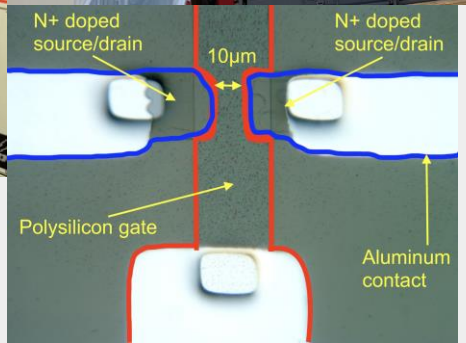
the open-source semiconductor fab.

Elio Bourcart | Alexander Hakim

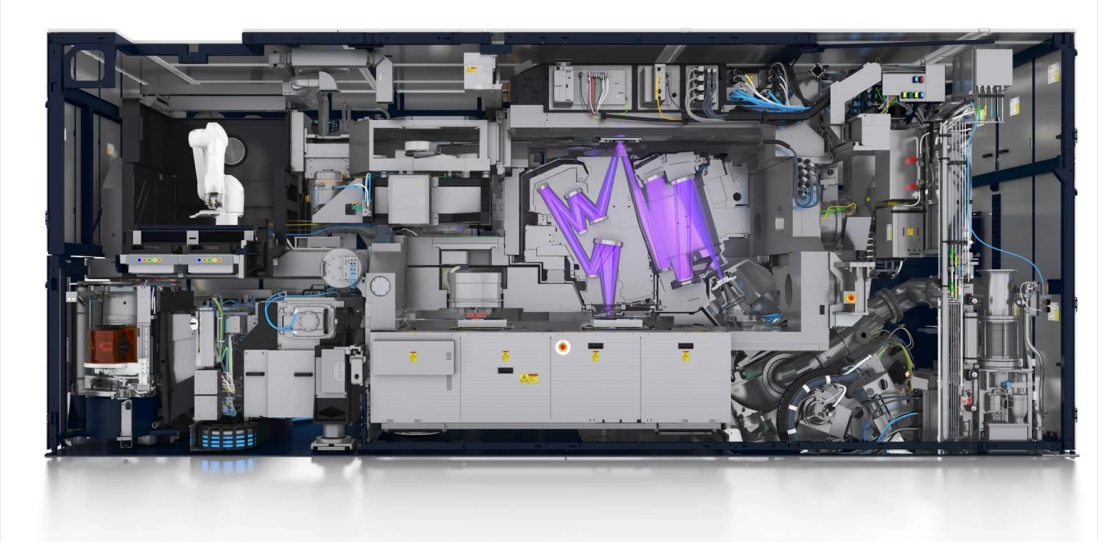
Sam Zeloof - The Garage Fab



Hacker Fab

The Semiconductor Fabrication Workforce Problem

How can the semiconductor industry demand the continuation of Moore's Law without students who invent new approaches, particularly when gaining hands-on experience requires access to immutable million dollar equipment?



$300M EUV Stepper Credit: ASML

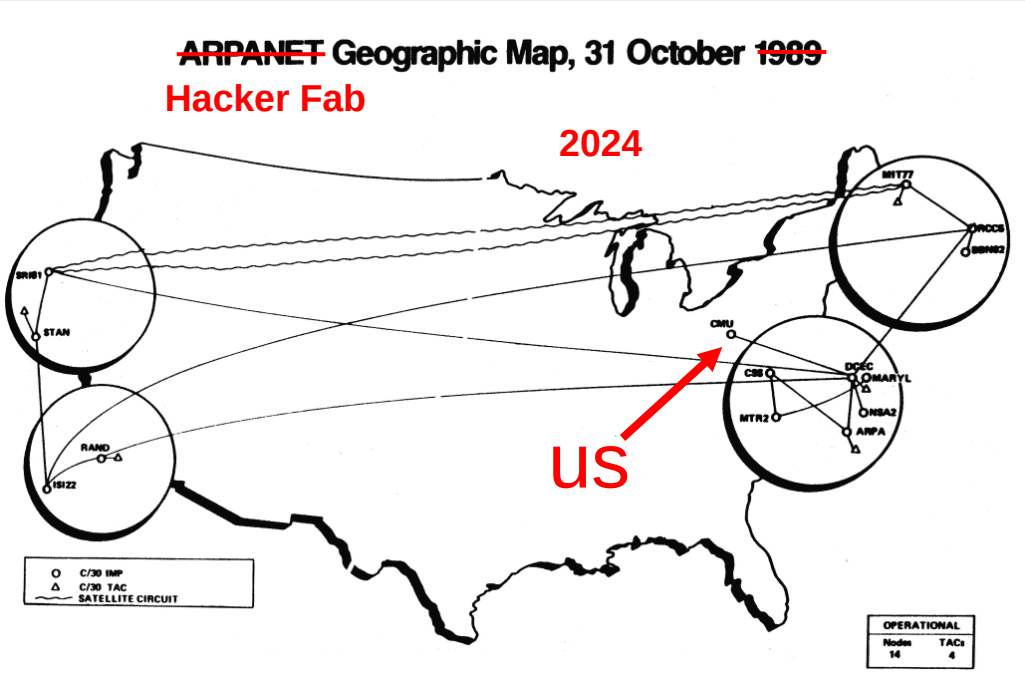
Hacker Fab

Our Goals:

1. Make the best semiconductor fab workforce education project

1. Create the largest collaborative open source hardware project

Here's How We're Starting



Create instructions for other institutions to form their own chapter of the Hacker Fab by:

- Open-sourcing machines
- Centralizing documentation
- Sharing process data
- Lowering fab cost requirements

Hacker Fab

Somewhere under Carnegie Mellon, January 17th, 2023

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Last Month

$70k, 600 sq ft, 4.5 kW, 12 people

Hacker
Fab

Fall 2023 Class: 15 Students, Freshman to PhD

Electrical, Mechanical, Materials, and Chemical Engineering Students

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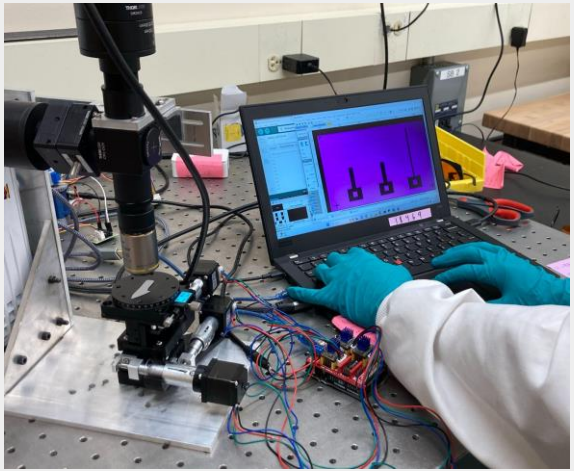
The Course Structure

Projects

Build new tools and processes



Labs

Make MOSFETS from scratch

Lectures

Learn nanofab techniques

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Human-Hours of Homework Every Semester

30 Students * 4 hours of homework per week * 14 weeks

= 1680 hours of work every semester

Let’s build something with this!

Hacker Fab

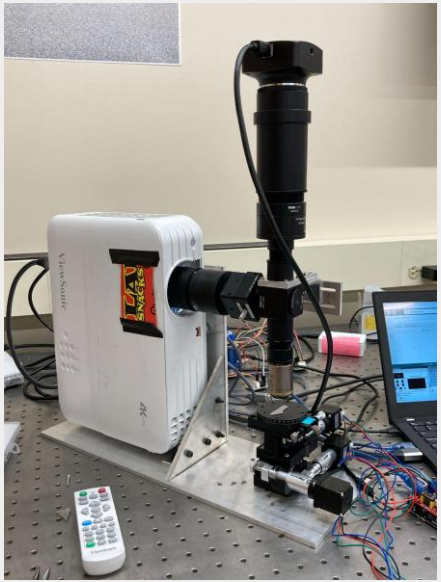
Tools we've built so far with complete documentation

Vacuum chuck spin coater

$5,000 → $200

Maskless Lithography Stepper

$100,000 → $6000



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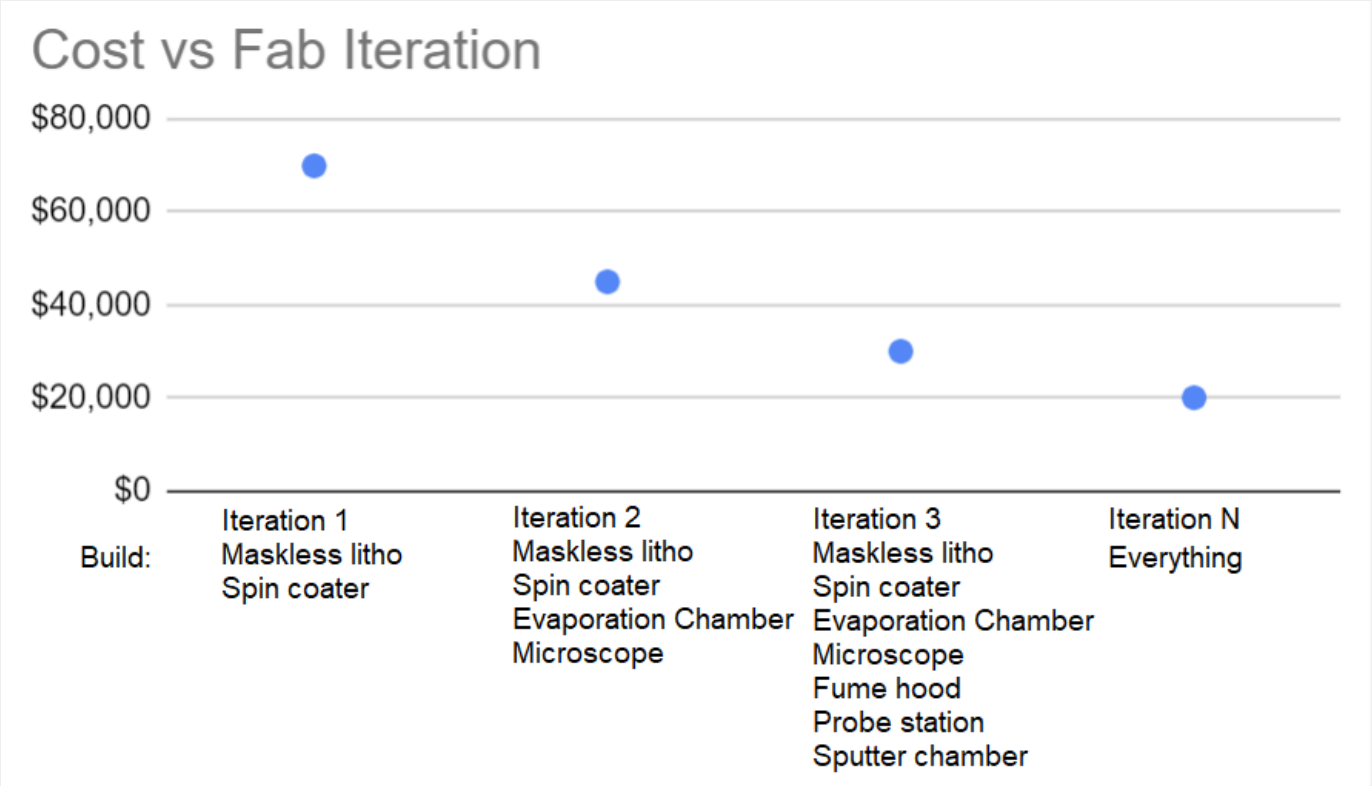
How much does your fab cost? Ours cost $70k.



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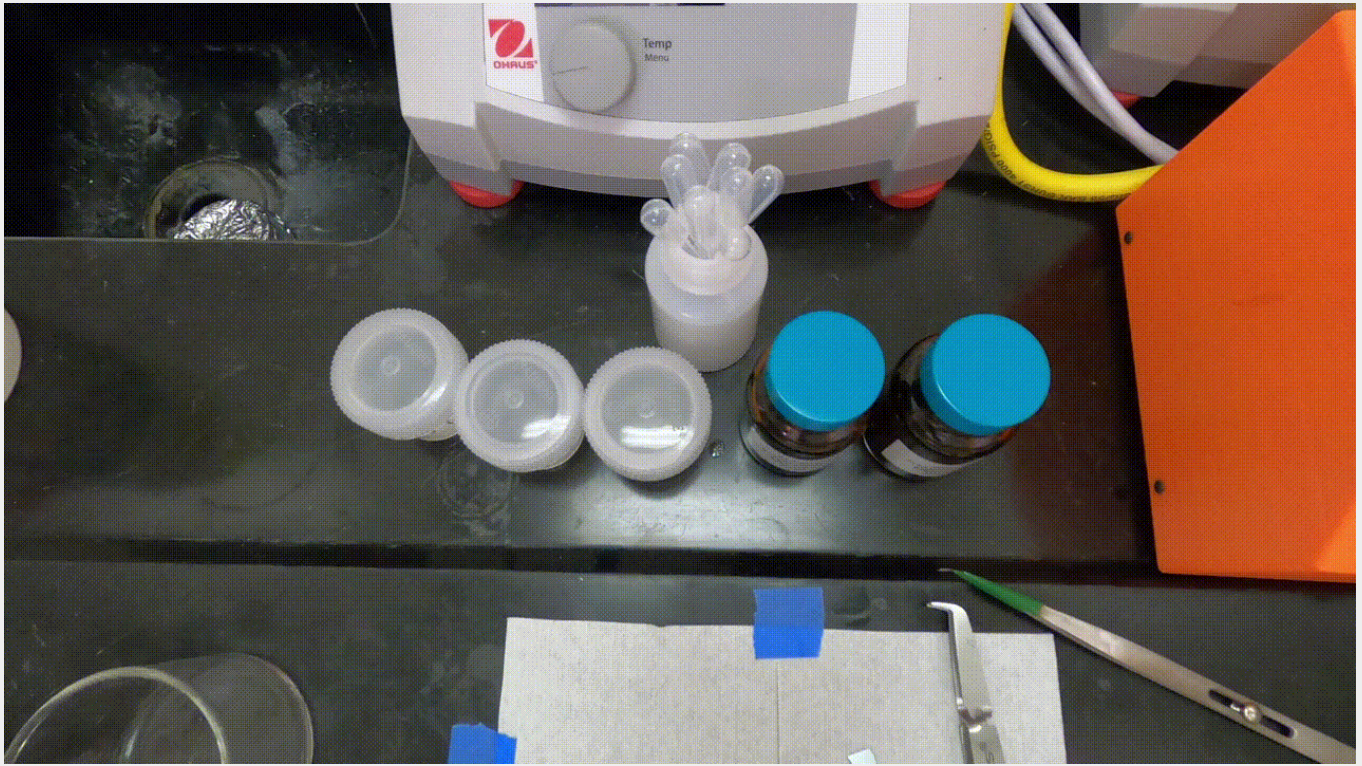
Lowering the Barrier to Entry Does not Simply Mean $



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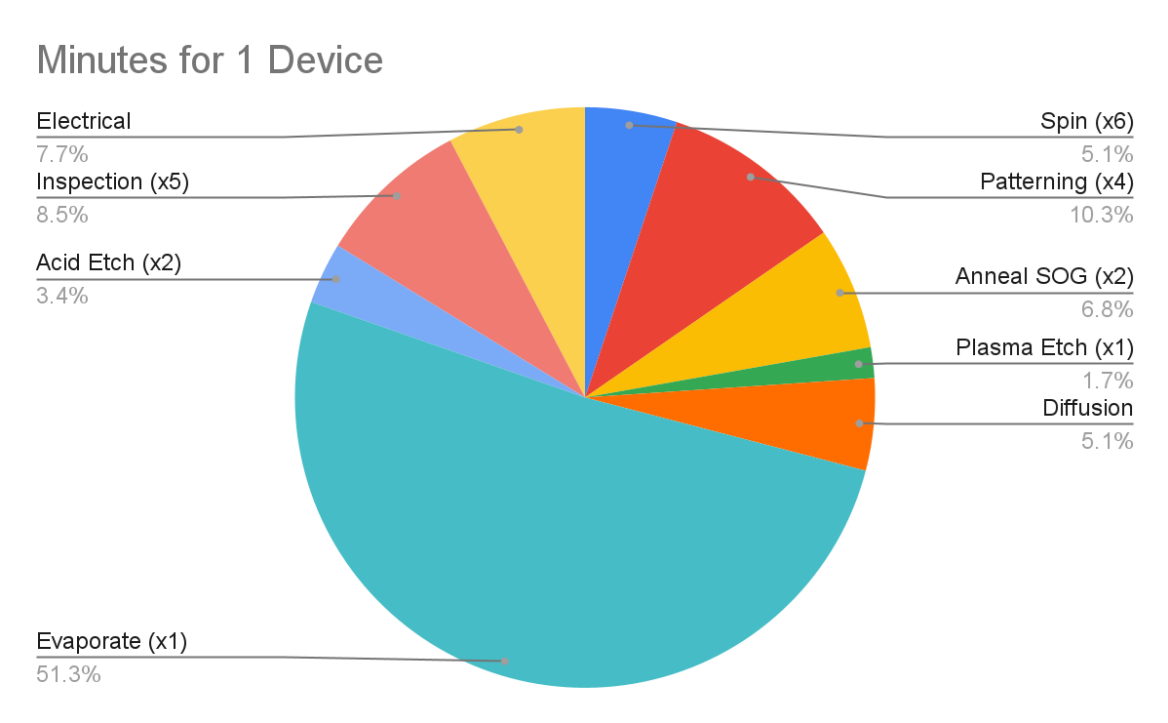
Tapeout Time in the Hacker Fab: 10 hours



	Minutes for 1 Device
Spin (x6)	30
Patterning (x4)	60
Anneal SOG (x2)	40
Plasma Etch (x1)	10
Diffusion	30
Evaporate (x1)	300
Acid Etch (x2)	20
Inspection (x5)	50
Electrical Characterization	45
Total Tape-Out Time	585 (~9.5 hours)
Active Work	240 (~4 hours)

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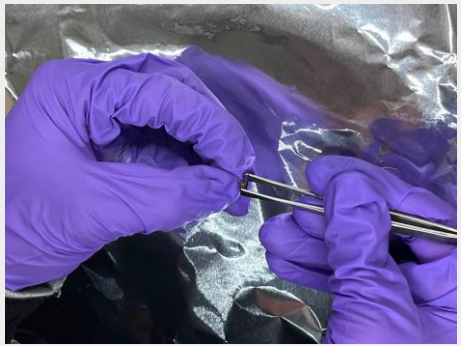
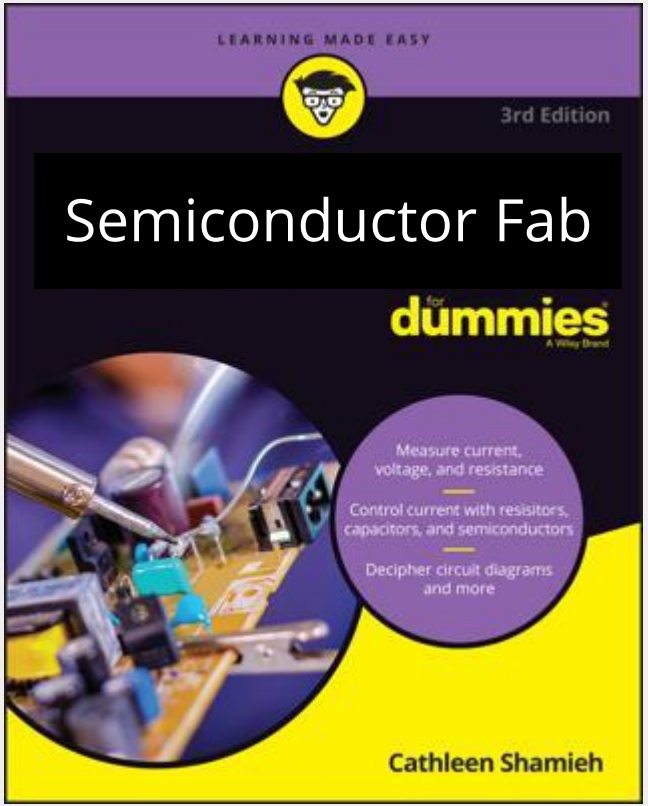
Excellent Process Manuals

Any student should be able to walk in and make chips with no supervision

This will support other courses and research





Hacker Fab

Our Goals:

1. ~~Make the best semiconductor fab workforce education project~~

1. Create the largest collaborative open source hardware project

Human-Hours of Homework Every Semester

30 Students * 4 hours of homework per week * 14 weeks * N schools

Let’s **really** build something with this!

Hacker Fab

Open-Source Software is not Open-Source Hardware

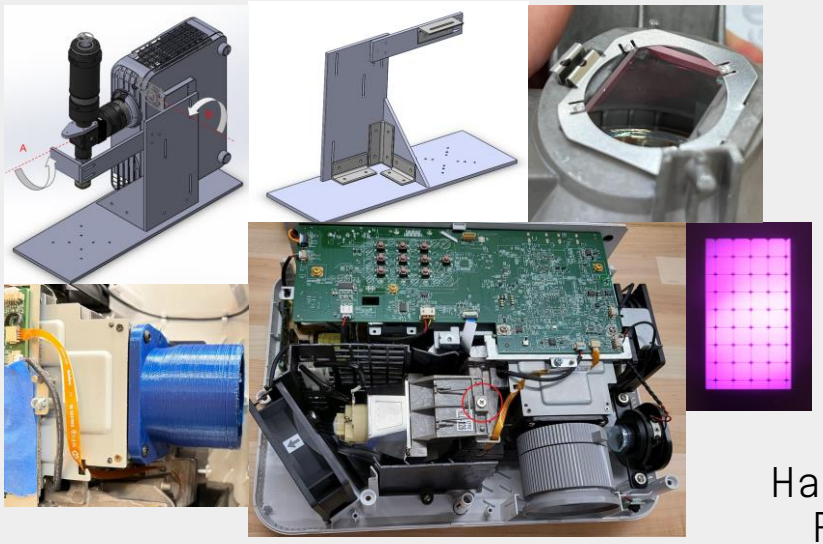
Software

Downloading the latest version takes 5 seconds

```
git pull
```

Hardware

Replicating means buying, building, testing equipment. This takes weeks.



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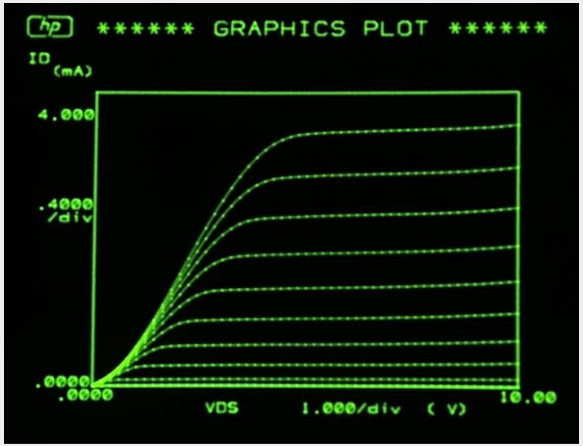
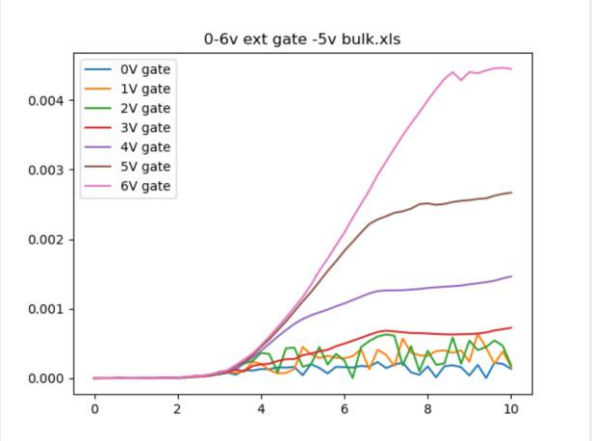
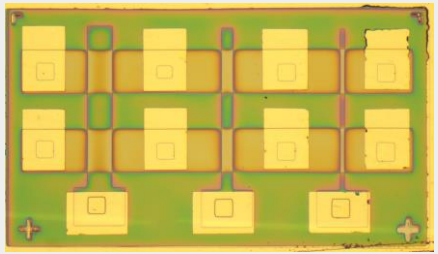
The Next Hacker Fab's Chips Won't Work the First Time

Sam's Z2



Hacker Fab 10µm NMOS





Documentation is an iterative process, there are parameters you don't know exist until someone else tries to replicate

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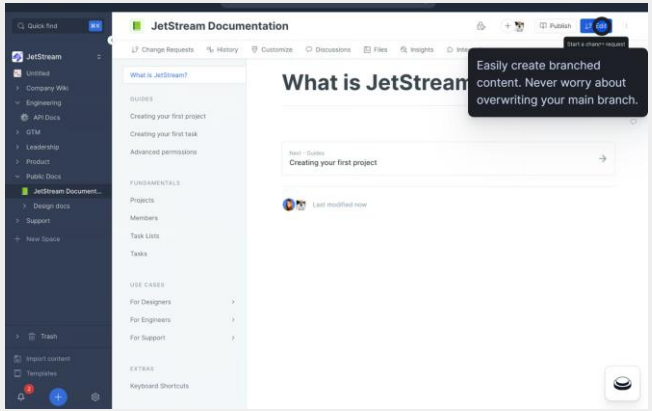
Improvement of Documentation Emerges from Project Infrastructure

Our first mistake: don't "release" a finished product, **develop** in public

Throwing files into a github with a README.md is not collaborative

GitBook

Gitbook provides Git-style version control for readable technical documentation



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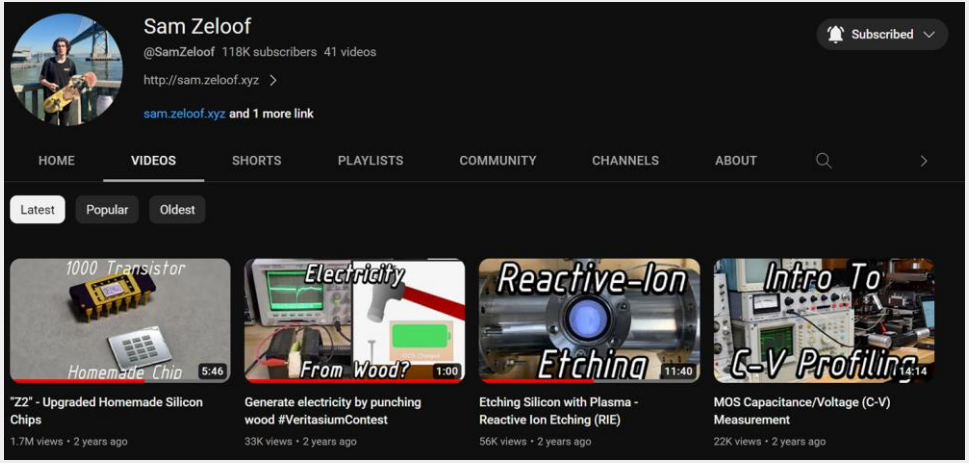
Engineers Hate Documentation...

Until They Feel Audience Feedback



Documenting the debugging, like a story, saves people hours of work

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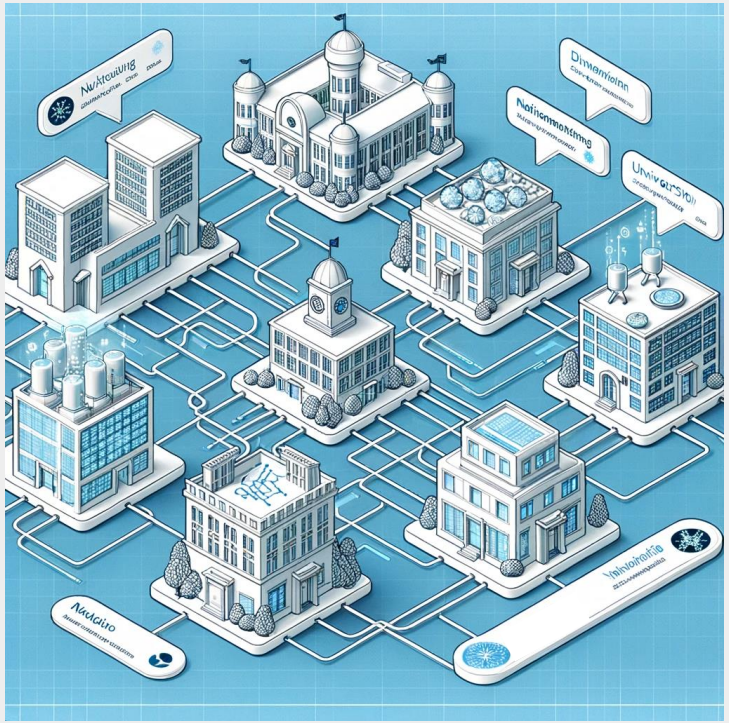
Sharing Fab Data

New Hacker Fabs will be able to leverage data from existing Hacker Fabs.

Tools will upload to a single Hacker Fab database by default

Account for differences in hardware - each tool has a unique ID



Hacker Fab

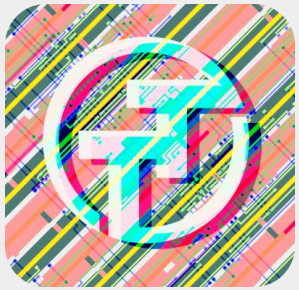
Open Source IC Design is Booming

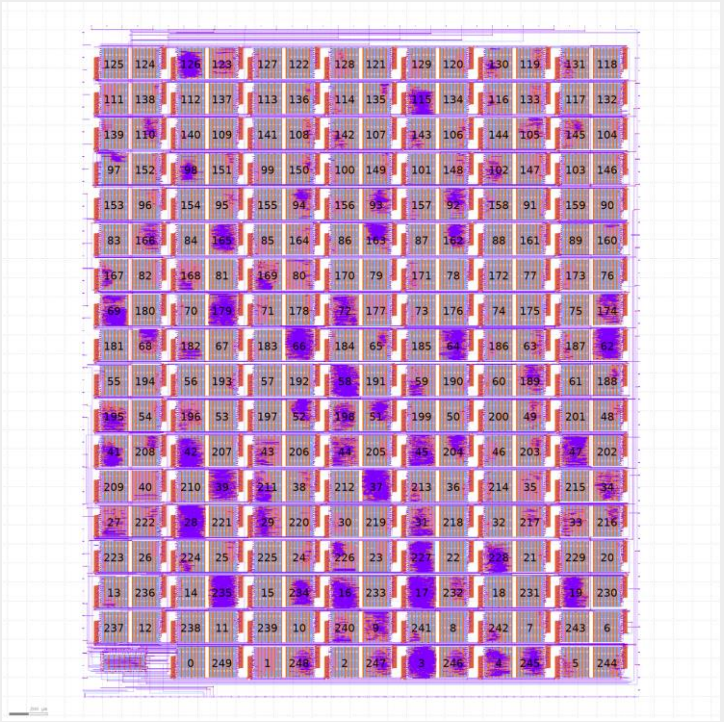
Tiny Tapeout for $100

Zero to Asic Course

Open Source PDKs

Open Source Design Tools





Credits: https://tinytapeout.com/
https://zerotoasiccourse.com/

Hacker Fab

We’d love to hear from you!

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Questions?

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