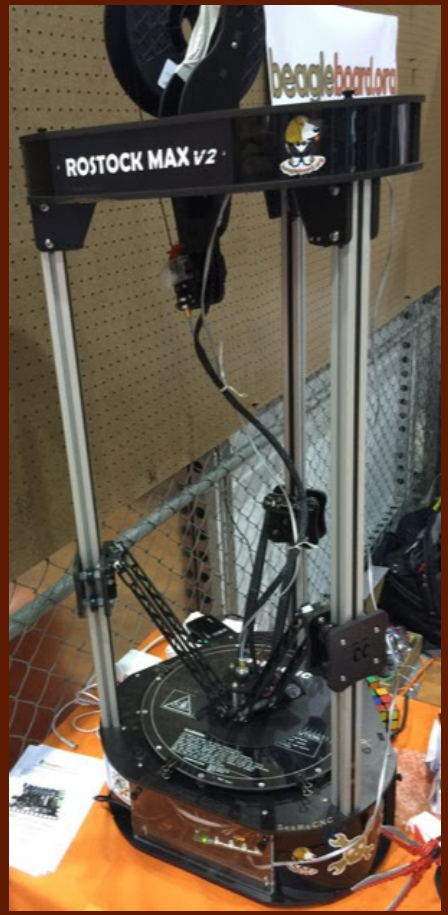


BUILDING 3D PRINTERS WITH MACHINEKIT AND BEAGLEBONE BLACK

beagleboard.org™ Jason Kridner, jkridner@beagleboard.org

Slides available

- http://beagleboard.org/show
- To be uploaded after the show
- Still under-going lots of updates

3D printing basics - http://reprap.org

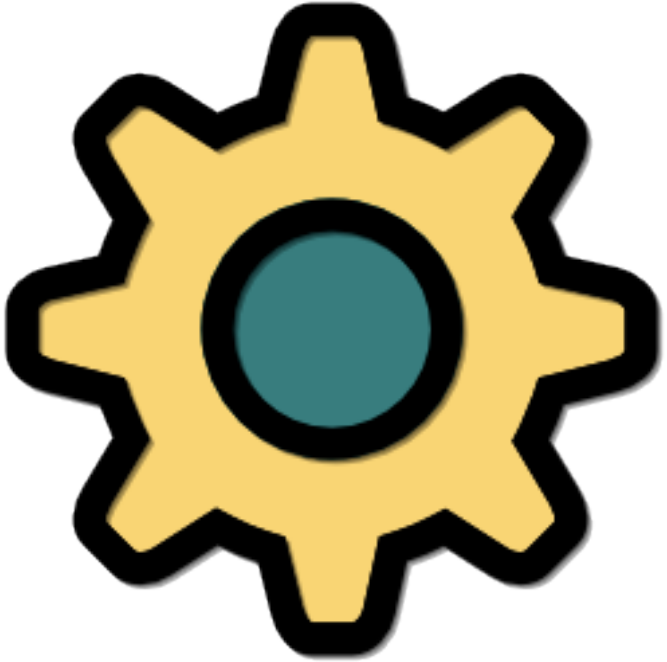
- Additive manufacturing
  - Plastic extrusion, rosin stereo lithography, ...
- Geometry
  - Cartesian, Delta, CoreXY/CoreXZ
- Machine control
  - Stepper motors, heating elements
- Software
  - Gcode interpreter, slicer, web interface

http://reprap.org/wiki/RepRapLogo

What is Machinekit?

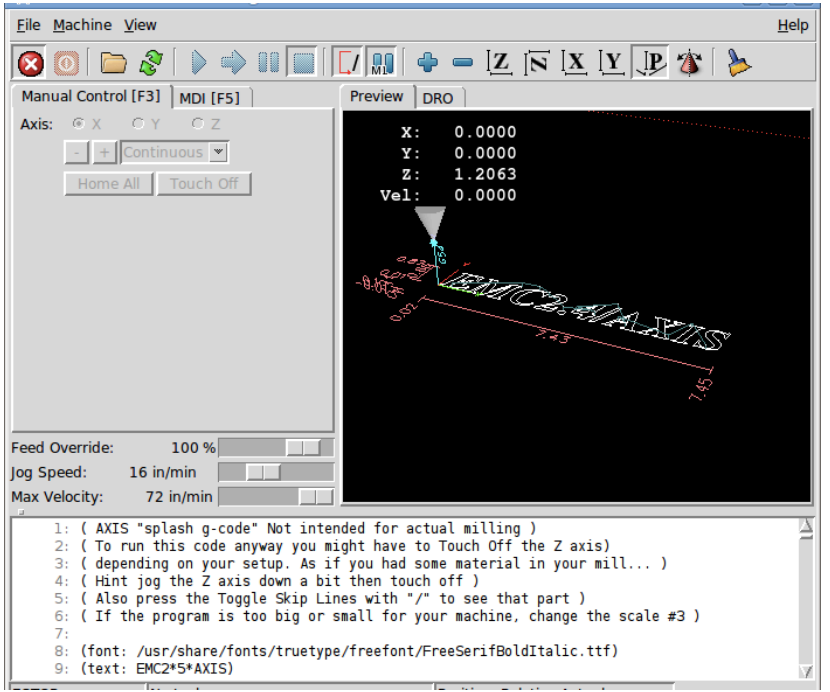
http://www.machinekit.io/

- Platform for machine control applications
- Built on Linux and portable across variety of hardware and real-time environments
- Interprets Gcode to control your machine



Machinekit is more than just a Gcode interpreter

- Interactive machine control
- Replaceable interface



BeagleBone Black

Open hardware computer for makers

Truly flexible open hardware and software development platform

All you need is in the box

Proven ecosystem from prototype to product

BeagleBone Black

- Ready to use: ~$50
- 1 GHz performance and embedded microcontrollers
- On-board HDMI to connect directly to TVs and monitors
- 512MB DDR3
- On-board 4GB flash storage frees up the microSD card slot
- Support for Cape plug-in boards: http://beaglebonecapes.com

Most affordable and proven open hardware Linux platform available

beagleboard.org™

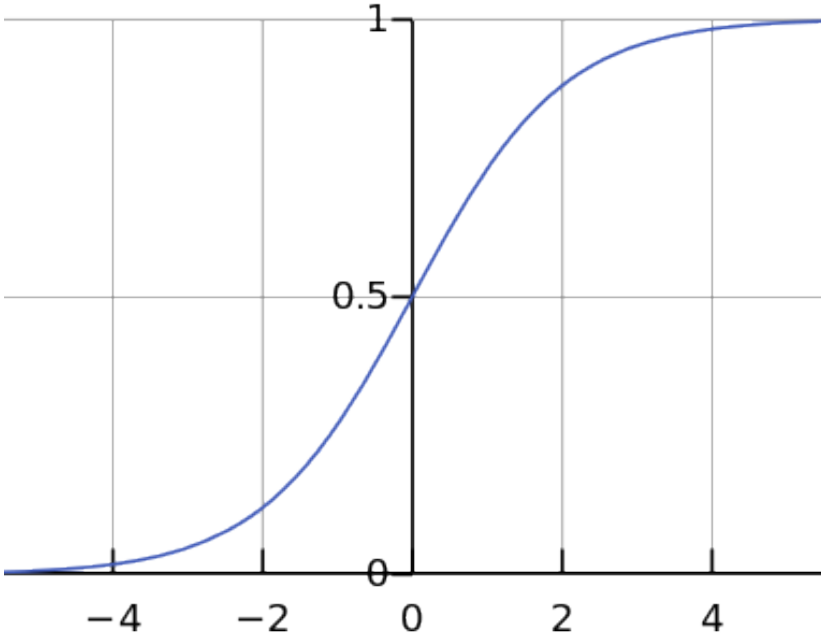
Why is BeagleBone Black perfect for machine control?

- Supported by Machinekit image
  - Easy to add to default Debian image via apt-get
- Based on industrial control and communications chip
  - Real-time microcontrollers (PRUs) guarantee predictable timing
  - Analog inputs, PWMs, quadrature encoders included
- Fast main processor (1GHz ARM Cortex-A8)
  - Runs Linux, supported in kernel mainline
- Open hardware enables derivative designs

http://reprap.org/wiki/Wally

How to drive a machine fast

- Need constant acceleration
- Need to adjust for complex geometry



http://en.wikipedia.org/wiki/Sigmoid_function

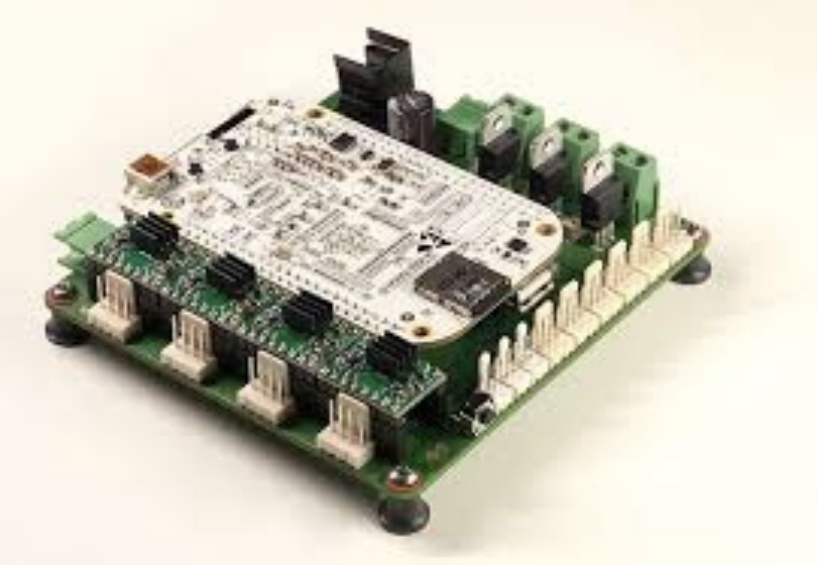
Controller boards

http://beaglebonecapes.com

BeBoPr: BeagleBone Printer

https://github.com/modmaker/BeBoPr

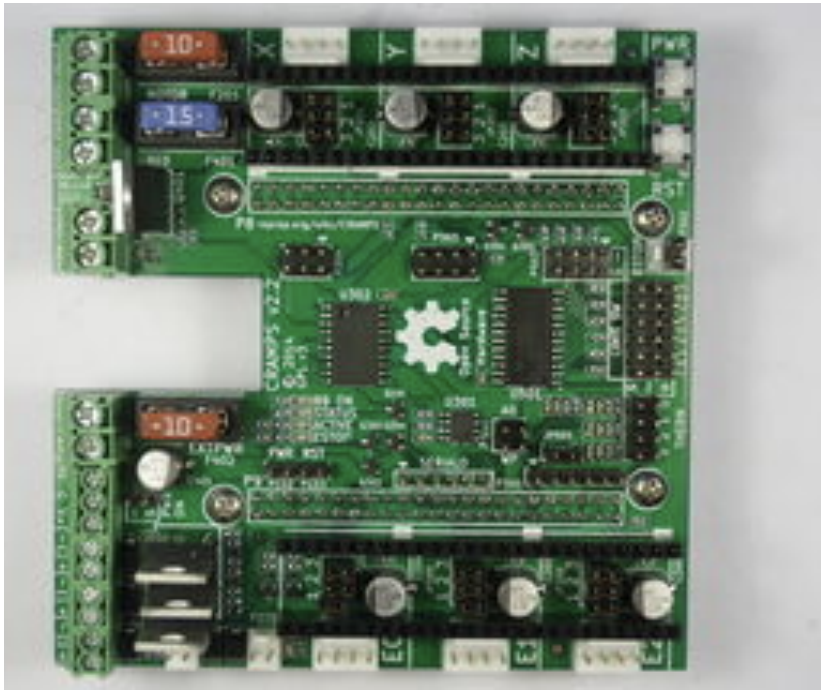
- First cape from the community
  - Originally for BeagleBone (white)
- Easy to wire up stepper motor drivers
- CircuitCo made several of first units
  - Sign up at booth for a giveaway
- Developer (Bas) did several updates and has other manufacturing now
- This is what I used for my demo



CRAMPS: Cape RAMPS for BeagleBone

http://reprap.org/wiki/CRAMPS

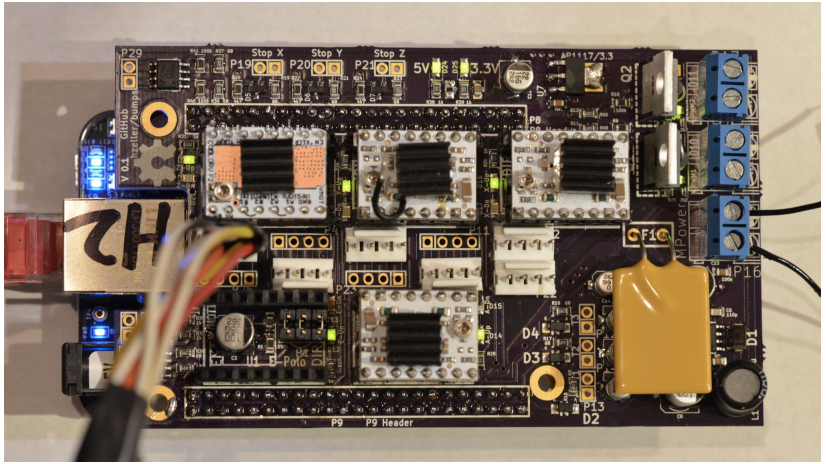
- Developed by one of the Machinekit maintainers



BUMPS: BeagleBone Universal Multi Pololu Steppers

https://github.com/hzeller/bumps

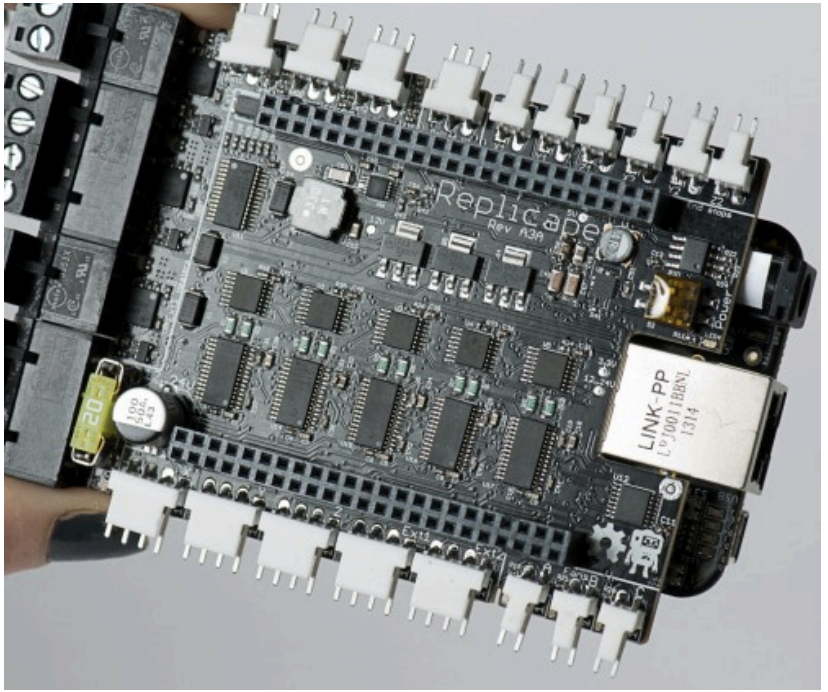
- Developed by makers of BeagleG Gcode interpreter



Replicape

http://thing-printer.com

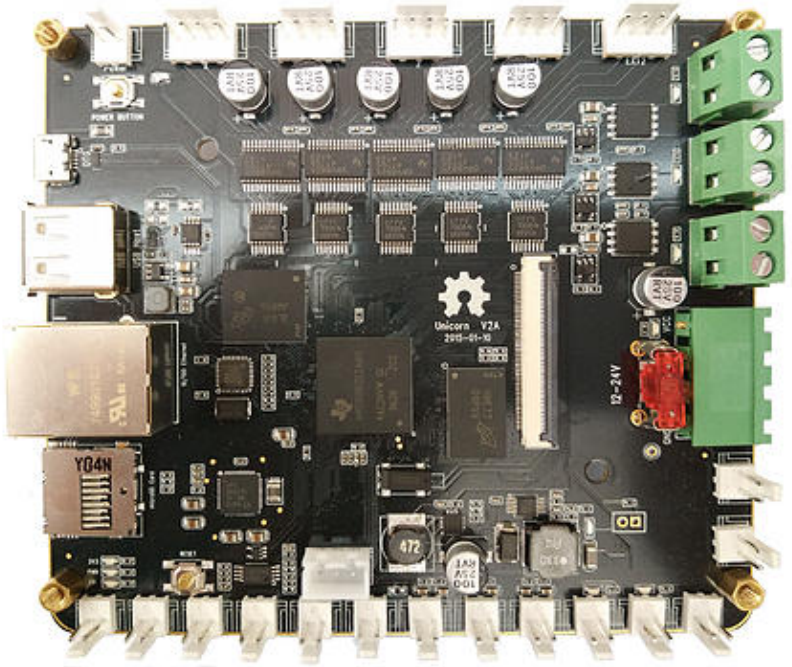
- Designed by Elias Bakken
- Integrates stepper motors onto single board
- Software controlled drive strength
- Also makes Manga Screen



FastbotBBP: machine controller

http://bit.ly/beagleprinter

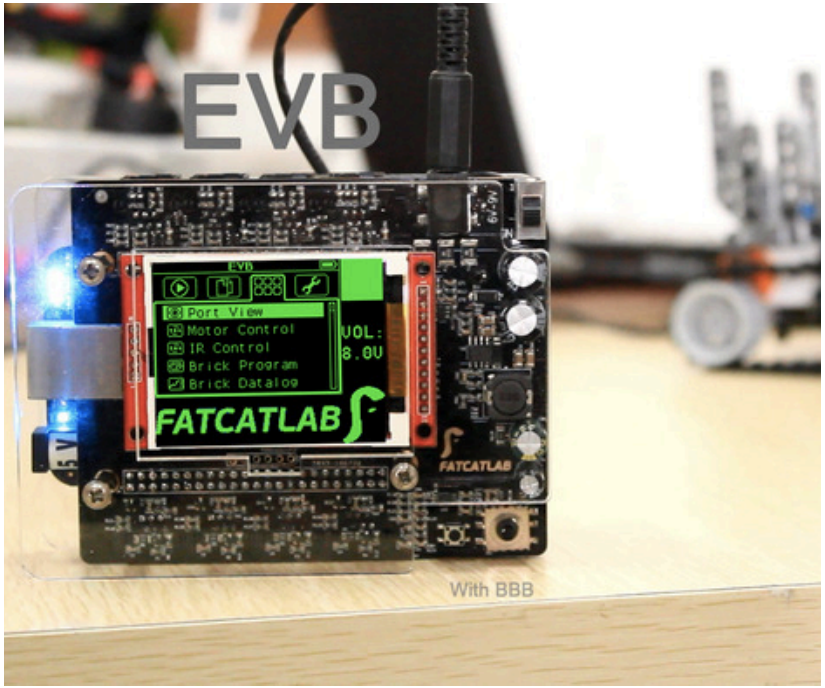
- Community member in China (Truby Zong)
- Combined BeagleBone Black and Elias Bakken's Replicape
- Sold on Kickstarter for $89



What about using LEGO robotics?

http://www.fatcatlab.com/

- Successful Kickstarter
- Runs LEGO software
- What about running Machinekit?



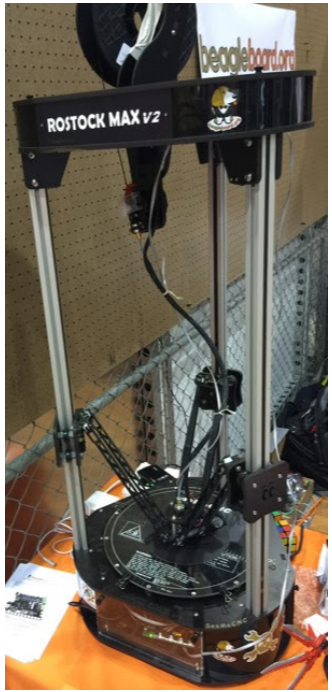
Where I’m at personally

3D printing is brand new to me

How did I put mine together?

https://github.com/jadonk/machinekit

- Complete details coming to wiki soon
- Used SeeMeCNC Rostock Max v2 frame, motors and extruder
  - They are in the 3D printer area here
  - They are open hardware!
- Used BeBoPr cape and Pololu DRV8825 stepper motor drivers
- Using Slic3r or MatterControl



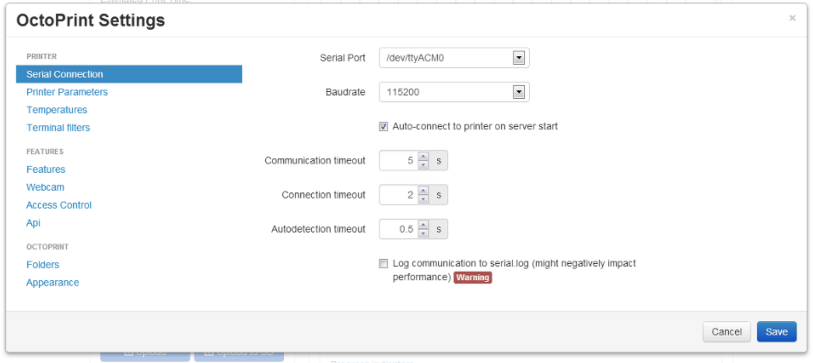
Issues

- Machinekit Gcode != Reprap Gcode
  - A axis vs. E axis
  - M commands
  - Other Gx oddities I don’t know yet
- Community rapidly addressing issues

Next step: Octoprint

http://octoprint.org/

- Web based printing possible
- Lulzbot already had nice write-ups on using this



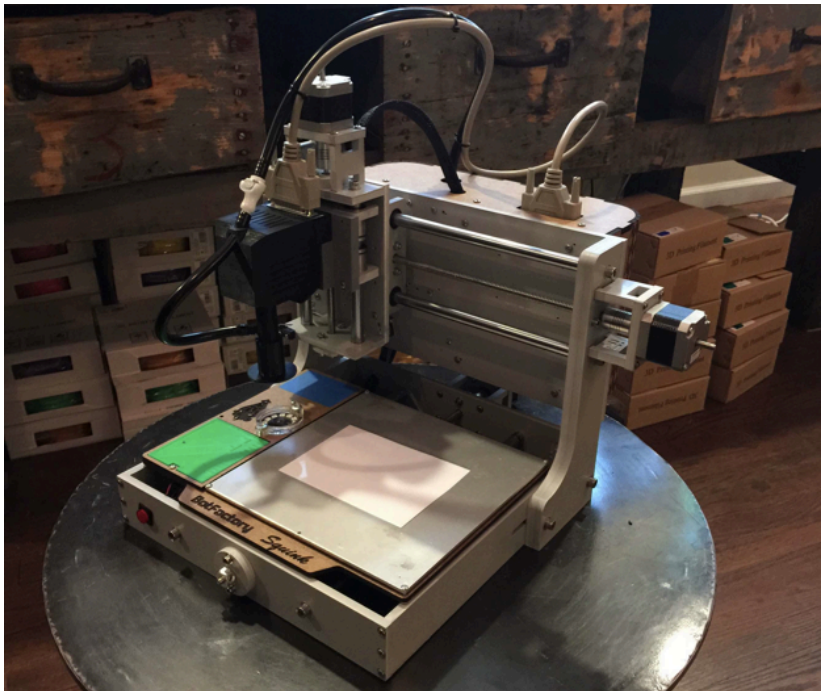
Some other systems

Machine control isn’t only for 3D printers

BotFactory Squink

https://www.botfactory.co/product

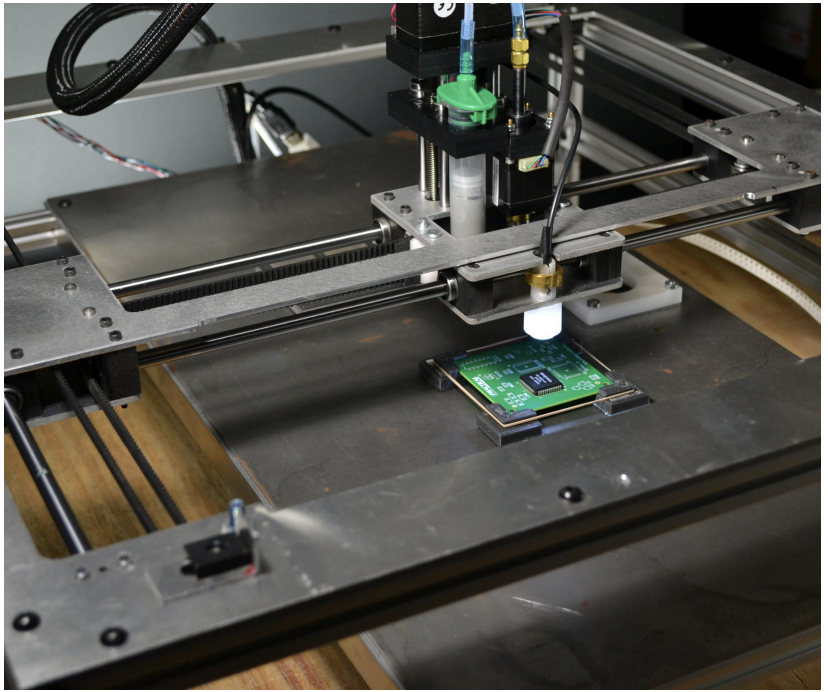
- Don’t need to just 3D print
- A personal electronics factory



Carbide Labs Pick ‘n Paste

http://pnp.carbidelabs.com/

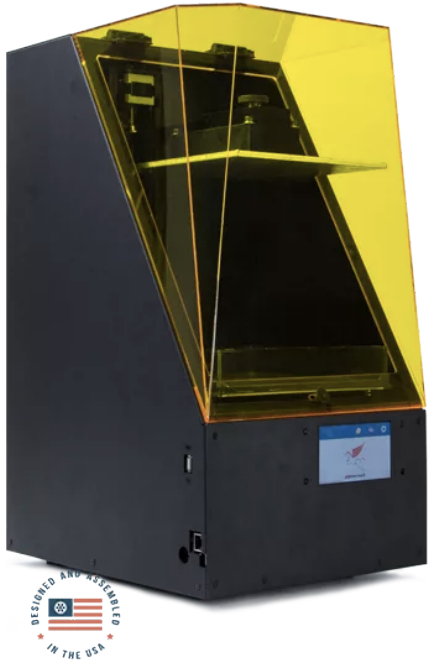
- Optical recognition of orientation
- Designed by author of Machinekit motion path planner



Full Spectrum Laser

http://www.fslaser.com/Products/Printers

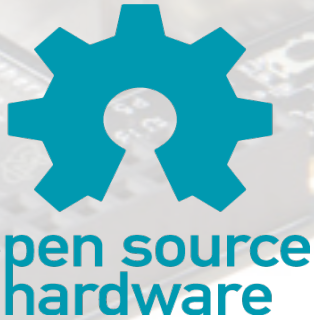
- Using BeagleBone Black in their product
- Rosin-based stereo lithography
- Also adding it to their laser cutters



Shopbot

- Check them out and ask

Thanks



@jadon

http://beagleboard.org/show

https://github.com/jadonk/machinekit