Full E-course

15 STEPS TO DEVELOP YOUR NEW ELECTRONIC HARDWARE PRODUCT

PREDICTABLE DESIGNS

Where Electronics and Entrepreneurship Intersect

STEP 1

Define your product

The first step in developing a new product is to create a document called a product specification that defines as many details as possible about your product.

The more details you specify the more likely you are to end up with the product you want, or more importantly the product that customers want. The product specification should be an evolving document that continually incorporates market feedback.

Below are some examples of what you should include in your specification:

Purpose of your product

Describe the overall purpose for the product. Who will use it, where will they use it, and why will they use it.

Summary of features

List all desired features with a brief summary of their intended purpose.

Target retail cost

This gives your development team some idea on the components that can be used. If you plan to sell your product for $10, then the component choices will be considerably different than for a $500 product.

Product dimensions

Small size is extremely important for a lot of modern tech products, but keep in mind that squeezing everything tighter will increase your development complexity.

Operating environment

Will your product be used in extreme environments? Then that will be very important for the design, so be sure to describe the intended operating environment for your product.

Battery requirements

How important is battery life for your product? Will your product have a rechargeable battery? What are the physical constraints on the battery size? These are all details you should specify.

Mobile app requirements

Does your product need to communicate with smart phones? Does it need a custom app? If so, will it be for Android, iPhone, or both? Describe in detail the desired mobile app.

Processing performance

Will your product process lots of data or perform complicated calculations quickly? Or perhaps your product has an advanced user interface with complex graphics? This will impact the decision on the best microprocessor or microcontroller for your project.

STEP 2

Formulate your plan

Developing, scaling, and eventually manufacturing a new electronic hardware product is no easy task. It takes tremendous focus and hard work. But it also takes planning. Developing and manufacturing a new product is too complicated to just "wing it".

You need a plan to succeed. I don't necessarily mean a formal business plan, but you must have a plan to surpass all the obstacles in your path to market success.

The types of questions you need to address include:

How much will the product cost to develop?

Development costs will be your first major financial obstacle. Development costs for most hardware products are broken down into two categories: the electronics and the enclosure (and other mechanical parts).

Whether you plan to bootstrap product development or raise outside funding you need an accurate estimate of how much money you will need. Otherwise you may run out of money before your product is fully developed.

How much will it cost to scale to mass manufacturing?

The electronics is usually the most complicated piece to develop, but the enclosure (and any other custom plastic pieces) is usually the most expensive and complex part of the product to scale to mass manufacturing. This is primarily due to the cost of the high pressure injection molds required to produce custom plastic parts.

The primary scaling cost for the electronics is certifications such as FCC, UL, CE, RoHS, etc. Obtaining these certifications isn't cheap so be sure to plan ahead for these costs.

How much will it cost to manufacture the product?

It's critical to know as soon as possible how much it will cost to manufacture your product. The worst-case scenario is to spend your life savings developing a new product that can't ever be sold at a reasonable profit. But that's a gamble many entrepreneurs take.

Don't spend thousands of dollars creating a new product until you know how much it will cost to develop, scale, and most importantly, to manufacture.

There's a lot that goes into the production cost for an electronic hardware product. This includes the costs of the electronic components, the PCB, the enclosure, product assembly, quality testing, scrap, duties, and logistics.

Don't make the manufacturing cost for your product an afterthought. Does Apple start developing a new product without knowing how much it will cost to make? Of course not, and neither should you.

How can you minimize your risk?

It's always a good idea to identify the riskiest parts of a new design. Those working with a limited budget should always be super focused on minimizing risk.

STEP 3 Pick your development team

There are really three options when it comes to developing a new product:

Option #1 - Do the product design yourself
You'll need to be experienced with electronics design, programming, 3D modeling, and manufacturing. In most cases, you may have one or two of these skills, but will likely need to outsource the other steps.

Option #2 - Find an engineer to become a co-founder
Bringing on co-founders can be very challenging. You will be tied to them for years, so make sure they are a good fit. Also bringing on co-founders reduces your equity in the company.

Option #3 - Hire freelance engineers or a design firm
Keep in mind that very few engineers will be knowledgeable in electronics circuit design, programming, 3D design, injection molding, and design for manufacturing (DFM) so you will likely need more than one engineer.

STEP 4 Select and price the critical components

When designing a new electronic circuit your first step is to select all of the critical electronic components. These include microchips, wireless radios, sensors, displays, connectors, and other components. Your choices are based upon the desiredfunctions and target retail price of your product.

At this early stage, I recommend you begin by creating a high level pre-design (for more information see my blog Why You Should "Pre-Design" Your Product).

The primary reason for a pre-design is because it provides you an early estimation of the production cost for your product, and early identification of the key development challenges. It's extremely important to know your production cost and key challenges as soon as possible.

To accurately estimate your product's full manufacturing cost (also called the Cost of Goods Sold – COGS) you must include the costs for the electronic components, PCB, enclosure, product assembly, quality testing, scrap rate, import/export duties, and logistics.

STEP 5 Design the schematic circuit

Now that you have the pre-design completed it's now time to create the schematic circuit diagram. A schematic is a conceptual diagram that is similar to a blueprint for a house.

The schematic circuit diagram shows exactly how all of the components, from microchips to resistors, connect together.

STEP 6 Generate the Bill of Materials (BOM)

Once the schematic diagram is finalized then a Bill of Materials (BOM) should be generated. The BOM lists the part number, quantity, manufacturer, and package for all of the electronic components.

Although you should have put together a preliminary BOM as part of the pre-design stage, now it's time to create the final BOM which includes even minor components like resistors and capacitors.

STEP 7 Design the Printed Circuit Board (PCB)

Once the schematic is completed it's time to design for the actual Printed Circuit Board (PCB). The PCB is the physical board that holds and connects all of the electronic components. PCBs are almost always green, but sometimes red.

A PCB is made up of stacked layers for routing the electrical signals. The simplest PCB uses just two layers. More complicated designs need more layers to connect everything together. Components can be mounted on one side or both sides of the PCB.

STEP 8 Get an independent design review

Engineers are human and we all make mistakes, so getting a second opinion before prototyping your product is always a smart move that will ultimately save you money and time. In product development, second opinions are called design reviews.

When it comes to anything complex and critical a second opinion is always smart. Whether it's a doctor saying you need brain surgery, or an engineer designing your new product, you would be wise to get a second opinion. Big companies always do this and so should you.

STEP 9 Order PCB prototypes

Now it's time to finally order your electronic prototypes! Producing electronic prototypes is a two-step process.

The first step is the manufacture of the empty printed circuit boards. The second step is soldering all of the electronic components onto the board. Many times these steps are performed by two different companies.

STEP 10 Develop firmware and software/app

Just about all modern electronic products include a microchip called a microcontroller or microprocessor that acts as the “brains” for the product.The microcontroller or microprocessor needs to be programmed to perform the desired functionality. Many products will also require either a custom mobile app or computer software program.

STEP 11 Evaluate, debug, then revise as necessary

The first version of any new product is almost never the final one, so any issues will need to be debugged and fixed for the next prototype iteration.

This can be a difficult stage to forecast in both terms of cost and time. Any bugs found are of course unexpected, so it can take some time to figure out the source of these bugs and how best to fix them.

STEP 12 Get required certfications (FCC, UL, CSA, CE, RoHS)

Almost all electronic products sold must have various types of certification. The certifications required vary depending on the product and the country the product will be sold in. Below are the most common certifications required in the USA, Canada, and the European Union.

FCC (Federal Communications Commission) certification is necessary for all electronic products sold in the United States. All electronic products emit some amount of electromagnetic radiation (i.e. radio waves) so the FCC wants to make sure that products don’t interfere with other wireless communication.

UL (Underwriters Laboratories) or CSA (Canadian Standards Association) certification is necessary for all electrical products sold in the United States or Canada that plug directly into an AC outlet.

CE certification is needed for the majority of electronic products sold in the European Union (EU). It is similar to the FCC and UL certifications required in the United States.

RoHS certification ensures that the product is lead-free. RoHS certification is required for electrical products sold in the European Union (EU) and California.

STEP 13 Create 3D computer model

The first step in developing your product's exterior (enclosure) is the creation of a 3D computer model. The 3D model can then be turned into a physical prototype.

The 3D model can also be used for marketing purposes, especially before you have functional prototypes available.

STEP 14 Build looks-like prototype

You may consider purchasing a 3D printer, especially if you think you will need several iterations to get your enclosure right. 3D printers can be purchased now for only a few hundred dollars allowing you to create as many prototype versions as desired.

Otherwise, there are many companies at your disposal that will happily turn your 3D model into a real plastic prototype.

STEP 15 Evaluate prototype, revise as necessary

Now it's time to evaluate the enclosure prototypes and change the 3D model as necessary. Generally it will take several prototype iterations to get the enclosure design right.

Although 3D computer models allow you to visualize the case, nothing compares to holding a real prototype in your hand. There will almost certainly be both functional and cosmetic changes you'll want to make once you have your first real prototype.

Want to bring your new electronic hardware product to market **faster**, **cheaper**, and with **less risk**?

Check out the **Predictable Hardware Report** – a product pre-design service with **detailed cost analysis** for new electronic products.