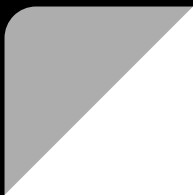
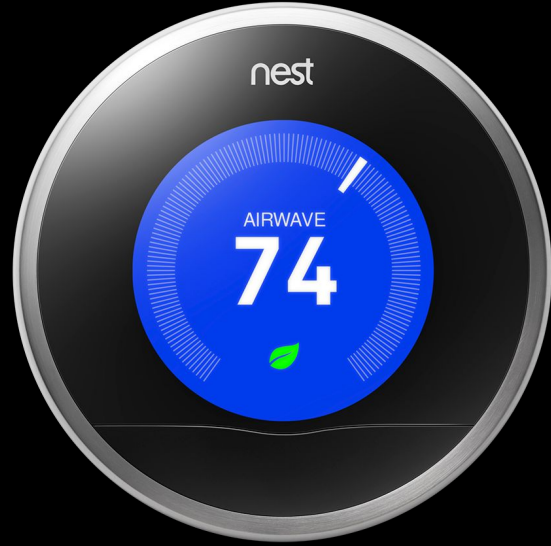


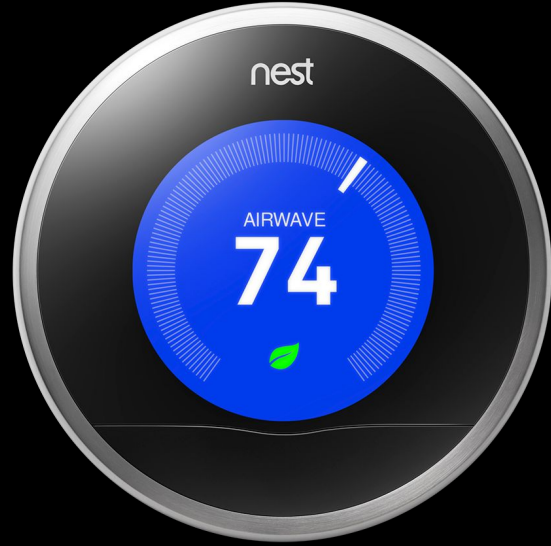
You Can and Should Make Hardware

QCon/SF 2017

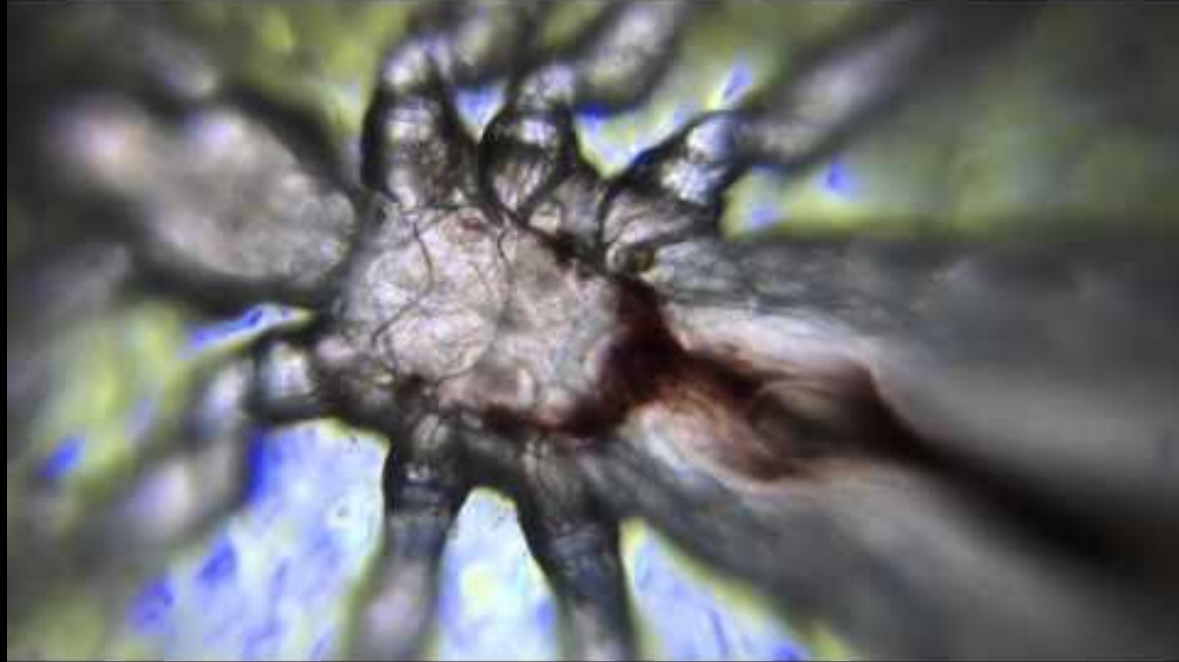




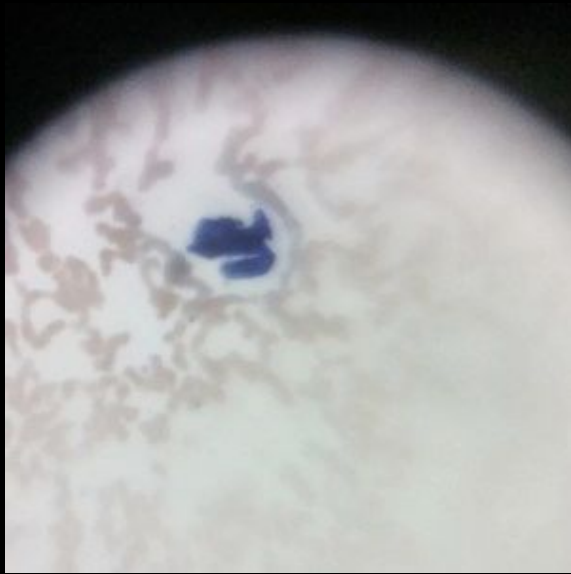




Two Microns at This Scale → ||



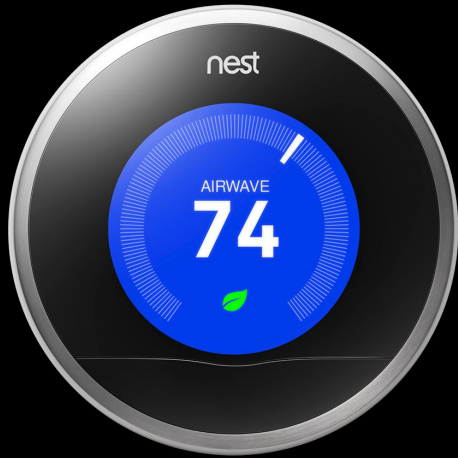
Malaria Diagnosis



Diseased Blood

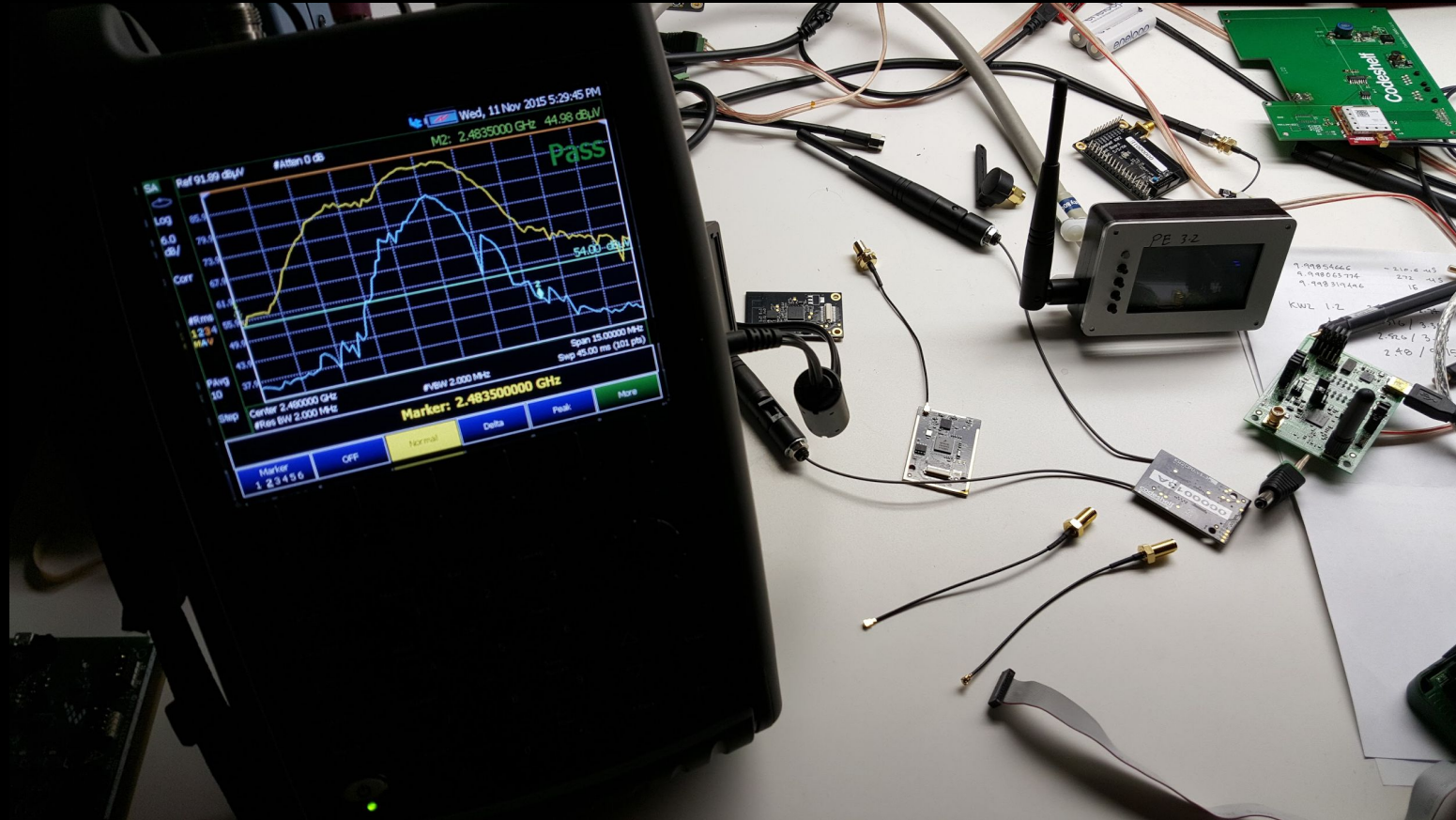


Healthy Blood



ECommerce Automation

Value Building



You Cannot Compete with This

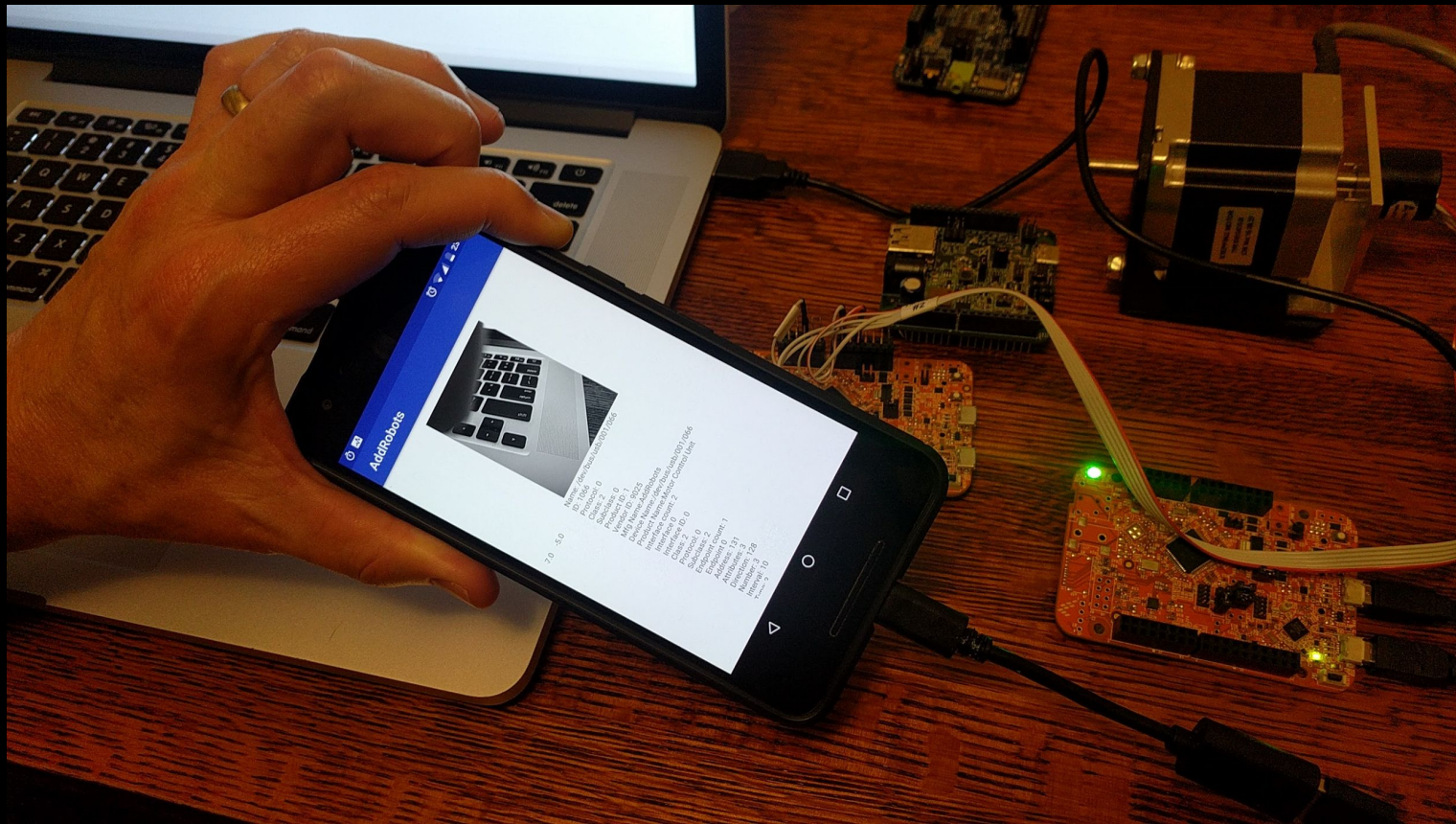
The screenshot shows the Alibaba.com search results for 'stikbox-case'. The search bar at the top contains 'Products' and 'stikbox-case'. On the left, there are filters for 'Product Features' (Sample Order, Paid samples, Min Order), 'Supplier Features' (Supplier by Area, Country/Region, Supplier Types), and 'Total Revenue'. The main product listing is for '2016 New degin stikbox 2 in 1 blue iphone66plus77plus' priced at 'US \$0.01-7.59 / Piece' with a '50 Pieces (Min. Order)'. A red arrow points from this listing to the product details on the right.

The product details page features a dark blue header with the text 'WHAT IS STIKBOX?'. Below this, it states 'Full-length selfie stick built into a phone case!'. A central image shows a blue phone case with a white selfie stick extending from the bottom. Dimensions are provided: Width: 2.9 in (75mm), Length: 5.7 in (145mm), and a small detail of 0.6 in (17mm). To the right, there is a list of color options: '(Blue/White/Black/Pink)'. Below this, it says 'Available for Samsung only.' and 'Regular retail price'. An 'ESTIMATED DELIVERY' date of 'May 2016' is shown. At the bottom right, there is a 'Pledge £29' offer and another list of color options: '(Blue/White/Black/Pink)'. The text 'Available for iPhone only.' is partially visible at the bottom.

Pretotyping



Smartphone Superpower



Smartphone Upcycle



Go for it?



Design

Essential User Task

Hike to that Mountaintop

Economically Launch 5000kg into LEO

Reveal the Microscopic World for \$2

Use Heart Rate Biofeedback to improve CBT Treatment

Accurately and efficiently execute tens of thousands of e-commerce orders with wildly different daily sku mix using transient labor

15 Iterations



Cost Calculations

\$100/unit (remote) vs \$400/unit (local)

50 sets per build, two major builds

\$10k (remote) vs \$40k (local)

One week delay - \$40k

\$50k (remote) vs \$40k (local)

ZeroDiff

A Simple Philosophy

**If you maintain zero difference between prototype and production designs,
you can mass produce any revision even when you iterate designs rapidly**

Corollary

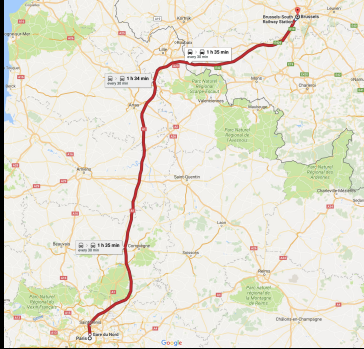
**Always manufacture prototype and production designs on the same tooling
- always**

Velocity



World Speed Record: 574km/hr

Velocity



Paris → Brussels: 314 km

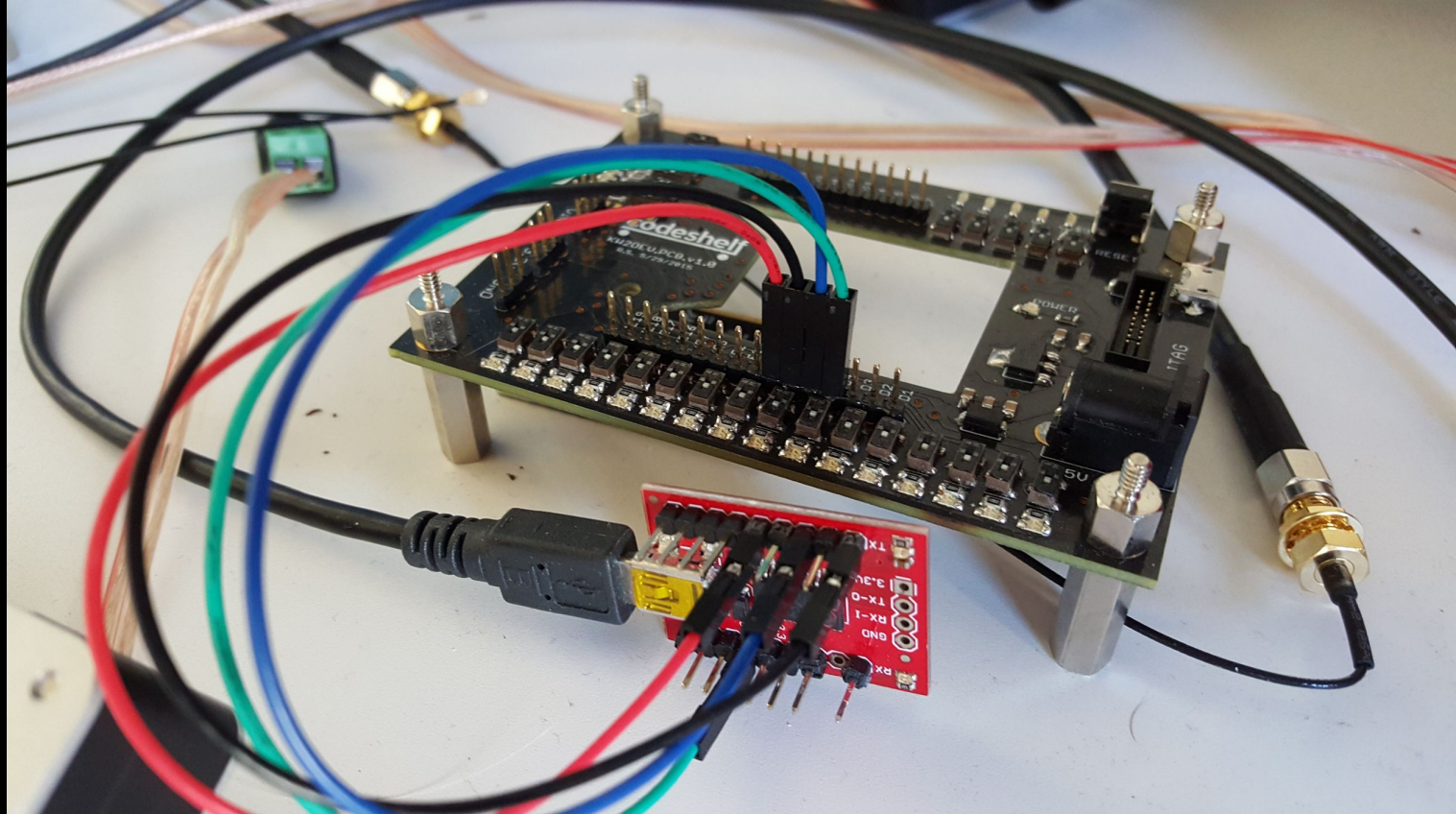
SNCF 574 km/hr → 32 minutes

10 minute station delay... now it's 42 minutes

Average velocity is now 448 km/hr... Taking us back to 1996!

Use a less expensive train, and still get there faster!

Kaizen



NY Review of Books

***“A pen is not a magic wand.* The critical faculty is not conjured from nothing. But it was remarkable how many students improved their performance with this simple stratagem. There is something predatory, cruel even, about a pen suspended over a text. Like a hawk over a field, *it is on the lookout for something vulnerable.*”**

–Tim Park

Read with a Pen

JeffW *KW2CPU v1.3*

2. PCB/A Development and Release Process

- Step 0: Kick-off Development Cycle
- Step 1: Create Design Artifacts (Engineer)
- Step 2: Create a Prototype Release
- Step 3: Test the Prototype
- Step 4: Create Production Artifacts (Engineer)
- Step 5: Create the Pre-Release/Release Package (Engineer)
- Step 6: Commit the Pre-Release Package to Git (Engineer)
- Step 7: Release Checklist (Engineer, HWTE and ProdMgr)
- Step 8: Release Tag (Engineer)
- Step 9: Arena (ProdMgr)
- Step 10: Build First Articles (ProdMgr)
- Step 11: Test and Validate First Articles (HWTE)
- Step 12: Release Announcement (ProdMgr)
- Step 13: Post Release Review (ProdMgr)
- Glossary

Ant. sel tied to CNA TX, ANT-1 ANT-2 ONP:?

Remove top JTAG
**TPs on top? CND TPD*
**Fix differential pair*
**Axial screw alignment*
**Snap-in Hirose*
**Ground change - foam*
** Net class for ANT*
** DRU/DFM files*
** Rebalance impedance*
** Antenna select change*
** I2C EEPROM*
** GPIO pins to Hirose*
** RF trace*

changes
add C-LNA res to VOPIN
- impedance

Step 0: Kick-off Development Cycle

The kick-off is essential to inform everyone that the object is now in-flight for another development cycle. The steps for kick-off are:

- Send an announce email to rd@codeshell.com
- Schedule kick-off meeting
- Create a JIRA epic for the object. E.g. "CHECON-PCBA-New Display"
- Create relevant JIRA stories (including steps 0-13 in this document)
- Go to the hardware release page and update the relevant information for the device and any relevant sub-component projects: Current and Planned Hardware Releases
- Print this page and make sure it follows the device through the development cycle.

** TP18 UNITS/CTS*
** Analog-a shutdown*
** Detach c-LNA control*
** Change 32MHz XTAL caps*
what did I have before?

Step 1: Create Design Artifacts (Engineer)

The first step to the design and manufacture of a PCB/A is to create all of the relevant design and production artifacts (files).

EagleCAD schematic

The first step for any new design is to capture it as an EagleCAD schematic. This is the architectural design document of the circuit. The schematic contains all of the parts in the design and is the central source of the BOM for any design.

Markdown + mkdocs + Github

The screenshot shows a web browser displaying a page on ZeroDiff. The navigation bar at the top is blue and contains links for Home, Beginners, Design, Hardware, Test, Glossary, and About. There are also search and navigation icons. The main content area has a light gray grid background. On the left, there is a sidebar with a list of links related to 'Kaizen'. The main text area contains the title 'Kaizen', a sub-header 'From the "Read with a Pen" TinyLetter post.', and a URL. The body text discusses lean manufacturing, process efficiency, and the author's experience with Toyota. At the bottom, there is a section titled 'Saved by the New York Review of Books' with a paragraph of text and a URL.

ZeroDiff Home Beginners ▾ Design ▾ Hardware ▾ Test ▾ Glossary About ▾ Q Search ← Previous Next → GitHub

Kaizen

From the "Read with a Pen" TinyLetter post.

<https://tinyletter.com/zerodiff/letters/zerodiff-efficient-kaizen-read-with-a-pen>

Done right, Kaizen reduces mistakes and waste. But what happens when process itself is the waste? We all experience this: the application of process to reduce mistakes (and waste) sometimes ends up being worse than the mistakes the new process reduces! To me, this is a central difficulty to "being in charge."

I started my career in factory automation with a mentor who embraced lean manufacturing decades ahead of its current stylishness. I would read anything even remotely connected to 1950s-80s Toyota Motor Company. I read "The Machine that Changed the World" twice. Because my natural inclination is laziness, "lean process" appeals to me deeply. So of course I'm a sucker for Eric Ries and Steve Blank's "Lean Startup" movement. Ditto for "The Prototyping Manifesto."

The key to lean operation is efficient, well-documented processes that everyone can easily follow and get right. Our process docs work like checklists. Checklists have been proven to prevent stupid mistakes by smart people - it's why doctors and pilots use them without exception.

Despite a big investment in good process and documentation, we used to make a lot of repeat mistakes. It drove me nuts. One careless mistake by a smart person cost us about \$75K. The harder I tried to stop these, the more frustrated the staff would get. The psychic load would offset the process wins. Plus, we'd invest more process only to trade one set of problems for another and have little gain to show for the investment. Sound familiar? No one likes this, yet we do it all the time!

Saved by the New York Review of Books

Often, late at night, I vacuum up the Internet on the hunt for cool ideas that I can apply to innovation of all sorts: product, process and people. One night last year, right after we started ZeroDiff, I ran across this [Tim Park](#) essay in the New York Review of Books:

<http://www.nybooks.com/blogs/nyrblog/2014/dec/03/weapon-for-readers/>

This sentence from Tim's essay hit me like lightning:

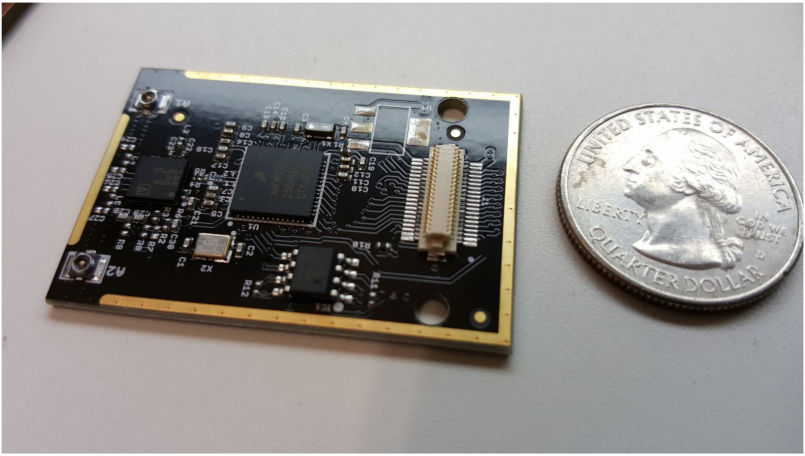
www.zerodiff.org

ZeroDiff Home Beginners Design Hardware Test Glossary About Search Previous Next GitHub

ZeroDiff
An Agile Process for Hardware Design and Development
Overview
Kill the Waterfall Method (Again!)
Permission-based Production is Terrible
The Joys of High-Value at Low-Volume

ZeroDiff

An Agile Process for Hardware Design and Development



A New Way to Design and Develop Products

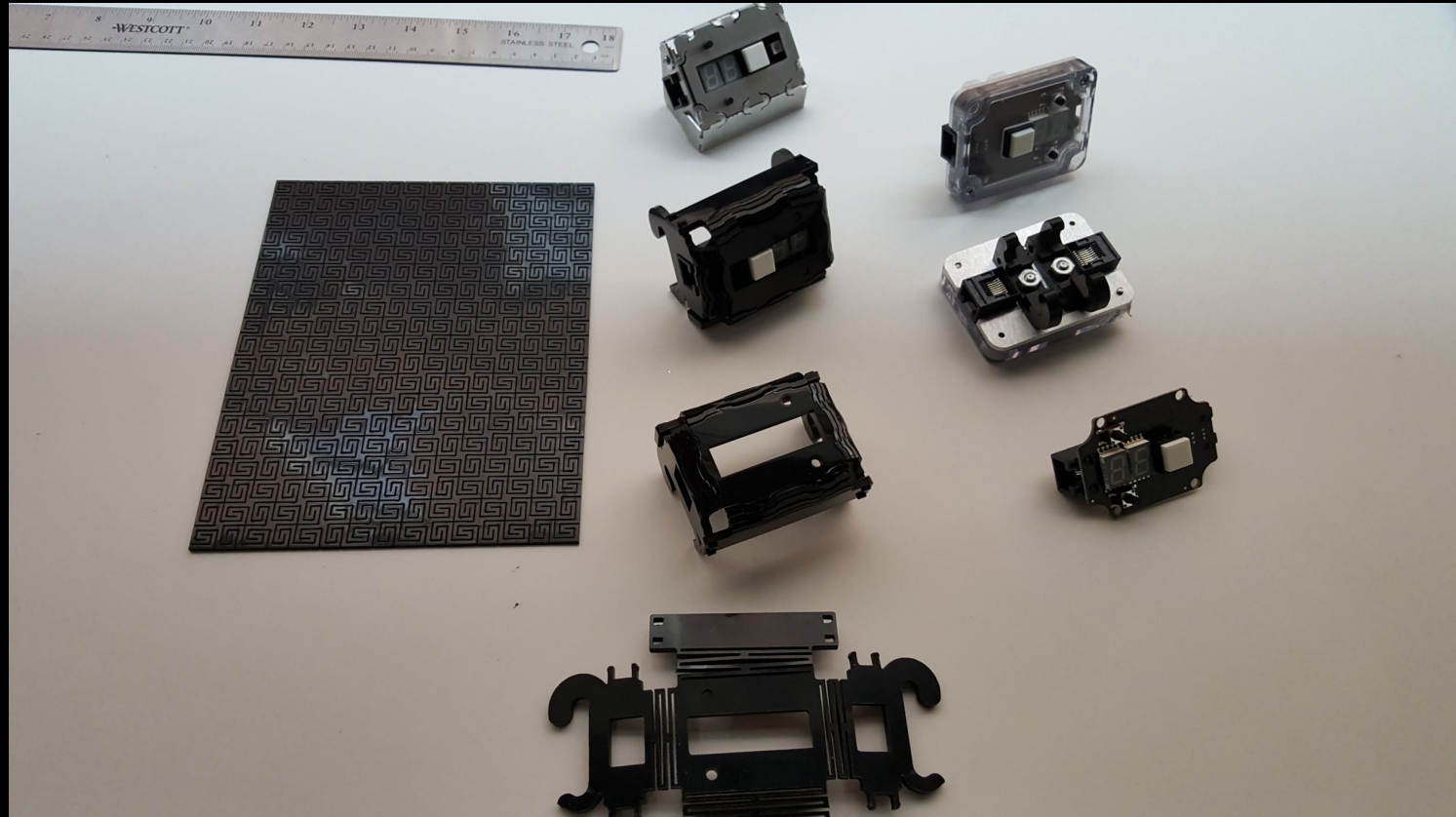
Origami



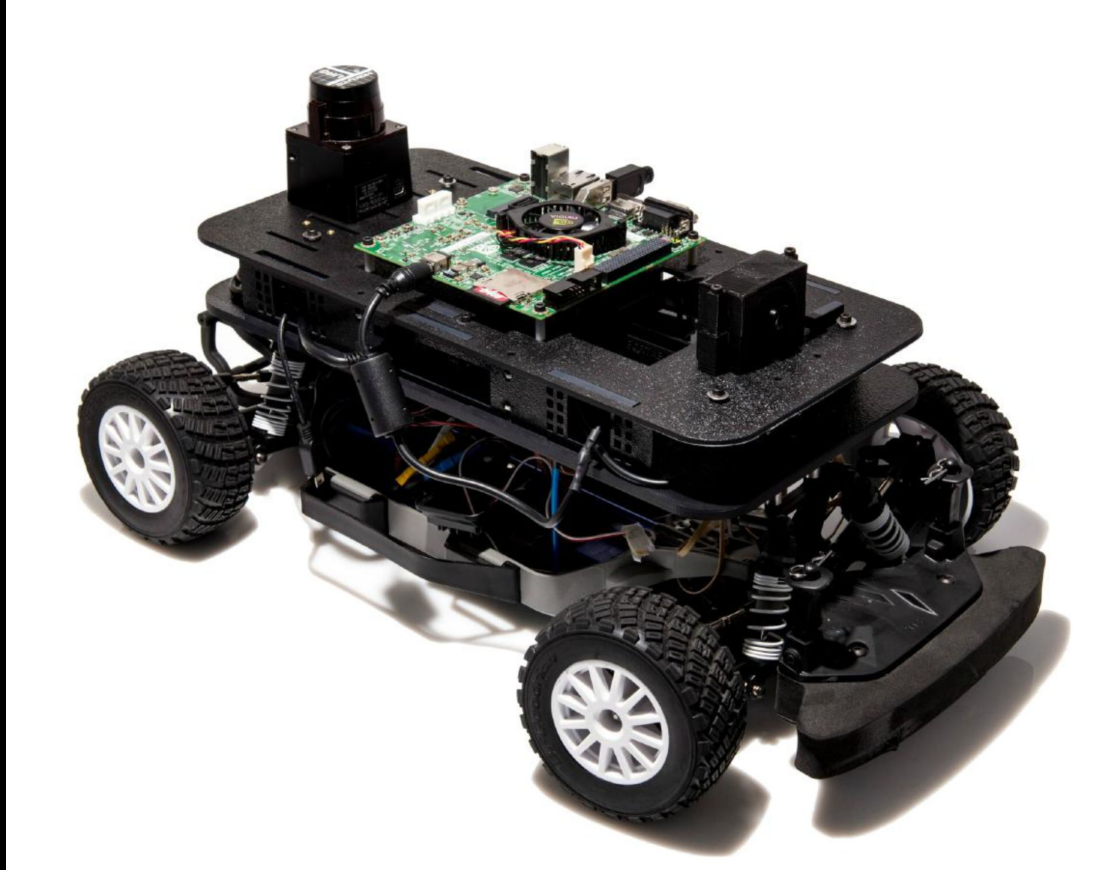
Industrial Origami



Poscon Origami Example



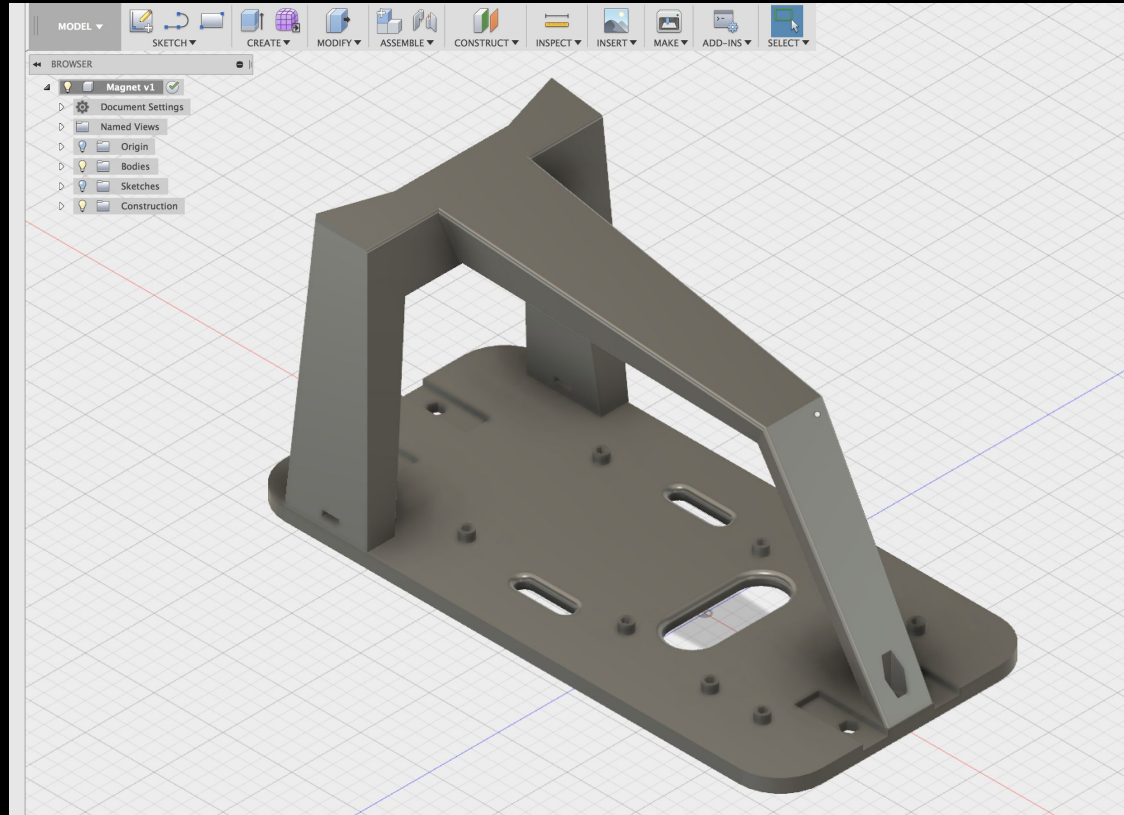
F 1/10 Robot Racing



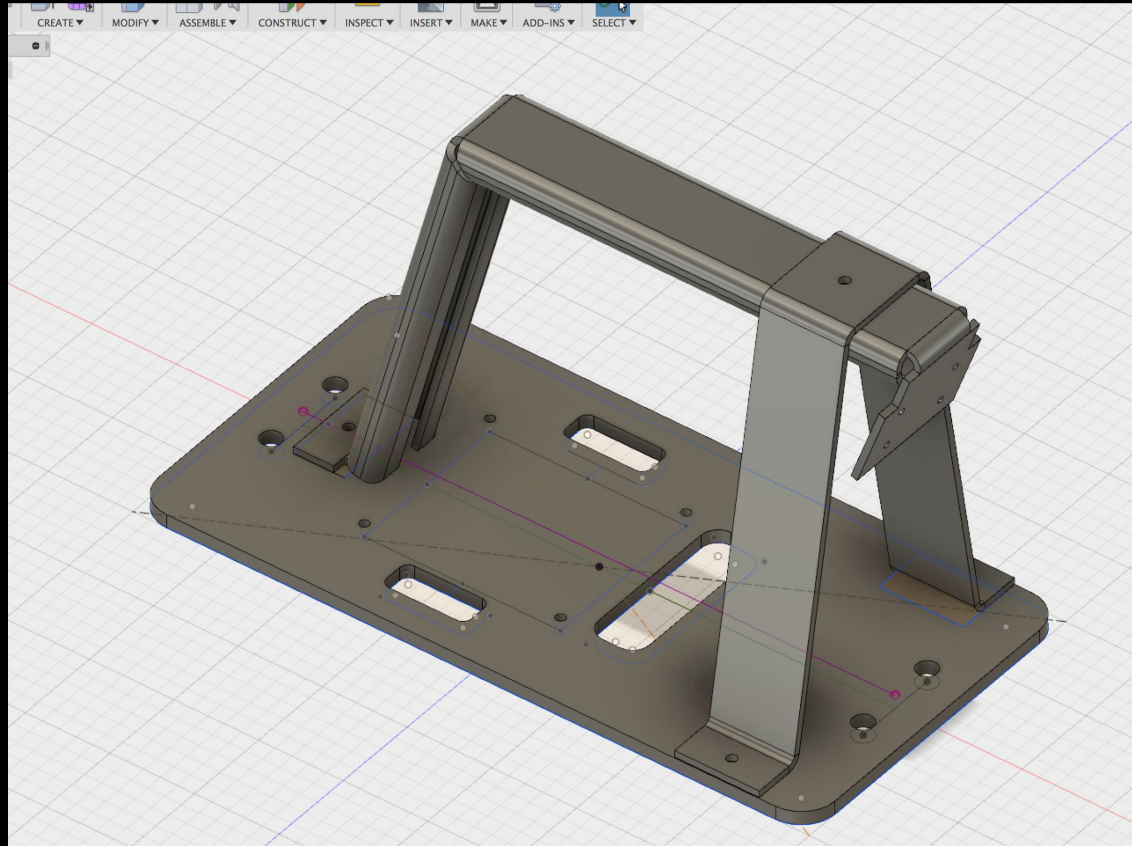
Donkey Car



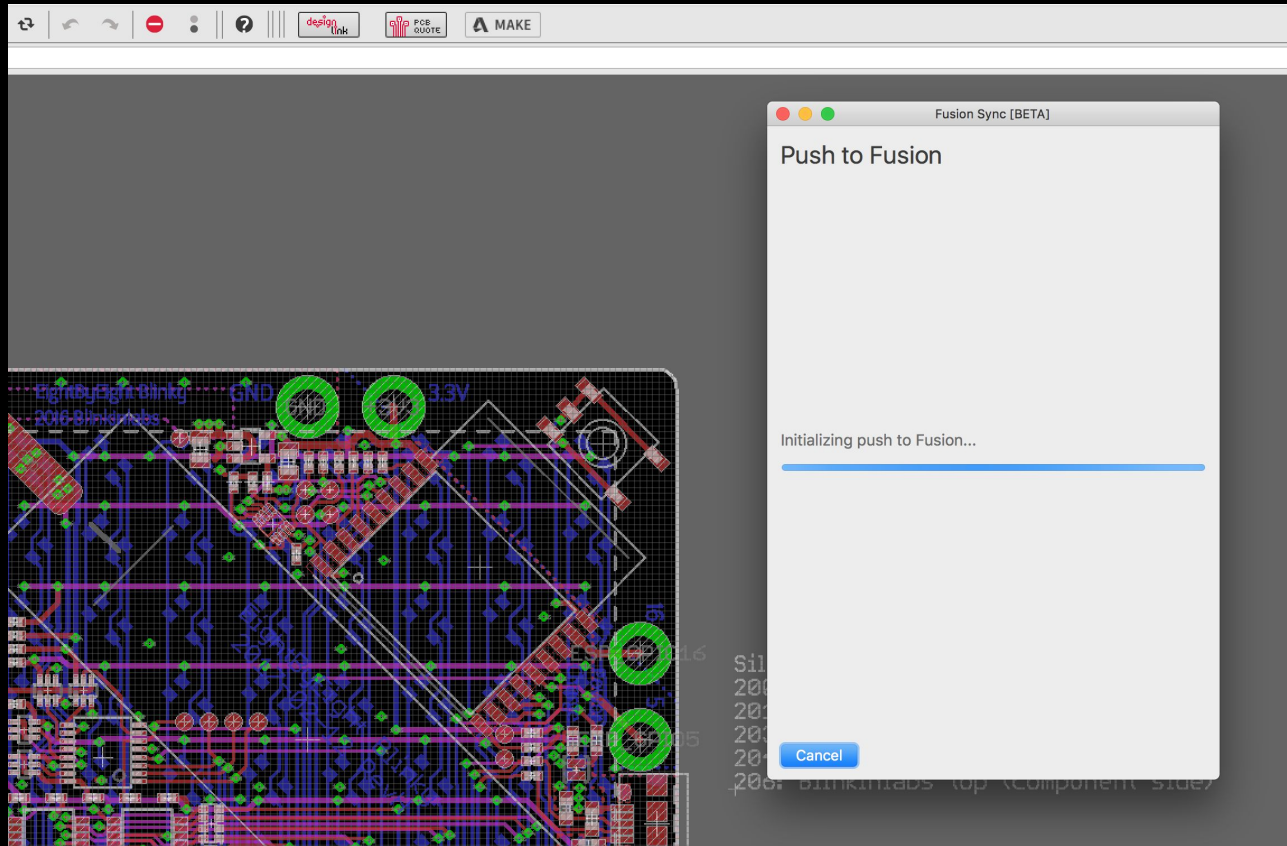
3D Printing is Slow/Expensive



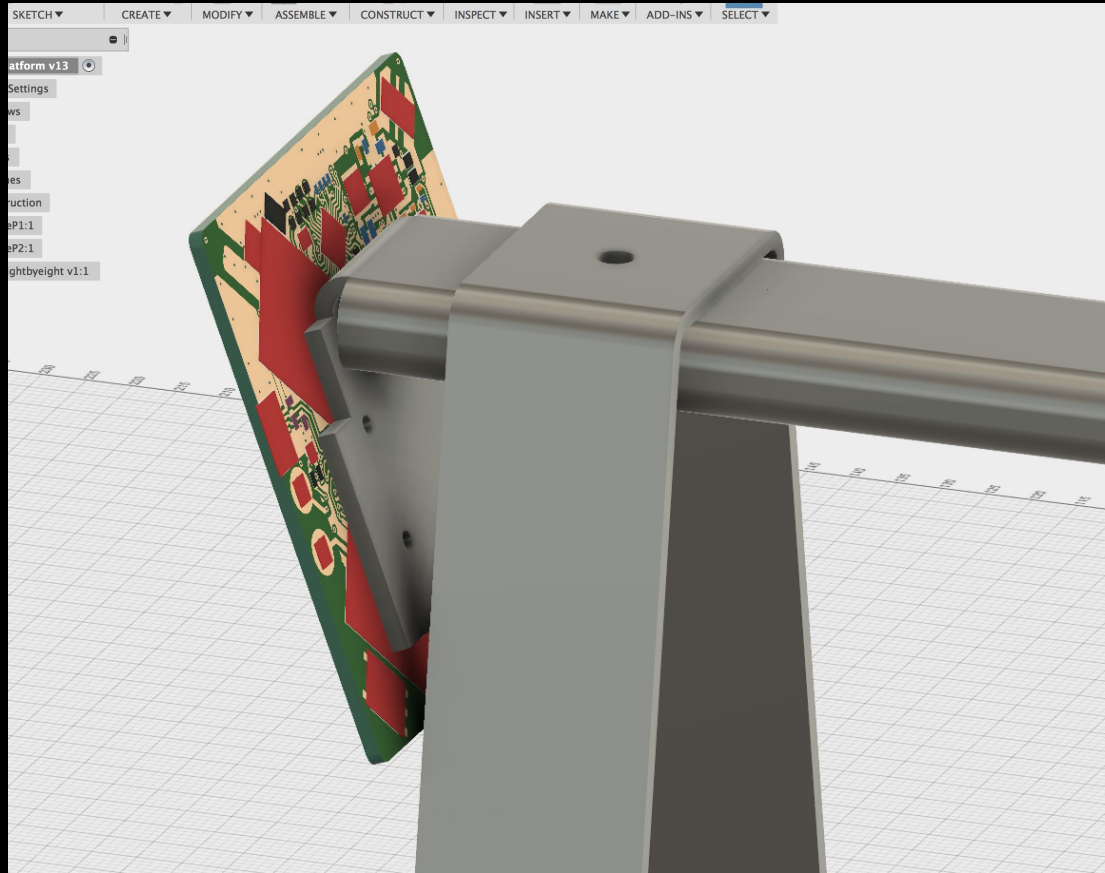
Design Stuff with Fusion 360



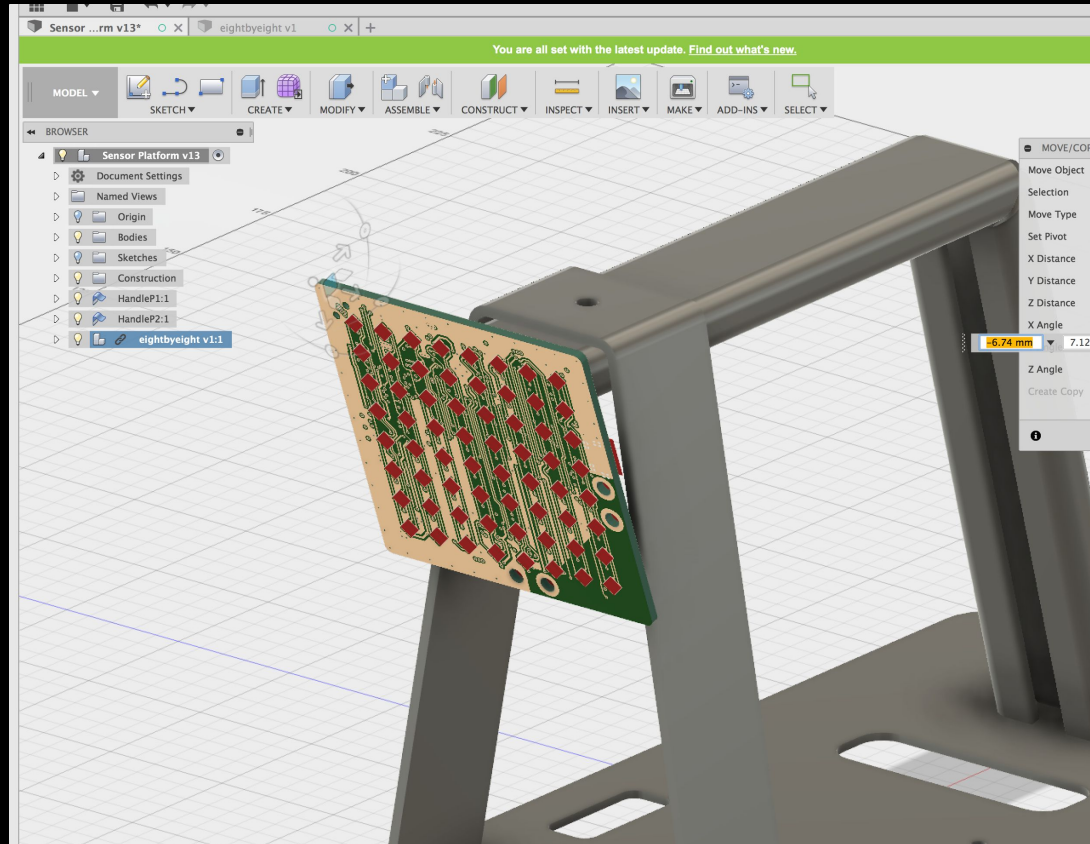
Push EagleCAD to Fusion360



Combined Object



Iteration Toward a \$25 Robot!



Don't Even







Image credit: Kenny McDonald



If they fear bill collectors or authorities, they can never ride

My Essential User Task



Cheap Open Source Robots that Workers Own and Program

Bits

tinyletter.com/zerodiff

www.zerodiff.org

jeff.williams@addrobots.com