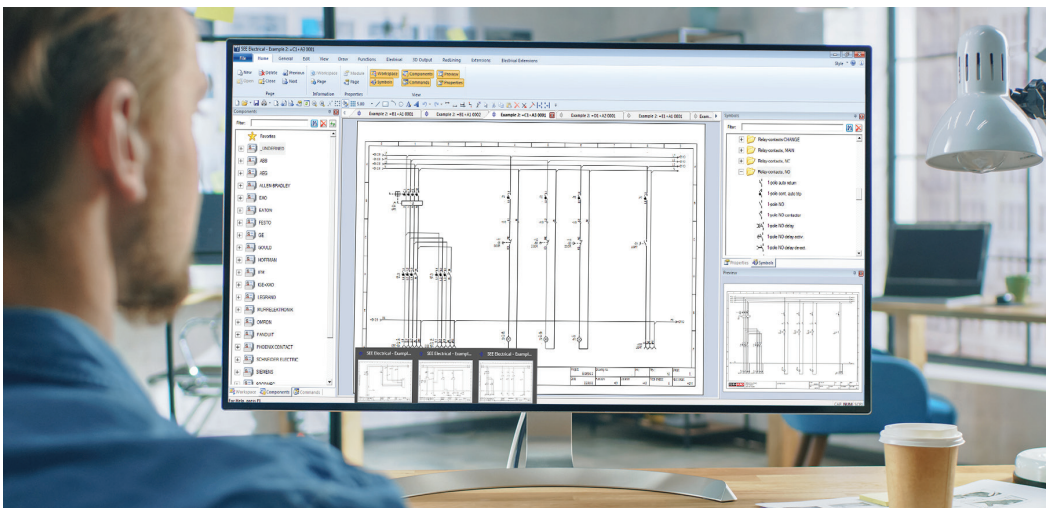
- Design the right panel for the need.
- Create the right documentation for the panel manufacturing stage: detailed view of the layout, detailed schematic diagram and BOM
- Create the right documentation for the commissioning and the maintenance of the panel: general assembly view, detailed schematic diagram and BOM

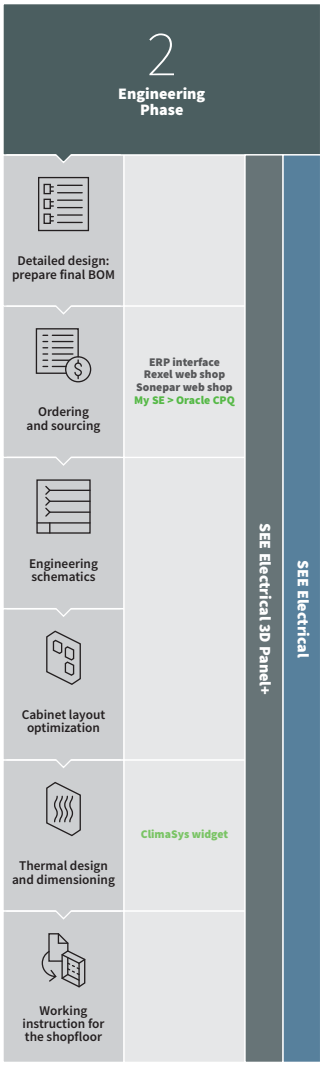
To achieve these goals, the first step is to create the multiline schematic diagram of the panel. The input used is:

- The preliminary analysis done in the tendering phase, which provides a basic BOM of equipment, along with other parts often determined by the customer
- A good description of the system that must be driven by the control panel

With this input and the electrical designers expertise, the power and control schematics are created to describe the connections between every device included in the panel, such as circuit breakers, transformers, or PLCs. This is one of the key values offered by the design office. The electrical designer is the only one who knows how to to properly drive and protect the pumps, fans, motors, or heaters in the sewage treatment plant system that their customer is building. At this stage, the project’s electrical component BOM is much more detailed than it was during the tendering phase, as it contains not only the part numbers, but also the labels that shall be assigned to each device.

As the documentation must be organized in a comprehensive way for both the manufacturing and commissioning phases, the electrical designer generally amends the schematic diagram with the panel and terminal strip physical layouts. The project
is now almost ready for manufacturing, but is lacking one key step before this: the customer's approval. Once the finalized design is shared and approved by the customer, the manufacturing process can begin.





Opportunities offered by digitization

"Electrical CAD tools can automatically control the correctness of the diagram and ensure compliance with standards and/or customer rules"

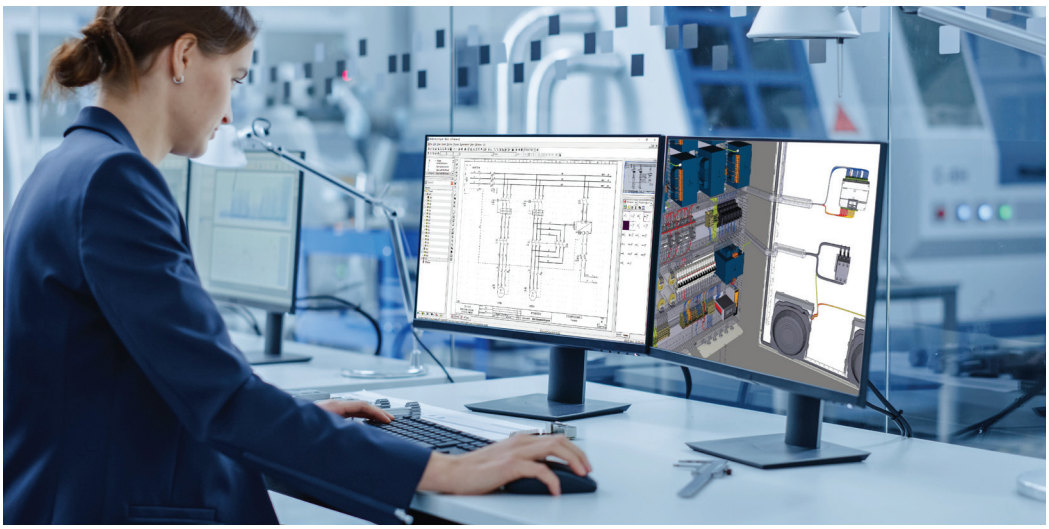
The first action of the electrical designer is to reuse the data from the tendering phase. In a non-digitized process, this means retyping the entire preliminary analysis, which can often be quite time consuming. However, if the data is already digital and integrated in a standardized flow between all departments, the project is already well begun for the electrical designer: there is a preliminary layout, a preliminary BOM and perhaps a high-level system description in the form of a synoptic diagram. Thre is no need to retype this step thanks to data consistency.

An additional challenge to face is the detailed schematic diagram of a panel, which can quickly lead to a substantial number of pages (several hundred at times), which consequently increases the risk of an omission or duplicate that can be difficult to identify during the project's vetting process. Electrical CAD tools can help with automatically controlling the correctness of the diagram by checking for duplicates or ensuring the product labels are correctly assigned with respect to the tagging rules imposed by the standards or the customer.

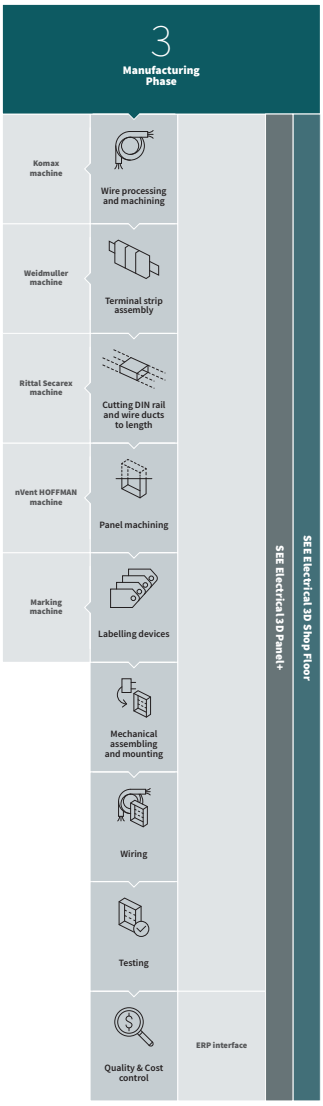
With less time spent on the schematic diagram, more time can be spent on engineering the panel to match the integrator's needs. For instance, one can spend more time on the panel's layout, ideally in 3D, to design a model of how the panel will look once manufactured.

Building the detailed schematic diagram and the 3D replica of the panel means we are in essence creating a digital twin. This level of detail can provide key productivity gains and risk management opportunities during key stages of the project. For instance, the project can easily be vetted by the stakeholders by gathering the comments directly within the project's digital model and maintenance documentation.

In these gains we left out one of the most time-intensive parts of a panel project: the manufacturing. We will observe in the next section how some key gains can be achieved through the digital twin.



Manufacturing phase



Phase outline

“A shop floor associate is often dedicated to retyping and printing the information provided in the BOM”

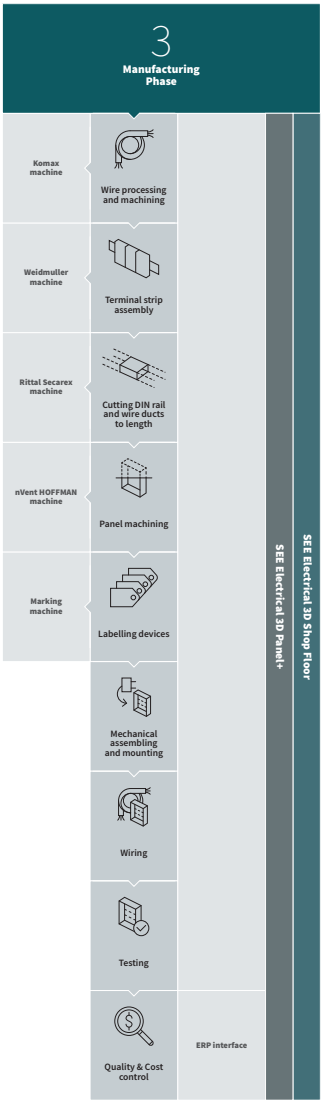
With the panel’s final design approved by the customer, manufacturing can begin. It is broken down into 5 steps: logistics, mechanical preparation, mechanical assembly, electrical preparation, and wiring.

The base documentation in a non-digitized environment is a manufacturing booklet that includes the BOM, the detailed schematic diagram, and ideally, a 2D Layout of the panel. The first step of the booklet is at the procurement office to launch the order of the enclosures and the devices that aren’t in stock or are not considered consumables. After this, the booklet heads off to the stockroom, where a logistics associate prepares and places all the components for this project on a dedicated cart and delivers it to the point of assembly in the shopfloor. In some cases, this cart can only be partially filled if there are some issues or delays with procurement.

Many other steps occur in parallel. The booklet also is used by the mechanical technician who needs to prepare the panel for the assembly. With their experience and the detailed schematics, they can evaluate how many rails and wire ducts need to be mounted in the panel. With this evaluation done, mounting plates and doors are drilled and the rails and ducts are cut to the appropriate length. If the design office was kind enough to provide a 2D layout with dimensions, this can help speed up the drilling and cutting process - unfortunately, this is not always the case in a digitized process.

The booklet’s data is again used to create all the labels to be put on the devices to properly identify them. A shop floor associate is often dedicated to retyping and printing the information provided in the BOM.

At this stage, the panel is ready to receive the electrical components. The technician often faces a challenge at this point: they must use the BOM and the diagram (or the 2D layout if it is available), which contains the product tag and its associated part number, to find the component in the cart provided by logistics, then label and mount it in the right position. This step can represent up to 23% of the whole project’s timeline. On top of this, the electrical technician must build the terminal strip and label it based on the booklet’s schematic diagram. Terminal strips themselves can account for many of the manufacturing issues. They link the panel with the system it has to power. Due to the versatility of these parts, there is a wide variety of setups that exist between those that can operate as relays, multiple level ones, jumpers that can reduce the amount of wiring used in the panel, and the separators to split them into groups. The electrical technician must combine the knowledge of the terminal manufacturer’s range with the constraints imposed by the size of the panel.

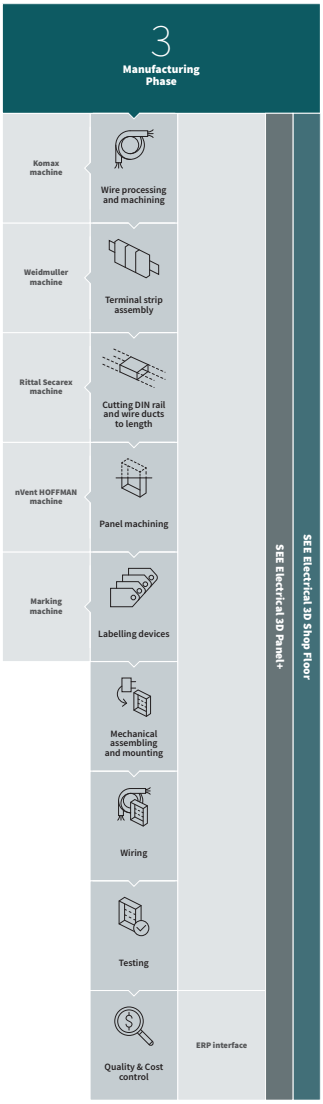


With the electrical components laid out, the panel is now ready to be wired. In a non-digitized environment, the wire lengths are not known ahead of time, so the wire preparation and wiring occur manually at the same time. From a general point of view, the wiring phase relies on the following process:

- Start with the internal wiring of the mounting plates or the doors.
- Then interconnect the mounting plates or the doors together.
- Always respect this sub ordering criteria: start with the big cross-sections as these are the less flexible cores that require more room in the cable ducts, wire the terminals from the bottom to the top (if using multi-level terminals).

The electrical technician's input is the booklet's detailed schematic diagram, and they must cut the wire to the right length, strip, crimp, and identify it. Both time consuming and costly, there is a great deal of trial and error during the wiring phase, which is why it accounts for up to 49% of the panel's total manufacturing time. It is often compensated by the high level of skill and experience of the technician.

With the panel's wiring done, the testing phase can begin.



Opportunities offered by digitization

"Digitization reduces manufacturing time by up to 49% – a necessary reduction given the market's current labor shortage."

For general reference, the manufacturing phase of a panel accounts for 28% of the total project time. The mechanical preparation and assembly account for 28% of this phase, and the wiring accounts for 49%.

Digitization can assist in reducing the total time all the while improving the overall project quality. The core element is to have a fully digitized project. Thanks to a fully digital design process, the digital twin can be fed with all the data that is required to create the proper manufacturing outputs and documentation.

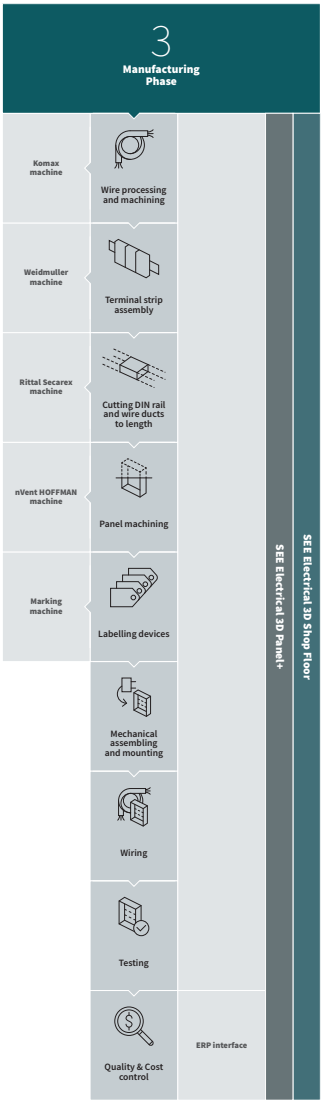
At the logistic department level

Earlier, we referred to the logistics department preparing cart for panel assembly. The panel assembly rules can be integrated into the digital twin so that the cart can be pre-organized for optimal order of assembly. If the best process is to start with the top left corner of a mounting plate, why not pre-sort the parts so that the panel assembly technician has the right part to start with? If we combine this with automatic exports to label printers to avoid the retyping of these same labels, one can save time and ease the electrical component labelling.

At the mechanical preparation level

At the mechanical preparation stage in a non-digitized environment, the mechanical technician must evaluate the number of rails and ducts to be mounted onto the panel and subsequently drill the mounting plates and doors and cut the rails and ducts. All of this bears a high risk of error. With a good level of digital project design, the digital twin will already contain all of this information and take out the guess work. This also paves the way to automating the process of drilling mounting plates and doors and cutting rails and ducts. and rail and duct cutting. Up to 47% of the time spent in this phase can be saved by automating these steps with the help of the digital twin.

Not only can the mechanical stage be optimized with the digital twin, it can also greatly improve how parts are installed in the panel. The panel's assembly rules can be used to automatically generate step by step work instructions for the technician. This combined with the component cart already pre-organized by the logistics department offers great potential for productivity gains and error mitigation. On top of that, the digital twin can also be used to speed up the assembly and labeling of the terminal strips by interfacing with the terminal strip configurators and relying on their automated assembly robots.



At the wiring level

Similar benefits can be gained in the wiring phase, first by creating a wire preparation stage. Wiring can be auto generated during the design stage and therefore fed into the digital twin. This data can then be used to automate the wire cutting, stripping and crimping process, reducing time spent on this stage by up to 80%. Secondly, if we also account for the extraction of the panel wiring rules mentioned above: multi-level terminals shall be wired at their bottommost point first, and big cross sections shall be wired first, before morving on to the smaller ones. The wires can be pre-organized for the electrical technician and wiring can be performed without a diagram thus taking out all of the guess work from this stage.

Overall, the digitization of the panel's project can greatly improve the manufacturing stage's productivity. It can also help panel builders manage their skillset risk. Panels are very complex products to design and assemble as they are at the crossroads of electrical and mechanical manufacturing. Finding labor with that skillset and a good level of experience can be a daunting task as they are increasingly difficult to find. The digital twin's data can be used to simplify the manufacturing stage and alleviate situations that are prone to error. This is also a key value to account for.

Testing and commissioning phase

5
Commissioning

Setup, test & commission

EcoStruxure Power Commission

Phase outline

“Testing is often performed with personnel that have no prior knowledge of the project”

Once the panel is assembled and wired, it must go through one final stage: testing. This is often performed in a dedicated area of the workshop with personnel that have no prior knowledge of the project to ensure the verification is as objective and unbiased as can be. This testing is broken down into 2 major steps:

- Verifying that the panel’s components are clearly identified and laid out to ensure no functions of the panels are missing and confirm the general integrity of the panel
- Validating the wiring by performing continuity tests and functional tests of some of the equipment such as PLCs

The input document used by the tester is quite similar to the manufacturing booklet's content. It often includes a detailed schematic diagram, a BOM, ideally a general arrangement view, and a general checklist of what must be verified.

After successful testing, the panel can be delivered and deployed to the customer’s facility. The final operational documentation is provided to the integrator in case any maintenance tasks may be required.

Opportunities offered by digitization

“Deploying a digitized manufacturing process can significantly reduce the need for detailed testing”

The panel testing phase accounts for 17% of the total lifecycle of a panel project. Opportunities can arise from working in a digital environment. If the digital twin can already be used to produce and assist the technicians during the assembly and the wiring, it can also receive feedback from each of these steps at little extra cost. Each step of the assembly can be digitally signed by the operator, therefore removing some of the testing steps. In this case, it may not be necessary to confirm that all the components have indeed been laid out as the digital process already manages the errors. To sum up, deploying a digitized manufacturing process that provides clear instructions for each step and also contains the feedback loop validating each operation can significantly reduce the need for detailed testing, resulting in sampling tests that confirm the process is sufficient and error-free.

Closing thoughts: What are the benefits of digitization?

By taking a comprehensive look at each step of a control panel project's lifecycle, we can observe that there are many benefits offered by digitization. An initial investment, or at least a slight change of habits, must be made during the tendering and the engineering phase; by deploying a digital process in which the customer, the tendering office, and the engineering office participate, one can efficiently create the exact replica of the panel to be built, e.g., the digital twin. By feeding data into it, we can manage many of the risks that can occur in the project's lifecycle and therefore increase quality and competitiveness. By reducing the time spent in the manufacturing stage by up to 49%, companies are better prepared to face the current labor shortage. The next step should be to evaluate which toolset can be deployed to achieve these goals and enter the realm of automation offered by the industry 4.0.

References and products

IGE+XAO offers a wide variety of tools that can support the digitization of the control panel projects. Below is a brief overview of some of our products:

SEE Electrical

Efficient schematic editor for easily creation of single line or multi lines diagrams.

SEE Electrical 3D Panel+

3D cabinet layout design optimization. Automatic wire routing. Ensure a consistent manufacturing. Automatic generation of outputs for manufacturing.

SEE Electrical 3D Shop Floor

Mounting and wiring assistant dedicated to shop floor.

Authors

Thierry Badorc
Matthieu Beaurain

998-21805531