

Prototyping Your New Electronic Product Idea

By Jim Usery

Do you have an idea for an electronic product, the next must-have gadget, music or video system, time saver, or greatest problem-solving device that was ever invented? Even if you have the electronics product design expertise available, there are a number of tasks that you must complete and issues that you must resolve before you have an actual product design that can be produced, marketed, and sold. Once you have completed a product specification document and a marketing study, you should be prepared to have the product electronics and packaging design processes begun so that a prototype unit can be assembled and tested.

One of the first choices that must be made in the electronics design is which microprocessor or microcontroller architecture will be utilized if your product idea requires processing capability. Most microprocessor or microcontroller devices are available in a variety of configurations of internal memory sizes with some including non-volatile Flash memory for program storage, quantity and types of input and output pins, package types for surface mount or through-hole applications, clock speeds, and interfaces that are supported by the processor without having to add additional devices.

Once a microprocessor or microcontroller family is selected, additional decisions must be made on which system clock frequency to use, how much processor and system memory will be required for the application, and how the software development processes are to be supported. The choice of processor architecture must consider the available software development and testing tools and the software design resources that will be required for your product's software/firmware design. Additional decisions must be made on how the software/firmware will be loaded into the processor's memory during the manufacturing process. Will the design allow the finished product to accept field or user initiated software/firmware upgrades, or will the product be a one-time programmable unit?

Before the processor portion of the design is completed, you must also define which types of interfaces to external systems will be required (serial port, parallel port, USB, Ethernet, wireless connection such as 802.11x or Bluetooth, infrared, etc.) and the minimum interface bandwidth rates required. All of these factors will play a role in choosing the best processor product to use in your design application. Some microprocessor/microcontroller product examples that you can research are the MicroChip PAL series and the family of products from Atmel as both of these suppliers provide some very powerful but low cost processor solutions.

Electronic components, including microprocessors and microcontrollers, are typically available in both surface mount and through-hole versions. Some electronic components may be available in only one format (such as some transformers, relays, capacitors, power resistors, or connectors being available only in through-hole packages). Surface mount components are preferred for any volume level production as they are usually less expensive to purchase, more readily available, and allow for more compact printed circuit board designs as the components take up much less space and can be applied to both sides of the board if necessary. Using surface mount technology may allow the printed circuit board design to use a smaller size and/or fewer layers, thus reducing raw board costs. However, surface mount components can make in-house assembly and soldering difficult if not impossible if you do not have the proper equipment and expertise.

The completed design will include a power supply section that will provide the voltage and current

levels required by the design's components. Input power options could include plugging the unit into a 120 VAC outlet and converting the AC voltage to the appropriate regulated DC voltage levels internally as part of the power supply design. You could also choose to use an external power adapter that converts 120 VAC to a DC voltage level and then regulates this incoming DC voltage level to the level required by the design. A third option would be to have the product powered by batteries. If your product is to be battery powered, in addition to defining the battery technology and the number of amp hours of power storage in the batteries, you should also consider if a rechargeable battery design or an end user replaceable battery design is best for the product application and pricing.

Once the electronics design and the printed circuit board design are completed, the mechanical packaging and external enclosure designs can be finalized and the initial software development can be completed. Now it is time to have a prototype unit assembled and tested and decisions must be made regarding the manufacturing of the initial prototype units. Choices include ordering all of the components and assembling the prototype product in-house if you have the assembly expertise, subcontracting the prototyping process to a domestic contract electronics manufacturing company, or subcontracting the prototyping process to a contract electronics manufacturing company located off shore. If you do not have the expertise or equipment to properly assemble the prototype units, you should prepare a list of companies who can support your prototyping and production needs and begin the process of identifying your best options.

In addition to identifying who will assemble the prototype units, you should also be identifying which option you will use for manufacturing the production units. Choices include manufacturing the units yourself, contracting the assembly of the units externally with a domestic, or contracting the assembly of the units with an off shore electronics manufacturing service provider. If you plan to use an external manufacturing source, consider that some companies specialize in low volume specialty assemblies, such as prototype units or initial production, but are not able to cost effectively support high volume production levels due to capacity limitations. Other companies are in the opposite spectrum and specialize only in high volume levels. The quantity of units that would be high volume production from your point of view may not be large enough to elicit any interest a strictly high volume manufacturer. You should also consider delivery times from receipt of your purchase order as a factor in choosing an outside assembly source.

Another important factor to consider in this process of evaluating electronics manufacturing service providers would be the design assistance that they may be able to provide throughout the process of developing the product. Services such as electronics design and printed circuit board layout design, component selection and procurement process with assistance in multi-sourcing components, enclosure design, mechanical packaging design, and providing production capability from prototyping to low volume to high volume could all be of immense help to you. In addition, a contract electronics manufacturer may also provide suggestions to improve the manufacturability, lower component costs, and improve the product's reliability. Be sure to have an appropriate Non-Disclosure Agreement in place with any and all parties that are involved in this process to protect your intellectual property.

You must also define how will the manufactured product is to be tested and packaged. Once the product has been prototyped and tested successfully, it is important to determine the quantity of units to be manufactured for the initial production run and for volume manufacturing levels. You must also understand how many levels of distribution the product go through (with each level taking a cut of the margins) before it gets in front of a consumer to purchase.

If you are an inventor or have a great electronic product idea, I don't want to discourage you, but you

must consider all of these activities and their associated costs before you commit to the thousands of dollars of expenses required for designing and prototyping your product idea. For instance, you should be prepared at a minimum to either perform yourself or to subcontract the completion of the following tasks:

- Product idea research (are there any existing products or patents already existing for this idea)
- Product specification document preparation (what it will do, how it will look, how will it be powered, and how the user will interface with it)
- Marketing study (what it will be named, who would buy this, how much would they pay, how will we get customers to purchase the product)
- Schematic or electronic circuit design process
- Creation of a bill of material or BOM and an approved vendor's list or AVL for each component in the design, preferably with multiple sources identified, with a BOM and AVL for each assembly level in the product
- Printed circuit board layout design process (single sided board, double sided board, or multilayer board; size of the pcb; board material)
- Mechanical packaging design with user interfaces (displays, buttons, switches, keys, interconnects, power supply, etc.); determining if the product assembly require sealing, internal conformal coating, or potting to protect against moisture
- Software/firmware development process and software tools required
- Prototype component procurement, prototype assembly and associated setup costs, and testing with software/firmware
- There may also be some UL and/or FCC regulatory compliance testing required depending upon your product application (such as FCC Part 15 and UL standards that may apply to the product category)
- Revisions to the designs as necessary based on initial testing results with possibly additional rounds of prototyping being required
- Any required changes from the prototype assembly and testing processes must be incorporated prior to the first production run. This may require changes to the schematic and printed board designs, changes to the mechanical packaging, changes to the software/firmware, or cosmetic changes to the enclosure packaging.

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