**Liquid Dispenser**

Buying Someone Else’s Liquid Handle

**Adaption of Existing 3D Printer**

Advantages:

* Materials sourced for us.
* Commercial designs are inexpensive and provide all necessary axis of motion.
* The extruder head and stepper motor can be repurposed for liquid handling. Probably.
* Prebuilt and assembled.

Possible Options:

Gantry Style:

Core XY Style

Delta Style (I have no idea why we would use this, but just a cool design)

Disadvantages:

* Motion control and software development. Most of these low-cost machines are built on the Marlin opensource framework, with control boards designed for the three axis and extruder in mind. Usually used for the implementation of G-Code. Considering our motions will not require complex tool pathing, this is just going to be an unnecessary complication. Reading Pipette Jockey’s problems with reprogramming motion control built for G-Code, I think this a dealbreaker.

<http://pipettejockey.com/2018/01/03/making-a-opentrons-compatible-liquid-handling-robot/>

To combat these issues, we would either be spending money replacing parts like the board or spending time writing software or reverse engineering someone else’s software to fit our purposes. Depending on preference, this is still a possibility. The price advantage is not worth the foreseeable issues with working with someone else’s design and code. Additionally, Z axis movement, extruder heads, and existing displays are unnecessary features. We will be paying for parts we do not need and purchasing more parts necessary for liquid handling.

**Conclusion:**

I would not recommend this option. While having a pre-assembled design capable of XYZ motion is attractive, it is both unnecessary for our purposes, and more complicated to adaptation as a liquid handler. When looking at other designs built from an existing printer, considerable effort was made to adapt the existing board to fit their purposes. This is an unnecessary step considering the use of a raspberry pi would give us far more flexibility and would be exponentially easier to write code for.

Furthermore, an accurate stepper driven liquid dispenser is not a trivial thing to design. Considering the purpose of the robot, more expense should be placed into accurate handling of liquids, rather than prioritizing the motion control. 3D printers are designed with pathing in mind, so we would be purchasing designs optimized and designed for motion, which is more of an ancillary goal to our project.

**Open Source Design/In-House Design**

Advantages:

* Someone already messed up to bring us this design!
* Easier implementation and sourcing of other people’s stuff
* Can be built to our specifications, with our design goals in mind.
* Many existing open-source projects to draw inspiration from.
* Educational. Programming a robotic motion control system from scratch is a learning experience. The systems at work are easier to understand building from the ground up, rather than modifying an existing design. It allows the programmer more flexibility in language choice, facilitating easier implementation.
* Servo over steppers. This greatly simplifies motion control.

Disadvantages:

* Requires more effort in the sourcing of necessary materials.
* More design time for the mechanical aspects of the robot.
* Can be more expensive.

**Conclusions:**

This is my recommended route, mainly for the design flexibility and because we build everything from the ground up. There would be less of a need to fiddle with existing printer firmware, and we could start from open-source projects. Also, for some added price we could greatly improve upon motor control with something like the Actuonix LAC.

Machine Types:

Fixed Head:

1. Cartesian Moving Head, 3x 96 Well Plate Capacity
   1. Motion
      1. 2x Mechaduino ($128)

**Currently out of stock! Emailed**

<https://www.kickstarter.com/projects/tropicallabs/mechaduino-powerful-open-source-industrial-servo-m>

* + 1. 2x Actuonix ($180) Track or Regular, either would work fine. <https://www.actuonix.com/T16-P-Mini-Track-Actuator-p/t16-p.htm>
    2. 2x Mechaduino Clone ($76.42)

<https://www.aliexpress.com/item/32952527069.html?src=google&albch=shopping&acnt=708-803-3821&isdl=y&slnk=&plac=&mtctp=&albbt=Google_7_shopping&aff_platform=google&aff_short_key=UneMJZVf&&albagn=888888&isSmbAutoCall=false&needSmbHouyi=false&albcp=9594035441&albag=102695258807&trgt=374448549250&crea=en32952527069&netw=u&device=c&albpg=374448549250&albpd=en32952527069&gclid=Cj0KCQjwl9GCBhDvARIsAFunhsmjli_86k35g4NwoBm-TJ2t-kwZkpQSydPqmk7eT_onyZq_0WPlzckaAvVtEALw_wcB&gclsrc=aw.ds>

* 1. Chassis
     1. 3D Printed Head (Free – $40)

If we went with the Actuonix Track Actuators, we could use 3D printed parts for the armature. PLA has great stiffness and is easy to print with. Two rolls would be around 40$.

* + 1. Aluminum Extrusions ($1.50/ft). We can get custom cut parts made at websites like:

<https://www.zyltech.com/aluminum-extrusion-custom-cut-service/>

* + 1. Plexiglass Plate for loading and unloading.
    2. Linear Rail ($40) for supporting linear motion of the actuonix

<https://www.amazon.com/ReliaBot-Linear-Carriage-Printer-Machine/dp/B07V5VBPGG/ref=zg_bs_350663011_5?_encoding=UTF8&psc=1&refRID=MGJS3ZGXZVJWGZ3A58R0>

* 1. Controller
     1. Actuonix motion controllers ($40) Optional

Would simplify movement, but they are an added cost. We could just use a Raspberry Pi 4 for everything. (Maybe? Not entirely sure about this)

* + 1. Raspberry Pi 4 ($35)

https://www.adafruit.com/product/4296

* 1. Liquid Dispensing
     1. Peristaltic. Not sure you can clear the lines of the LPD Lee and Co’s pump for the large travel distance. Here’s an open source one:

https://grabcad.com/library/peristaltic-pump-nema17-1

* 1. Vision
     1. Raspberry Pi Camera ($25)
  2. Power Supply:
  3. Assorted Mounting Hardware Etc.

1. Single Moving Plate, Fixed Head:
   1. Motion
      1. 2x Mechaduino Clone ($76.42)

<https://www.aliexpress.com/item/32952527069.html?src=google&albch=shopping&acnt=708-803-3821&isdl=y&slnk=&plac=&mtctp=&albbt=Google_7_shopping&aff_platform=google&aff_short_key=UneMJZVf&&albagn=888888&isSmbAutoCall=false&needSmbHouyi=false&albcp=9594035441&albag=102695258807&trgt=374448549250&crea=en32952527069&netw=u&device=c&albpg=374448549250&albpd=en32952527069&gclid=Cj0KCQjwl9GCBhDvARIsAFunhsmjli_86k35g4NwoBm-TJ2t-kwZkpQSydPqmk7eT_onyZq_0WPlzckaAvVtEALw_wcB&gclsrc=aw.ds>

* 1. Chassis
     1. 3D Printed Head (Free – $40)

If we went with the Actuonix Track Actuators, we could use 3D printed parts for the armature. PLA has great stiffness and is easy to print with. Two rolls would be around 40$.

* + 1. Aluminum Extrusions ($1.50/ft). We can get custom cut parts made at websites like:

<https://www.zyltech.com/aluminum-extrusion-custom-cut-service/>

* + 1. Linear Rail ($40) for supporting linear motion for the Actuonix

<https://www.amazon.com/ReliaBot-Linear-Carriage-Printer-Machine/dp/B07V5VBPGG/ref=zg_bs_350663011_5?_encoding=UTF8&psc=1&refRID=MGJS3ZGXZVJWGZ3A58R0>

* 1. Controller
     1. Actuonix motion controllers ($40) Optional

Would simplify movement, but they are added cost. We could just use a Raspberry Pi 4 for everything. (Maybe? I am not sure about this)

* + 1. Raspberry Pi 4 ($35)

https://www.adafruit.com/product/4296

* 1. Liquid Dispensing
     1. 4X LPD High Performance Model

https://www.theleeco.com/products/electro-fluidic-systems/dispense-pumps/variable-volume-dispense-pumps/lpd-series-pumps/high-performance-model/

* 1. Vision
     1. Raspberry Pi Camera ($25)
  2. Power Supply:
  3. Assorted Mounting Hardware etc.

1. Gantry Style
   1. Motion
   2. Liquid Dispensing
      1. Having three axes to move about in does allow us more options for liquid dispensing. We could also eject and use new tips. Seems like a more flexible solution…
   3. Vision
2. Rotational Bed
3. Moving Head Servo Arm (This one is out there, but very cool! Would allow for the use of hobbyist RC’s)
   1. <https://makezine.com/projects/trs-drawbot-2>
      1. Ours would not be open loop. This kind of design would allow us to save money on the chassis and would allow us to use RC servos. These are a little cheaper and more widely available.
      2. Also, a fun project for inverse kinematics.