

## Design & Manufacturing of Industrial Controls: An Ideal Process & Partnership

### Achieving Market Success Through Good Design

OEMs with niche industrial control products often outsource their manufacturing to a contract manufacturer (CM) to round-out their product lines, meet customer-specific needs, or free up engineering resources for other priorities.

This short paper explains the **unique design requirements specific to industrial controls**, and examines key considerations for the successful design and manufacture of such products. It also defines a working partnership model for OEMs with niche industrial control products and their CMs – a model designed to ensure an appropriate balance between product design creativity and manufacturing design best practices.

Industrial controls systems must meet strict tolerances for reliability and temperature. They are also designed to last for many years or decades.

### Industrial Controls Design Goals: Safe, Reliable, Manufacturable

Industrial controls are electrical modules or systems used in industrial environments for the purpose of automating or monitoring processes. Examples include simple operator consoles consisting of switches and lights, to large, fully-computerized control systems. They may also be components of a larger system, such as a hydraulic valve driver, an oil pump pressure controller, a temperature controller, a blast control system – to list just a few examples. In many cases, the design of the control must meet strict operator safety, equipment safety, and manufactured material safety requirements.

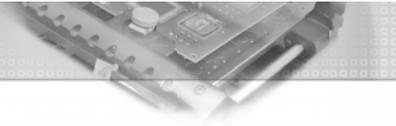
Industrial controls differ from consumer electronics due to their strict tolerances for reliability and temperature. These systems are generally designed to last for more than 10 years, while consumer electronics are usually designed to last only a year or two. Moreover, while consumer electronics are normally rated to operate in temperatures of 0 to 70 degrees Celsius, industrial controls must usually accommodate temperatures that range from -40 to 85 Celsius.

Industrial control designs are generally available for 10 years beyond the product discontinuation notice. They must be designed to be easier to repair, maintain, and replace in comparison consumer electronics.

### Industrial Control Design

Traditionally, the design of an industrial control product is envisaged by a “sponsor” or promoter. The sponsor engages one or more third parties to create the design and manufacture the final product. Once the product is complete, the sponsor’s marketing and sales teams promote and sell it to the end user.

This can lead to a “waterfall” approach to design, which has limitations. If sales and marketing expertise is brought to bear only at the end of the process, is the product may be ill-suited to the target audience or designed for an end user that does not actually exist. If manufacturing is involved only after a design is well underway, the product may prove to be too costly or otherwise unfeasible to manufacture. Sponsors must also tailor the design approach to the life-stage of the product in question. The design and manufacturing requirements of an entirely new product differ substantially from those of a product that is being repackaged.



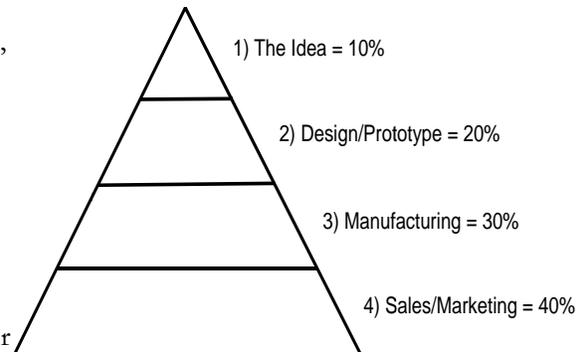
In general, there are three types of industrial control design projects:

1. **New Designs:** If the fit, form, and function of an existing industrial control element does not match an identified marketplace need, it's time to create a new design. Often, the sponsor will not possess the expertise required to design and develop the product in-house and will look to outsource it to a design firm. In this case, the sponsor should consider all aspects of the design (fit, form, and function) and select a firm with experience in industrial control design and manufacturing.
2. **Modernized Designs:** Anyone involved in maintenance can attest to the difficulties associated with the repair of old equipment. No matter how well-designed a module or system may be, it will eventually need to be repaired or upgraded. In cases where the designs exist but replacement parts cannot be found, the design needs to be modernized. This may involve swapping obsolete components or redesigning the system. In either case, the design firm's capabilities must match the scope of the redesign project, and the manufacturing organization must be involved consult with designers on component availability, reliability, and opportunities for reducing costs.
3. **Repackaged Designs:** Sometimes, a proven design simply won't fit into a given application. In this case, a design firm must repackage the existing design to physically accommodate the new application. This is the simplest of design projects, but still requires a design firm with expertise in industrial control systems.

## Bringing an Idea to Market

For an industrial control product to achieve success in the marketplace, the following steps must be successfully executed: the idea, the design/prototype, the manufacturing, and the sales/marketing.

The effort-to-reward ratio varies for each of these steps, as shown in the diagram at right. Generating the idea and developing a prototype represent just 30% of the total effort required to create and support a successful product design. A successful manufacturing, sales, and marketing operation is critical to success.



### The Idea

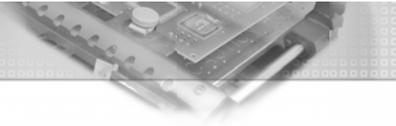
The idea is the starting point of any design and extra effort invested in this stage will pay off handsomely later on. One unit of time spent here equals 10 units of time spent making changes in the design/prototyping stage, and 100 units of time saved during the manufacturing stage.

The first step of the Idea stage is a “Design Requirements” document that lists the features required in the end product. Typically created by the sponsor, this document should contain as many details as possible – such as fit, form, function, and cost – in order to simplify the next (design) stage.

The sponsor should also include product certification details in this document. In many cases, a design firm can answer certification questions and offer feedback on the sponsor's concepts, implementation choices, and limitations.

### Design Phase

The next stage of product design is for the selected design firm – and, ideally, the intended CM, as well – to offer concrete, written feedback on the sponsor's Design Requirements document. Typically, the design and manufacturing team will respond with a “Design Specification” document that includes:



- A description of the recommended parts to be used, their size, construction information, mechanical details, software details, and a cost/time estimate.
- An explanation of how the product will be manufactured and tested, as well as guidance on the agency approvals that the product may require.
- For microprocessor and microcontroller designs, the Design Specification document should also include an estimate of processing speed and internal memory size/organization is provided.

This is not a detailed design document, but an outline that summarizes the product to be realized. At this stage, the design is still flexible and the sponsor, design/manufacturing team should work in partnership to fully realize the product's vision and ensure that design proceeds in a timely manner. During design, it is common to make changes to the design specification to address issues uncovered in the detailed design. Once the design specifications are complete, both groups should feel confident that they are designing a viable product for which they have considered – and minimized – all potential risks.

### **Prototyping**

With an approved design specification, the design firm can begin detailed design of the electrical, electronic, software, and mechanical components of the product prototype. The contract manufacturer will typically produce a small number of prototypes of the initial design.

Close partnerships are also important during prototyping. As the mechanical components of the product are designed and manufactured, electrical and mechanical designers should work together to ensure that all mechanical details are correct and that all electronics fit with the mechanical assembly. Moreover, although software/firmware is very flexible, concurrent design of the software is important, since the limitations of the components selected for the design will affect the software and vice versa. It's not uncommon to need hardware changes during the design/prototype phase due to hardware limitations discovered during the software development.

During the electrical/electronic design process, time must also be budgeted for **testing**. Testing can be simplified by including components such as JTAG ports, test pads for a BON (bed of nails test station), or other support test electronics.

Once the design is complete and the prototypes have been manufactured, the prototypes should be tested for:

- Software/hardware integration
- Environmental and mechanical performance, if needed

It is not uncommon for complex electrical/electronic designs to require a “clean-up” revision of the design to address details discovered during testing and certification. It's also not uncommon for electronic components to fail and some may need adjustments or replacement.

Finally, the sponsor may wish to send some prototype units away for agency testing. This might include testing for CE Mark, Emissions, CUL/UL testing, or other testing required for the target industry.

### **Manufacturing, Sales & Marketing**

While the sales and marketing function moves into high gear once the product has been produced, the sponsor's marketing team should be involved in all phases of the product development process – beginning at the idea stage – to ensure that the product's design and key attributes are appropriate for the intended target market.



## A Design & Manufacturing Partnership Model

Decisions made during the design of an industrial controls product will directly affect an industrial control product's manufacturability. For this reason, the sponsor's contract manufacturer should play a consultative role in early-stage product design – a role known as design for manufacturing (DFM).

Talented contract manufacturers often have extensive design experience and actively employ experienced design personnel. At OCM Manufacturing, for example, we provide a turnkey design-and-manufacturing service specifically for industrial controls customers. This delivers an added benefit: we can provide the careful balance between design and manufacturing required to achieve the most cost-effective, most easily manufactured product while maintaining high quality.

Because DFM skills are gained through experience in an array of manufacturing scenarios, a contract manufacturer can provide the benefit of that experience to a product company – if the CM is involved in early design stages. A strong partnership with a CM should include these elements:

- Commitment by the product company to involve the CM in early design and discussions
- Openness to a CM's recommendations for design changes or component selection
- Advice and guidance from the CM regarding best practices for design for manufacturing as well as specific commentary on proposed designs and materials aimed at improving the design's manufacturability
- Competitive bidding by the CM on the materials and manufacture of the product
- Willingness of the CM to develop the initial prototypes, rather than forcing prototypes to be developed outside the manufacturing environment. Expect valuable DFM input and guidance from your CM.

At OCM Manufacturing, we have provided original design and turnkey manufacturing services to leading global original equipment manufacturers (OEMs.) Our industrial controls development services include:

- Feasibility studies
- Specification development
- Electronics design
- Design for manufacturing (DFM)
- Fast prototypes
- Design validation
- Agency approvals
- Test design and validation
- Documentation
- Packaging design
- Production ramp up
- ...and more

If you are looking for a high-quality design and manufacturing partner for industrial control systems, please contact us at OCM Manufacturing, at 1-800-268-3961.