# Control Panel Design Approaches

How are electrical (and pneumatic) control panels for industry designed and built? I see that two methods are still largely in use. In this article 2 approaches are compared to each other noting the strengths and weaknesses I see in each of them. I leave for another discussion how engineers are adding value to either of these approaches, as well as what I have been calling a "data driven engineering" approach, to not just panel design, but the entire capital equipment intensive design project. For now let's just compare these two common approaches to panel designs.

**Panel Design Foundations**

Traditionally Designed Control Panel Example

***A bill of material (BOM)*** is often the basis for each control panel design. This is usually prepared by an engineer or experienced designer who can take the available design information (P&ID's, layout drawings, similar equipment, equipment list(s),and/ or other basis for the new design) and convert this into control panel designs needed to house all the required electrical and/or pneumatic control components.

***Electrical (and Pneumatic) schematic (elementary) drawings*** are also needed so the panel shop can wire up the devices correctly. To show where terminals should be added or other special wiring, these can be shown on the schematic drawing as well turning a logic drawing into a hybrid drawing containing wiring information as well.

**Panel Design Approaches**

**Traditional approach*:*** Scaled Layout and Schematic Drawings using a CAD tool are prepared for the panel shop. The BOM is included (usually hand entered) on the CAD layout drawing, balloon all the items to match the physical depiction of the layout with the BOM.

***Pros:*** Well recognized method. Very clear to the panel fabricator what to do.

***Cons:*** labor intensive from a design view: requiring manual checking to verify part information is entered correctly, spatial relationships not easy to visualize often requiring the actual panel to be modified during assembly, drawings difficult to maintain. BOM often exists on the drawing only. Data from the drawing is often impossible to extract for analysis or to make part changes across the project. Not kept up to date after initial build.

Value Engineered Panel (Click to see enlarged view)

**Value approach*:*** Prepare a BOM on a spreadsheet, make a sketch only to verify that all the parts will fit in the box if needed. Panel shop must estimate the amount of wiring needed from the BOM. If intermediate or special wiring is required describe this in the Request for Quote (RFQ) or Purchase Order (PO). Schematic drawings are supplied when wiring begins.

***Pros:*** One spreadsheet can be generated for all the parts for all the panels and field equipment on the entire project. Issuing this spreadsheet to a panel shop directly requires only a day of prep typically since no drawings are needed to bid. This allows more time to collect information and/or allows panels to be built quicker. Layout drawings or sketches could follow later as a guide to assembly once all parts are received.

Changes to the BOM are easier to manage on a spreadsheet then on drawings typically.

***Cons:*** Drawings are usually filed in a manner that makes them retrievable by anyone within the company. Spreadsheets are typically project specific and are often lost when the original engineering team has moved on.

In both the above approaches the "design" is then sent to the Panel Shop(s) to Quote and/or order parts and assemble.

**Panel Layout Review and Checkout**

**Layout Review:** Optionally the engineer/designer can show up when all the parts are received to modify the layout based on actual parts received and other changes that might require last minute modifications. Also it is much easier to visualize what the finished control panel will look like when the engineer, designer, and assemblers can layout the actual parts to optimize the panel for spare space, wiring access, to review wire routing, and the like. There is much more that can be said for the value this step can add to the finished product. In the two approaches discussed here this step is often (if not usually) omitted.

In the ***traditional approach*** the designer/engineer do not show up at the panel shop till it is time to "checkout" the panel unless called by the panel shop.

Sometimes when the schedule demands it, the panels will be shipped and checked after installation in the field. This increases the risk of adding cost to the checkout when modifications are needed since the resources of the panel shop are not very handy and electricians earn significantly more and are usually not as efficient at doing control panel modifications/corrections. It can also add to the checkout time

The ***value approach*** also places value on using a panel shop that can make reasonable decisions about how to layout the panel for themselves. The value approach also qualifies panel shops to do all of the required "checkout" making sure that all the components are functional or at least appear to be powering up correctly and verifying that the wiring is correct per the elementary drawings and functioning as expected.

Sometimes in both these approaches ***additional checkout*** is required and performed. This includes loading programs, configuring drives, setting up communications as applicable, testing I/O from the programming environment to test operations end to end. In addition some functional testing might occur for higher risk items such as running a new servo drive system when a motor is available to testing some new I/O device. This high risk testing will allow any problems to be identified as early as possible allowing extra time to address special problems. Also when successful the potential risks can now be reduced.

**Conclusion**

Many companies have abandoned the traditional approach to panel design in favor of some form of the ***value approach*** for control panel fabrications. This has led to the reduction of CAD design support for these companies.

Those that continue to use the ***traditional approach*** to panel design tend to have larger CAD design groups in house.

Both approaches require answering the question what is the cost/benefit of each approach. Increasingly companies are realizing that the value of detailed assembly drawings, especially once already built, is continuing to decrease. Both approaches do not value keeping the assembly drawings up to date. For new projects, a set of good digital photos with or without a parts list is often all that is needed to check, modify, or add to an existing panel.

Earlier in my career about half of the CAD design effort was spent with the control panel designs. Now, I'd estimate that perhaps this is down to between 5 – 20% of the CAD design effort depending on whether assembly drawings are required at all.

What is left for another discussion is how to layout panels for optimal space utilization, for good access, for maintainability, for field wiring, for cooling or thermal management, for arc flash protection and working on a panel "hot", for good power and signal wiring separation, for good grounding and shielding for analog signals, and the like.

What is also left out is how to determine the number and type of panels and the location of panels in the first place.

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