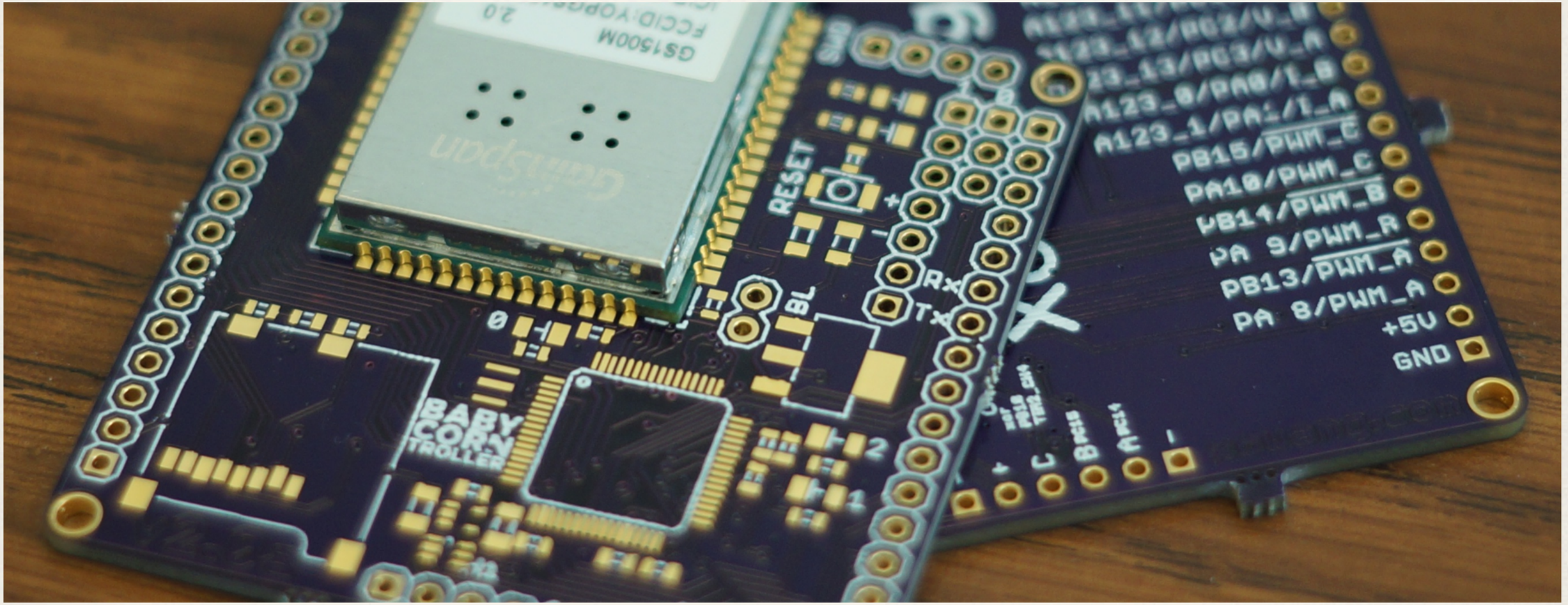


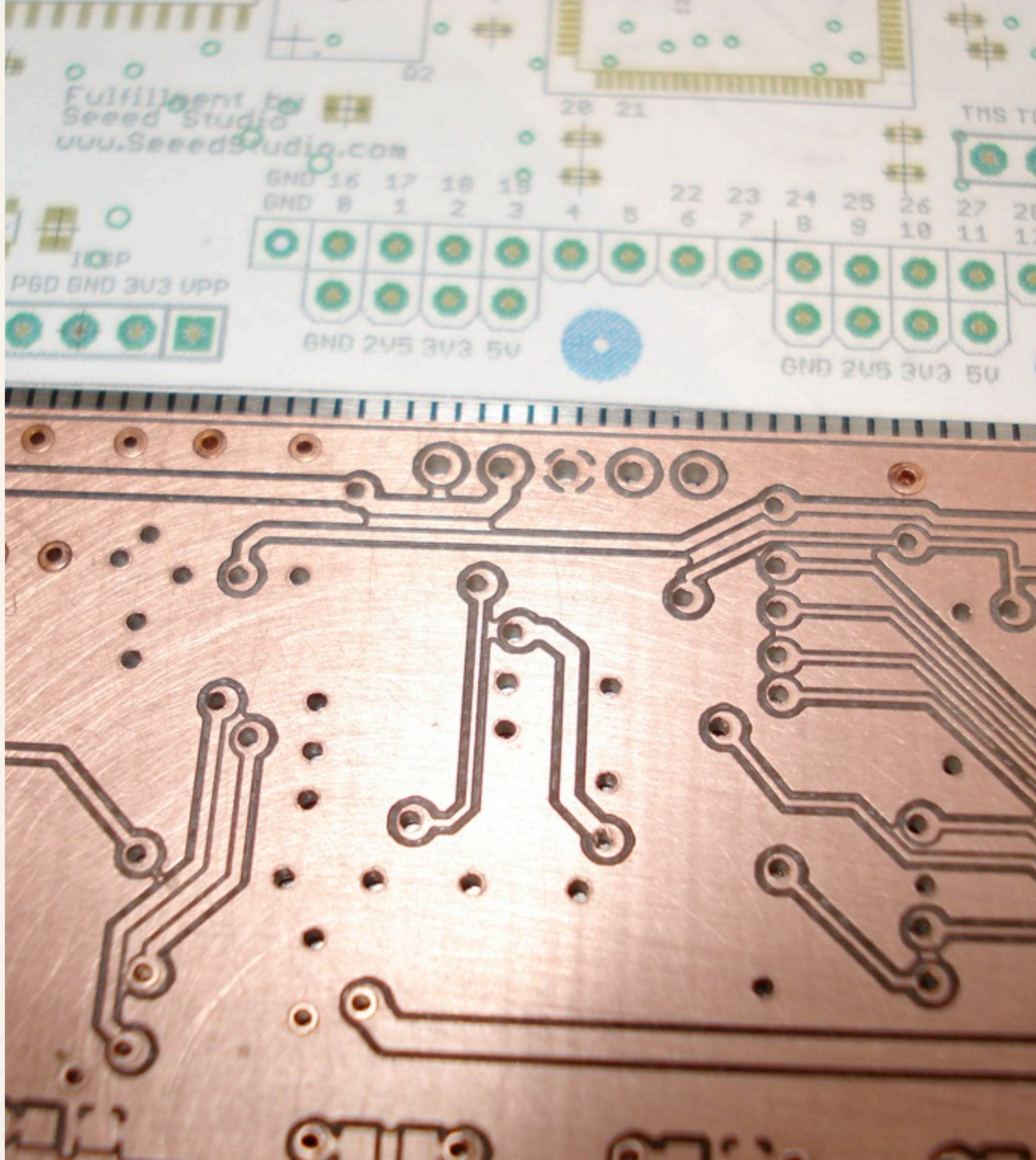
Creating Printed Circuit Boards - Part III

Xo Wang (xo@geekshavefeelings.com)

11/27/2012

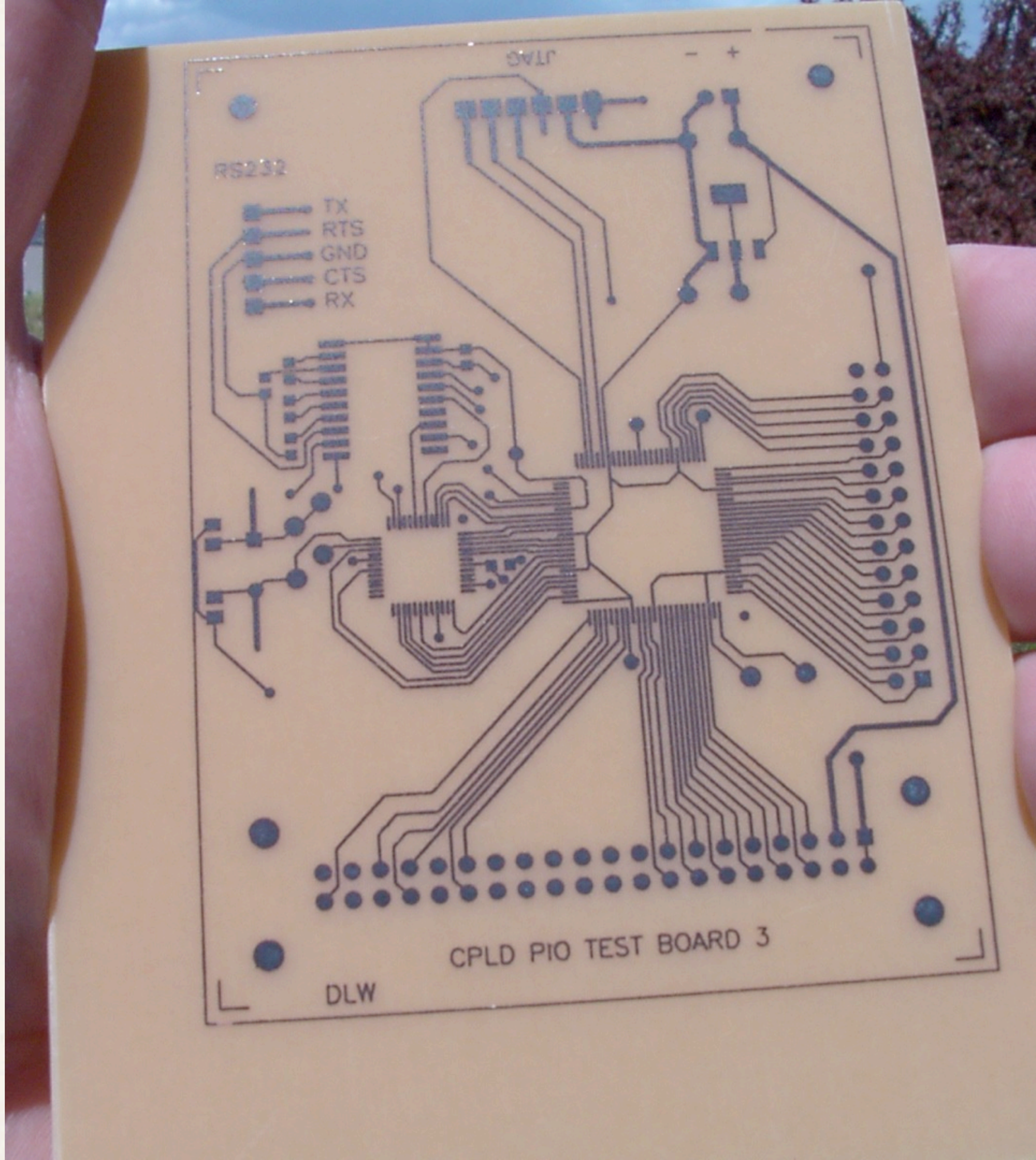
Making boards

- Send it out to a **fabrication house**
- **Etch** it yourself
- **Mill** the board



Etching

- 2D laser **print** mirrored board design
- **Transfer** toner to copper clad board
- **Etch** away copper with ferric chloride
- **Drill** through holes



Etching

- **Good**
  - Completely DIY
  - Cheap (consumes copper clad, etchant, and drill bits)
- **Bad**
  - Incredibly tedious (especially drilling)
  - Unreliable copper removal
  - No plated holes, soldermask, or silkscreen
  - Takes time

Milling

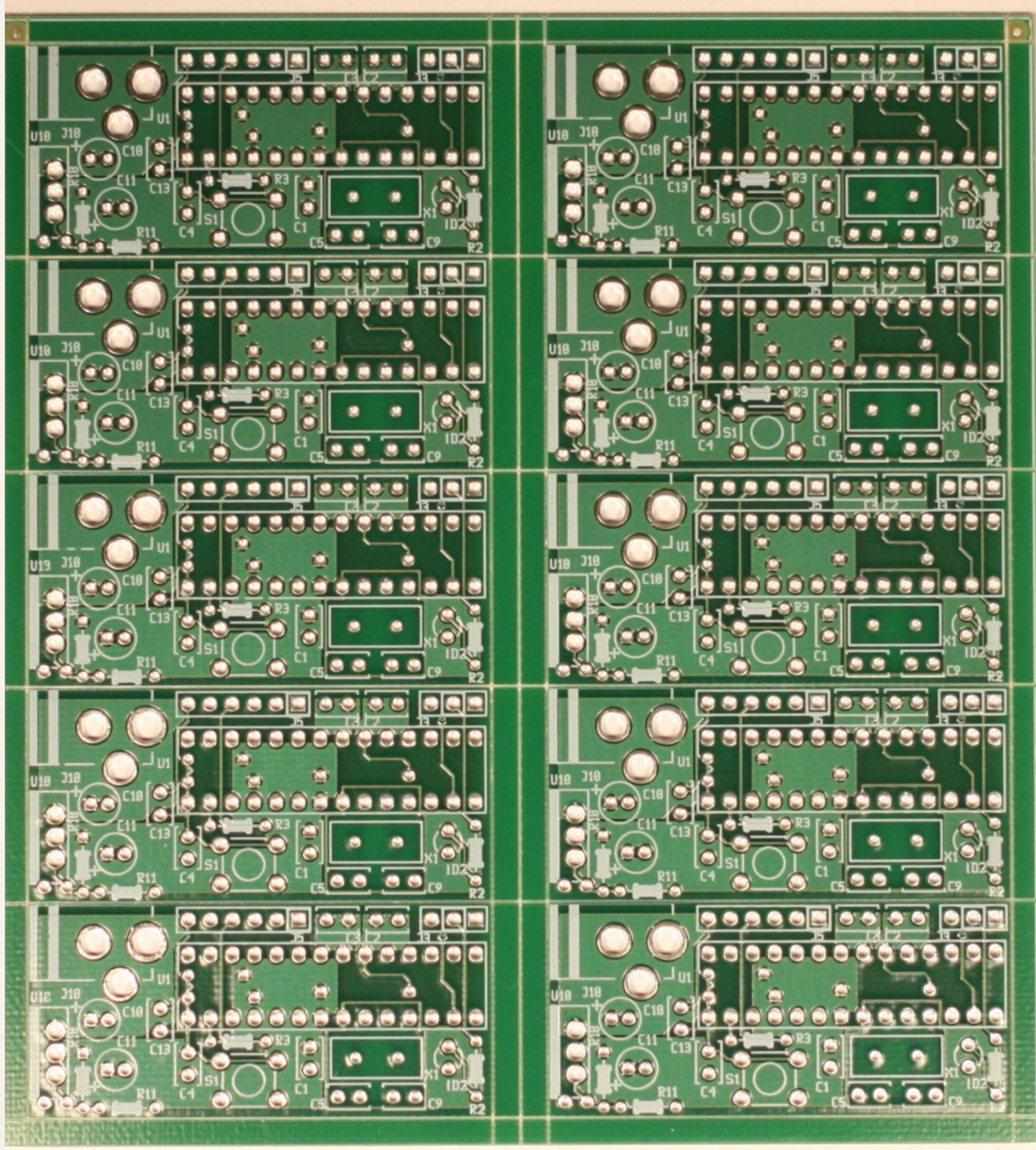
- CNC **mill** removes copper
  - High spindle speeds (40k–100k RPM)
- Machines with tool changers can also **drill** out through holes
- Board is **routed** out of copper clad panel
- On campus: Mechatronics, GVU Proto Lab, ECE

Milling

- **Good**
  - Automated board build
  - Cheap (consumes copper clad and tooling)
  - Extremely fast (hours)
  - Boards can be routed out
- **Bad**
  - No plated holes (kind of), soldermask, or silkscreen
  - Possible shorts from flakes of copper

Ordering

- Send out gerber files to board fabs
- Processes vary, but “full service” is feasible for even hobbyists
  - Plated through holes
  - Soldermask
  - Silkscreen
  - Routed outlines



Ordering

- **Good**
  - Highest quality
    - Thin traces/spaces (typ. ≤8mil/8mil)
    - Almost never get electrical problems
  - Less work to get a prototype done
- **Bad**
  - Speed/cost tradeoff
  - Sometimes high minimum orders
  - Anxiety from not DIYing

Fabs (fast, domestic)

Fab	**PCB Unlimited**	**Adv. Circuits (Bare bones)**	**AP Circuits**
Cost for TinyHusk	$46.00/2pc +$54.89 UPS 1day	$70 + $2.24/pc +$61.98 UPS 1day	$65.52/2pc +$30 FedEx 1day
Lead time	2 days (1 day +$11.00)	1 day	3 days
Spec	Full service 5/5, min hole 8	No mask or silk 6/6, min hole 15	Full service 7/7, min hole 16
Notes	Xo's choice	Plated holes and tin finish	Drill spec is ◔◔ Boards smell funny

Fabs (slow, domestic)

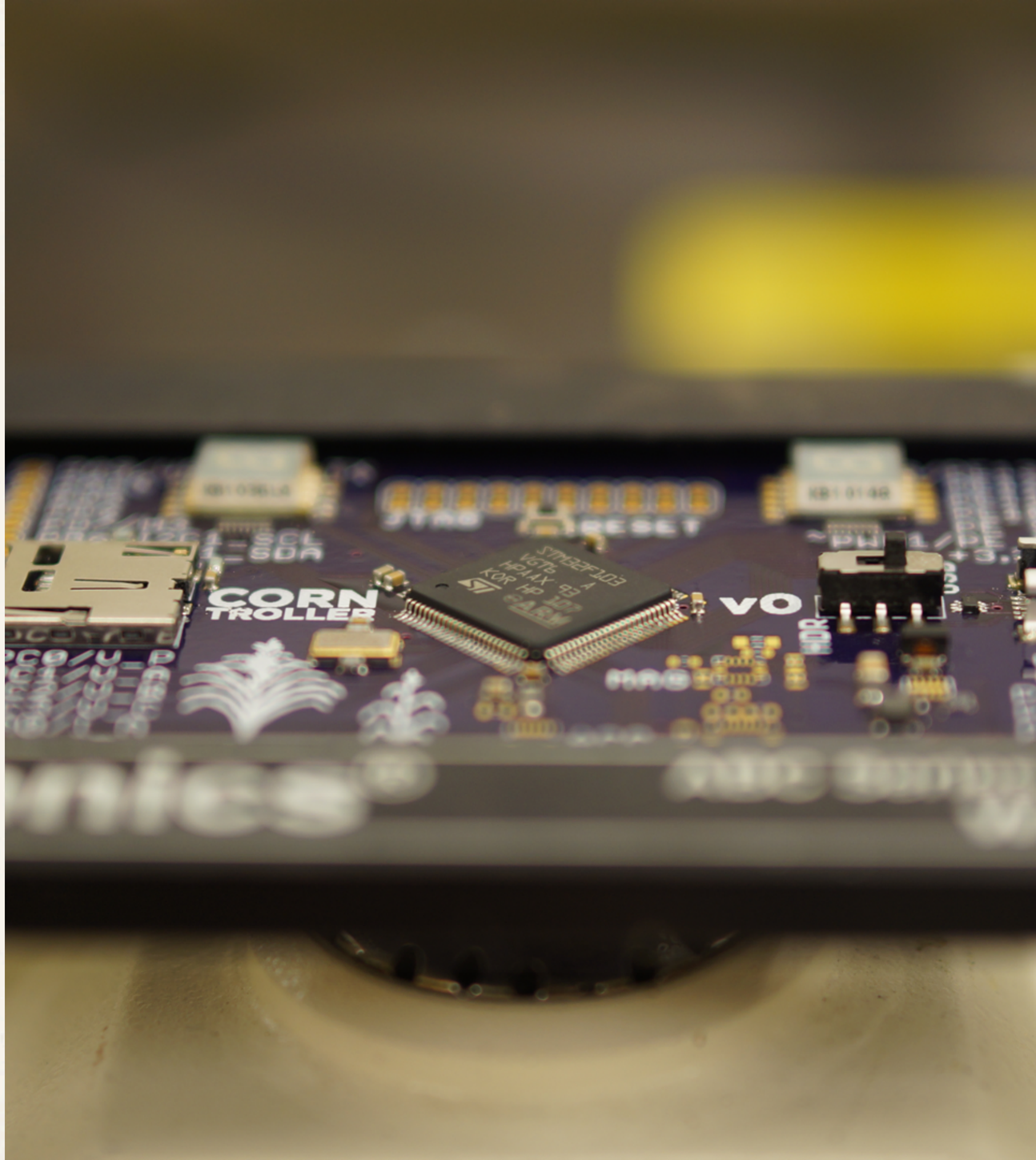
Fab	**OSH Park (Dorkbot PDX)**	**Advanced Circuits ($33 each)**
Cost for TinyHusk	$19.01/3pc +$0 USPS FCM	$33/pc +~$10 UPS Ground
Lead time	~1–2 weeks	5 days
Spec	Full service 6/6, min hole 13	Full service 6/6, min hole 15
Notes	Gold plating, ×2 4-layer, USPS Prio +$5, Exp +$25	$66 each for 4-layer

Fabs (slowest, international)

Fab	**BatchPCB**	**MyroPCB**	**SeeedStudio & IteadStudio**
Cost for TinyHusk	$10 + $9.51/pc +~$3 USPS FCM	$17.98/pc +~$35 various	$10/10pc +~$20 Airmail
Lead time	~2–3 weeks	6 days	~1–2 weeks
Spec	Full service 6/6, min hole 13	Full service 6/6, min hole ?	Full service 8/8, min hole 20
Notes	Sparkfun-run	Preferred by our friends at MIT	Direct from China Lots of options

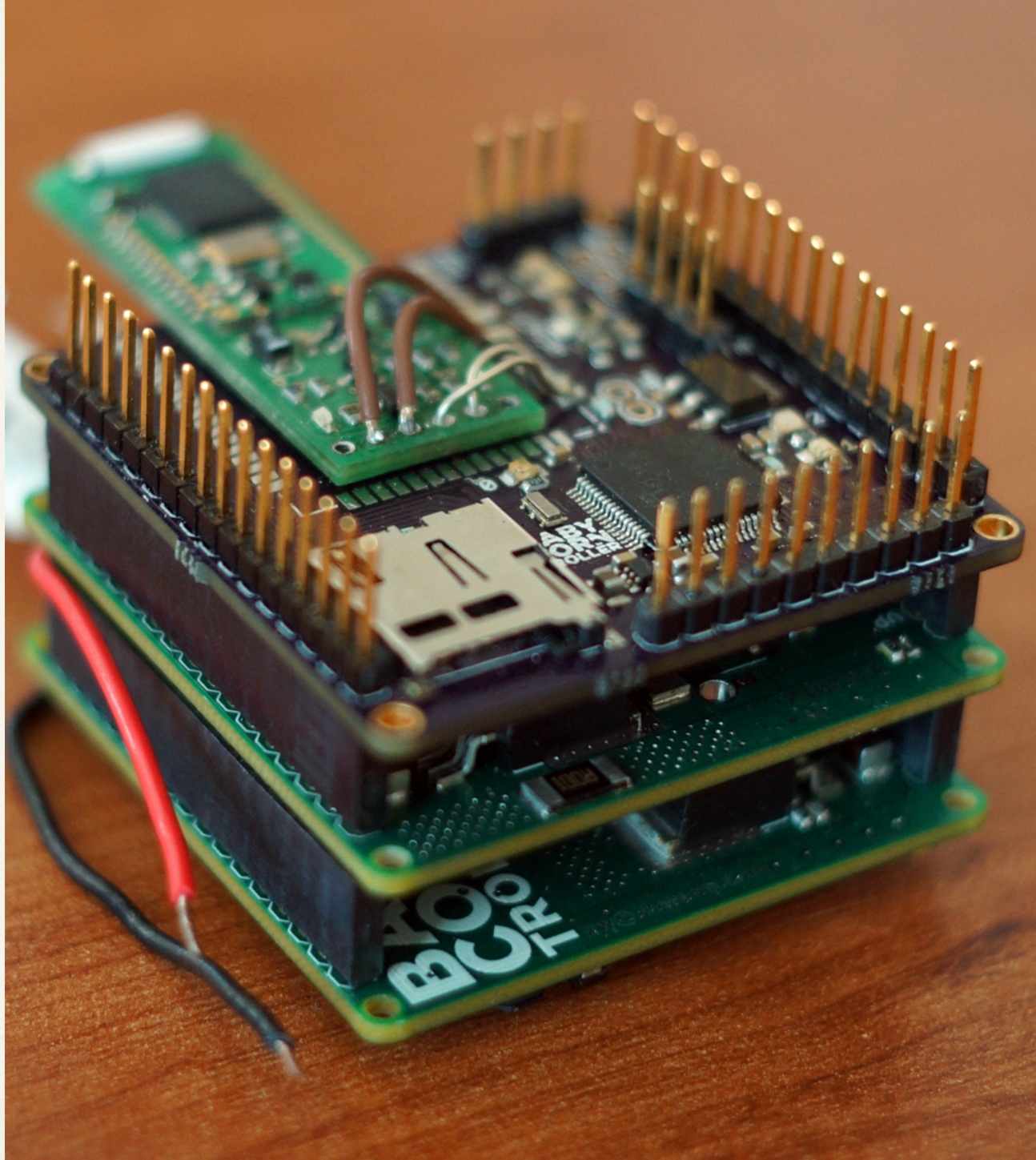
The Corntroller Story

- First version had too many features, too little core functionality
  - Took a long time to design/assemble
- Law of prototypes—it didn't work anyways
  - Still costed a lot to find out
- Also just too large



Corntroller v2.0

- Fewer components, no features I didn't need
  - Lower cost meant I could afford to iterate boards faster
  - The green boards had two iterations
- Exchange features for development time



Closing

- Go build boards!


INVENTION STUDIO