

# DIY Electronics Formats

- Products
- Kits
- Break-out Boards
- Hybrids

# Products

- Finished assembly with stand-alone functionality
- How do I make this?
  - Collection of sub-assemblies (e.g. Sparkfun breakout boards)
  - Single PCB
  - Re-purposed electronics (Buy something, hack it, resell it!)

# Collection of Sub-assemblies

- This is a costly method from a \$ perspective, but cheap from a design/build perspective.
- Good for low volume / high margin products.
  - You can easily make a few without ramping up a big production line. (Sell 10, move on to the next thing!)
  - Ideal for when the the technology is not the main sale-point for your product. (What's inside? - Who cares!)
- Bad because your supply relies upon another manufacturer, their QC, etc.

# Collection of Sub-assemblies

- The most difficult part of this method is the interconnects.
- Cables & connectors suck!
  - Very costly.
  - Difficult to crimp the connectors on.
  - Lots of noise and stray capacitance. Be very worried about I2C over long cable runs (> 3”).
- Your housing is more complicated, as all those components need to be mounted someplace.

# Collection of Sub-assemblies

- You can use a PCB to do all the routing.
- This is usually very expensive, unless you are clever about where the parts go. PCB costs increase with surface area.
- The PCB gives a common platform for mounting.
- Use sockets so it's easy to replace parts.
- Sockets are NOT mechanical fasteners. The sub-assemblies should be screwed down.

# Single PCB

- This is the middle of the road option, cost wise, for medium volume production. For high volume, it's the cheapest.
- If you are good at PCB / circuit design, this will perform the best.
- Can be very complicated to deal with the whole manufacturing process.
- Usually long lead times.

# Single PCB

- Decide if you are going to solder them, or if someone else will. Self soldering is NOT cost effective for medium to high volumes, unless you can hire someone else to do it for you in-house.
- If self soldering, are you faster with SMT or through-hole? There is a learning curve with SMT, but its generally faster for quantities over 10, and SMT parts are usually cheaper, and take up less space – lower PCB cost.

# Single PCB

- If self-soldering:
  - If through-hole, design it as a kit (more later), and sell kits as well!
  - If SMT, get stencils made, and use a toaster-oven / solder paste.

# Single PCB

- If someone else is assembling:
  - Lead times of 1 week to 6 weeks. Faster is more expensive.
  - Mixed SMT / through-hole is more expensive. Stick with SMT where possible. Stuff through-hole yourself if its cheaper.
  - Don't let them source components for you, unless it's a really good deal.
  - In the US it's around 10\$ - 20\$ a board for stuffing. Tiny boards can be as low as 3\$.

# Single PCB

- If someone else is stuffing:
  - Prepare a BOM (more on this later).
  - Order 10% extra parts (the machines need some leader tape).
  - Get parts on tape and reel / tubes.
  - Order PCBs, (1 week to 4 week lead time). Faster is MUCH more expensive here.
  - Clearly label everything!

# Single PCB

- If someone else is stuffing:
  - Will they do Quality Control?
  - Prepare a thorough QC checklist.
  - This is usually billed by the minute, so be efficient.
  - You should probably do this anyways if you're stuffing, as returns are more hassle than they are worth. They hurt your reputation and cost you money on shipping / customer interface time.

# Single PCB

- If going to a foreign fab (e.g SEEED):
  - Send a prototype.
  - They might require money in advance. This costs you in lost interest, and lost leverage.
  - Write emails clearly and plainly. Spell EVERYTHING out in detail.
  - Will be much, much less expensive. Will be more willing to work with you on details.
  - Very costly to import parts to China, have them source, unless it's critical.

# Repurposed Electronics

- Usually only good for smaller runs – you have the least control over inventory.
- Very cost effective for small runs.
- Parts from toys / surplus houses / [Alibaba.com](http://Alibaba.com).
- Buy as many as you need for the full life cycle of the product, as you may not get the part again, or it may be altered slightly.
- Find something fun to do with the unused bits!

# Kits

- Very low entry cost, minimal tooling.
- Not as popular, you will not sell as many.
- Often the same price as an assembled product, if overseas manufacturing is used.
- More overhead of customer support – they will break everything! And then blame you!
- Good for testing the waters (see if there is interest in a full product).
- More labor intensive.

# Kits

- Designing for kits:
  - The kit owner will make mistakes, and need to rework the PCB.
  - Use large annular rings, large trace / space.
  - Do NOT use a black PCB – you can not see the traces!
  - Design all your own PCB footprints. Or steal from a kit that you have assembled.
  - Assemble a kit, and measure how far the leads of resistors are spaced when you bend them by hand.

# Kits

- Designing for kits;
  - Use through-hole parts.
  - If you have to use SMT, send along a bit of braid, and have detailed instructions. Or offer that part pre-soldered.
  - Use sockets for the ICs, unless it's too expensive. Your customers will thank you immensely.
  - Avoid cables if at all possible.
  - Use cables with headers and sockets on one end.
  - Use common parts. It will be easier for you and your customer to source.

# Kits

- Stuffing a kit:
  - Can be outsourced (elexp.com).
  - Get bags / boxes / bubble wrap.
  - Line up ~40 solo cups in a row – and go down the row, dropping parts in to each one. Counts as you go, to make sure you hit them all.
  - For part counts of 2 or less, buy parts in bulk.
  - For part counts above 2, buy parts on tape and reel.
  - Place a marker on the table for the length of N components, and cut all of the taped parts at once.

# Kits

- Stuffing kits:
  - If you have a large quantity of loose parts, weigh them on a precise scale. Most will allow you to enter the quantity, so you can easily add 1 or 2 to get the right amount.
  - Keep similar parts together: ICs in rails, or on foam and in static sensitive bags. Resistors in a separate bag.
  - Reuse the bags / rails your parts came in – mail your trash to the customer.

# Kits

- Stuffing kits:
  - Once a cup is full, dump the parts into a bag, and start the next set of parts.
  - 2 people can be more efficient at this game.
  - Be careful about how you pack. Sharp parts can burst bags, or scratch finished surfaces.
  - Prepare a lot of kits at once, it's way more efficient.

Yes, this is actually how it's done!



Adafruit, 11.14.2011

# Break-out Boards

- Must be (mostly) pre-assembled.
- Use SMT, leave through-hole parts for the customer. Unless it's the same price not to!
- Label all jumpers / modifiable bits very well.
- Keep it small.
- Use 0.1" lead spacing for headers.
- Have example code / usage ready! People expect these things to solve all their problems.

# Break-out Boards

- Same rules apply for PCB design as for a final product, except more clear labeling is required.
- Break out ALL the pins. You never know what someone will want to do with it.
- Not all the pins need to be as easily accessible.
- Use jumpers to change functionality.
- Cut-trace jumpers are cheap, but they also are cheap. So don't use them if possible.

# Hybrids

- Sometimes it's cheaper / you have to use a particular part.
  - Have a header for a break-out board on a kit.
  - Use some SMT in a through-hole kit.
  - Use some through hole in an SMT product.
- Good for when a section is out of your expertise. E.g., wireless modules, low noise design, high power LEDs.
- Usually more expensive in the above case.

# Hybrids

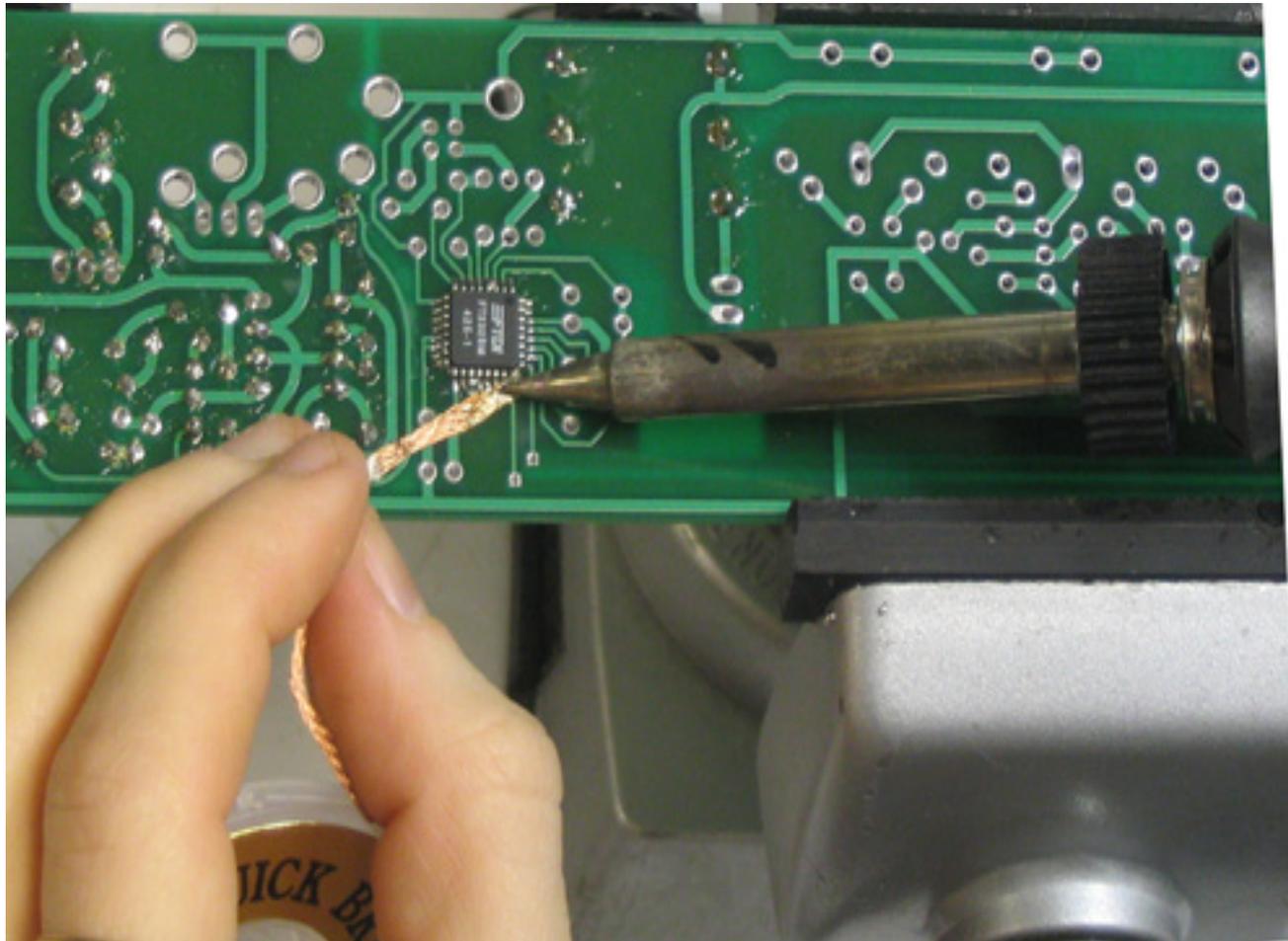
- Decide which side of the fence your product lands on.
- If it's a finished product, use those design guidelines, and then tack on the kit parts.
- If it's a kit, design a really good kit, and make it easy for the end user to get a module / SMT part.

# Examples: Hybrids



MICrODEC, Open Music Labs: Through hole left to the customer

# Examples: Hybrids



Adafruit, x0xb0x: 1 SMT part in a kit, left to consumer

# Examples: Good Cabling



Sparkfun, Molex jumper wire with connector, 0.1":  
Has both male and female connector on one end,  
and bare leads on the other.

# Resources

- Adafruit has a whole section devoted to developing a kit / product business:
  - [adafruit.com/forums](http://adafruit.com/forums) – look for Kitbiz header
  - [ladyada.net/library/kits/kitmaking](http://ladyada.net/library/kits/kitmaking)
  - [adafruit.com/blog/2009/06/08/kit-business-slides-and-notes-from-maker-faire/](http://adafruit.com/blog/2009/06/08/kit-business-slides-and-notes-from-maker-faire/)
  - Tons of other stuff in the blog.

# A Word of Caution:

Making the kit / product will be the easy part.