Volume 45 | Issue 1
Spring 2022

# MITERS JOURNAL

*Published by the MIT Electronic Research Society*

## What is MITERS?

To answer this question, let us look into the past to the very first issue of the MITERS Journal where they attempted to answer this very question.

*"What is MITERS? MITERS is the MIT Electronic Research Society, a non-profit, student-run laboratory for MIT's EE hackers. The Society provides work space, tools, low-cost parts and information to any number of the MIT community. We have a few good scopes, various and sundry pieces of test equipment, a b'zillion power supplies, and Bertha, our beloved PDP-7 computer. (No snickers from the peanut gallery, please. Bertha is very sensitive.) We also have the most incredible plunder-trove on campus"* - **1976 Journal 1 Number 1**

From its humble beginning in building 20 (20-B-119) back in the 1970's, MITERS has grown, changed, and adapted to the ever-evolving technological world. But when you take a hard look at the core of what MITERS is, the spirit and culture are still rooted in the ideology of the original hackers that founded it.

Since those early days MITERS has gone through various evolutions, from migrating out of Building 20 to a shop space in Building N52, to acquiring new and interesting tools, cruft, and various heavy duty equipment. In its current state, MITERS is a member-run project space and machine shop where we provide the MIT community with access to tools, knowledge, and the space needed to make their projects come to life. We are both a shop space as well as a vibrant community of students, staff, and alumni who are happy to answer questions, teach new members, or just hangout and chat.

Though we have somehow become a respected shop around campus, we still are the finders and keepers of the great MIT Cruft. We still find time to plunder Reuse posts, lab clean-outs, and tech. dumps on the loading docks for recycled electronics and hardware.

## What is the MITERS Journal?

Originally the MITERS journal was intended to serve as a means for intra-society communication. Going forward, we plan to follow the original intent of the journal as a guide. The journal will be used as a way to inform and update both our undergraduates, and the greater community as a whole, about the goings-on of MITERS. It will also serve as a platform to share projects (In-Progress & Completed) with the greater MITERS network, as well as friends and family. To this end, we will strive to publish an issue once a semester; publishing them as PDF's onto the MITERS webpage. The journal will take the place of the MITERS Blog as the society's way of bringing attention to the projects of its members.

General Layout:

(1) Promote MITERS member projects (Completed/In-Progress)

(2) Inform everyone about the Goings-on in and related to MITERS

- New Tools / Equipment
- Organization
- News Stories

(3) Important Upcoming Dates

- Swapfest
- MakerFaire (or whatever the tech. faires evolve into)

(4) Asbestos Soap-box

- In case there are interesting topics, stories, or things members would like to write up (Editorial)

(5) Gizmo-of-the-Month/Semester

- If a member finds something interesting that they want to document and share. This will generally be dependent on member submissions.

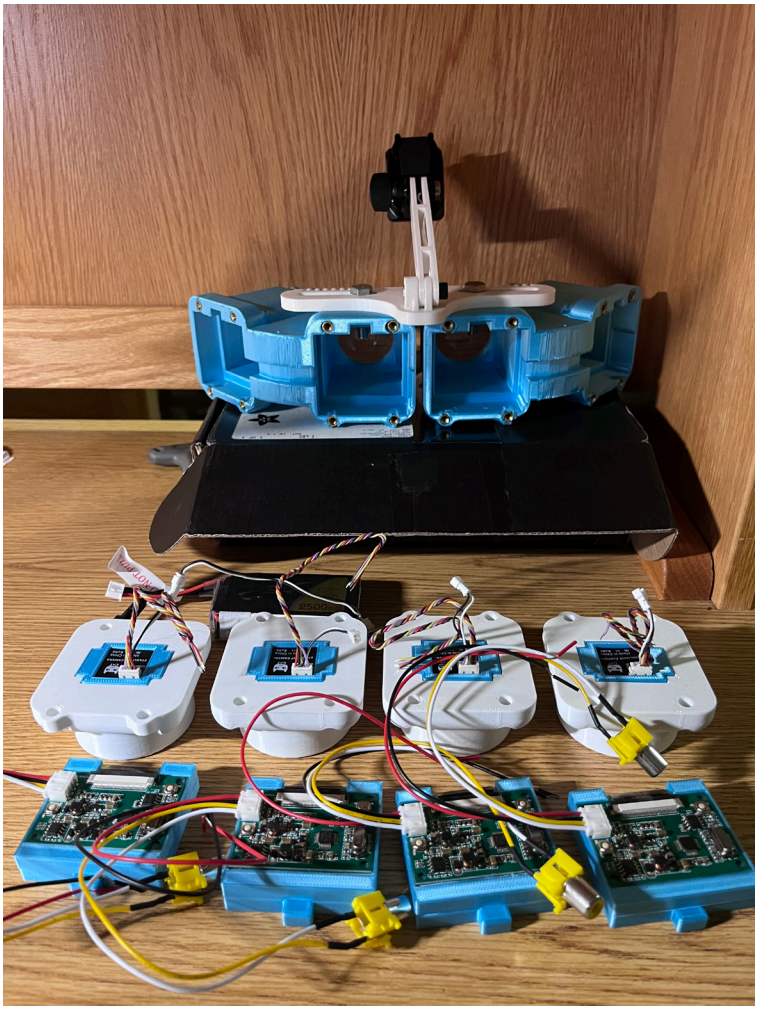
So, this is the starting point of a new generation of the MITERS journal experiment and we shall see how it evolves from here.

**Enjoy!**


# A Look inside MITERS

MITERS is not just a shop space, but a living and breathing hacker space. This is evident in the constantly changing landscape that is the shop space. From mounted winches on the ceilings to hold various electric vehicles up and out of the way when they are not being worked on, to the ever changing state of cleaniness of the work benches and floors through-out the space. But as you can see in the pictures, no space is left un-used for long, be it a new machine/equipment or simply a harebrained scheme to build a crazy contraption in the course of a night. If you are a part of the MIT community and you are wondering when we are open, check out the door twitter: https://twitter.com/MITERS_DOOR

# *DIY Night Vision Goggles*



For my second official project I wanted to build another fun and functional device and thanks to ProjX funding, I had a $500 budget. This turned out to be perfect for building this pair (or two pairs?) of night vision goggles which I had been interested in creating. Besides the cool factor due to its similarity to a videogame, I thought they might be useful for traversing a dark room after my roommates went to sleep.

The Specs:

- Each "tube" of the goggles is a functionally independent module.
- A Foxeer Night Cat 3 camera at the front takes in visible and IR light, which it passes onto the display.
- The displays are 1.5" TFT screens made by Adafruit, which display the analog output from the cameras.

The light from the display passes through a biconvex lens. The lens corrects the picture so that the screen is clear, which is important due the distance between the screen and your eye. This helps prevent eye strain which can be caused by your eyes constantly trying to focus on the screens.


Going forward I want to improve the design by:

- waterproofing the goggles like I'd originally intended
- redesign the suspension/mounting solution so that the goggles are more rigidly connected to the helmet
- And paint the inside of the tubes black so the brightness from the screens is less overwhelming.

Disclaimer: The original project files (.stl files & parts list) were taken from the BPNVG project, however, I did ample modification (rebuilding/remodeling in CAD) to where I believe these goggles are a new revision and unique to those of others in both design and construction.

Nigel Barnett
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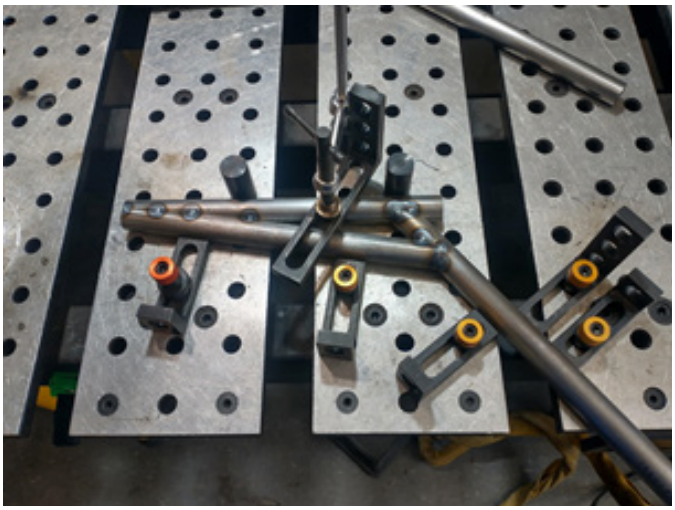
# Snowtercycle (WIP)

Traditional bikes tend to dig into snow with their relatively thin tires. They also are quite easy to lose traction while on icy roads with a traditional wheel. Ice can be combated with some success with studs, but distributing the weight more evenly can also be effective. Tracks act somewhat like a snowshoe, distributing the vehicle's weight across a wider area and reducing the likelihood of slippage and allowing the vehicle to "float" more effectively on soft snow. The unpowered front wheel can be replaced with a ski for snow use, but needs to also be able to switch back to a wheel for use on slushy or icy roads.

In my project I am using an older form of suspension: leading link suspension. Rather than relying on telescoping tubes, leading links use steel linkages and standard shock absorbers. This suspension is more resistant to corrosion because there is no need for perfectly smooth, rust free, telescoping tubes. The suspension rises while braking, instead of collapsing and limiting travel like a more traditional suspension.

So far in this project, there have been many interesting fixturing and machining operations to make the leading link suspension. The tubes were coped (cut to mate up nearly perfectly with the other tubes) on the bridgeport mill.

If all goes according to plan, the snowtercycle will be ready for the next heavy snowfall!



Jonhenry Poss
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# *Hydrofoiling a Row-boat?*

Boats consume a lot of power and as a rule of thumb a linear increase in velocity requires a cubic increase in power usage. You can sneeeeak around this requirement if your boat's mechanical footprint decreases, mainly by making the boat 'fly' in the water, using hydrofoil wings.

Row-boats are inherently low speed vehicles and as a result they need a lot of mechanical bracing for any external hydrofoil mounts. One of the biggest structural upgrades was a solid rear mounting plate for the longer outboard which translates force from the back into the sides of the craft.

To avoid 'rusting' everything was made of 6061 aluminum, which allowed for some excellent weldments using the D-Lab TIG welder and the Hobby Shop OMAX waterjet.

Dane Kouttron
*transistor-man.com*

To get the foil shape I used waterjet wood pieces connected on an aluminum skeleton, wrapped with a 1/16" thick sheet of clear ldpe sheet. Expanding foam was used to ensure that the wings themselves did not end up sinking if they came off:

The expanding foam was markedly exothermic and did cause the wing shape to become a bit distorted but it was really fast to prototype with!
A pivoting front wing with a surface follower was used to ideally keep the craft always on plane; however, due to the wubbly foil geometry and an error in rear foil design, the craft had trouble taking off.

# *Aerial Lyra and Trapeze*

I've been dancing with trapeze, lyra, and other circus props for years, and wanted to continue here at MIT. Commercial equipment goes for $200-500 per apparatus, but the core components are much cheaper, so I figured I'd build the equipment myself. MIT ProjX funded this project and I built the apparatus in MITERS and D-Lab.

I started with a steel tube for the trapeze, cut holes to attach the rope, and sewed the padding out of foam and recycled fabric.

For the lyra — essentially a metal circle — I used a tube roller to make the circular shape, cut out the rope attachment, and welded everything together. I painted it with leftover iridescent paints and added a swivel so that it can rotate indefinitely.

These were pretty fun builds. Now I hang them up and practice in out-of-the-way places around MIT.

Amber Velez
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# *The Ice Saw - A MITERS Swapfest Artifact*

If you have been around MITERS in the past decade, you may have stumbled upon the ancient ice saw. The origins of the saw have been somewhat lost to the fog of history. Through conversation with various members and alumni, the best guess at the origins of this delightful object is an eccentric Swapfest purchase from summers long past.

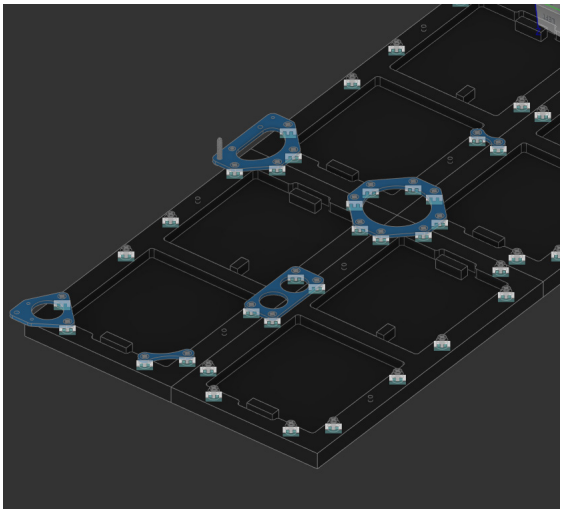
The nagging question, Does this thing even work? The pictures are better than any words! I dragged the saw into the middle of an ice covered lake this past winter and cut a roughly 24" x 24" x 7" block of ice out of the lake. Once the corner holes were drilled, and the cuts were started, it was surprisingly effective! A testiment to the engineers of a bygone era: They knew their stuff!

Andrew Birkel
*AndrewBirkel.com*

# An East Campus Door, For all Occasions!

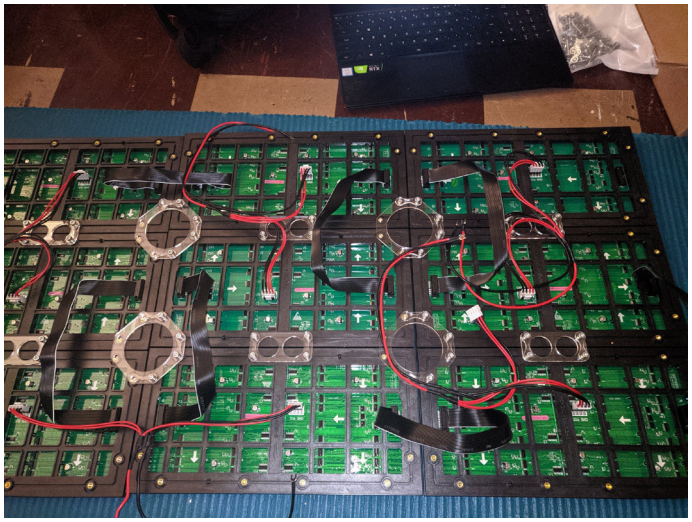
In my dorm, EaST camPUS, modifying our living space is a big part of the culture. Here, we are allowed to paint our walls, build lofts, drill holes in the walls, and generally do whatever we like to make our environment unique. My door already had a mural someone had painted before, so instead of painting over it, I decided to create an electronic art installation. This project was completed in October of my freshman year.

The project consists of a motion-activated LED display that greets passerby with a continuous scrolling animation. It also checks the status of MITERS, a local student-run makerspace, indicating when it is open.

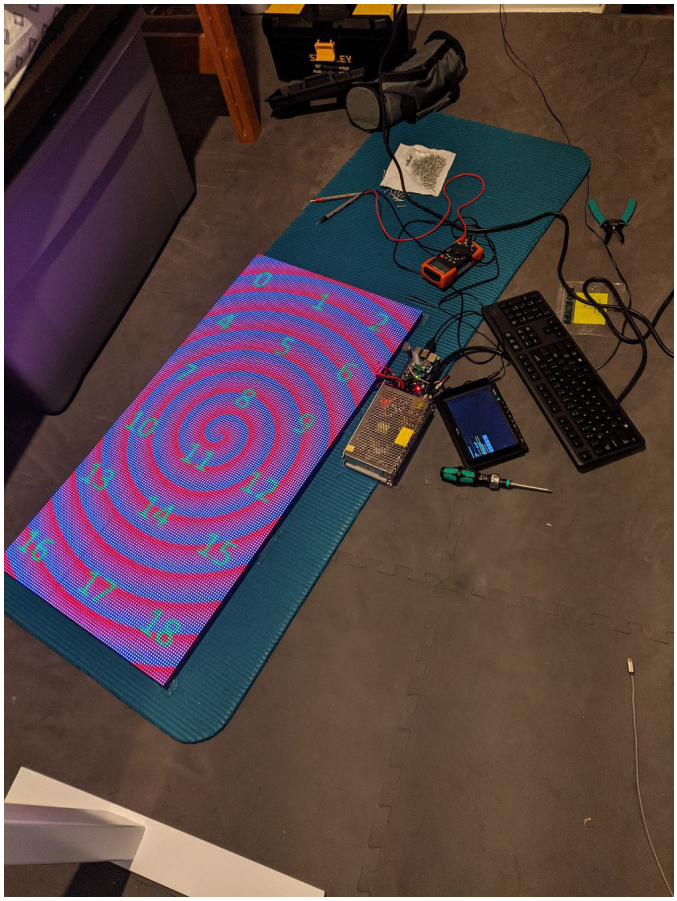


The build process started with a CAD model. I modeled the displays and their mounting holes, as well as the raspberry pi and the power supply. Next, I created brackets to hold everything together, which were laser cut.

After writing the code and testing each display, everything was then screwed together and mounted to my door. I had to drill a hole in my door to pass the power cable through.



The hardest part of the project was remapping the displays. They are wired in an alternating snake pattern (as shown by the white arrows in the diagram) to keep the data cables short. (Longer data cables degrade signal quality). This means that if the image is sent straight out of the raspberry pi, it ends up looking like a jumbled-up puzzle on the screen (the 12th image shows this). In order to fix this, a remapping step has to happen before the image is sent, which "inverse-jumbles" the image, so that it comes out correctly on the display. Figuring out exactly which parts of the image went where took a lot of trial and error.



Anhad Sawhney
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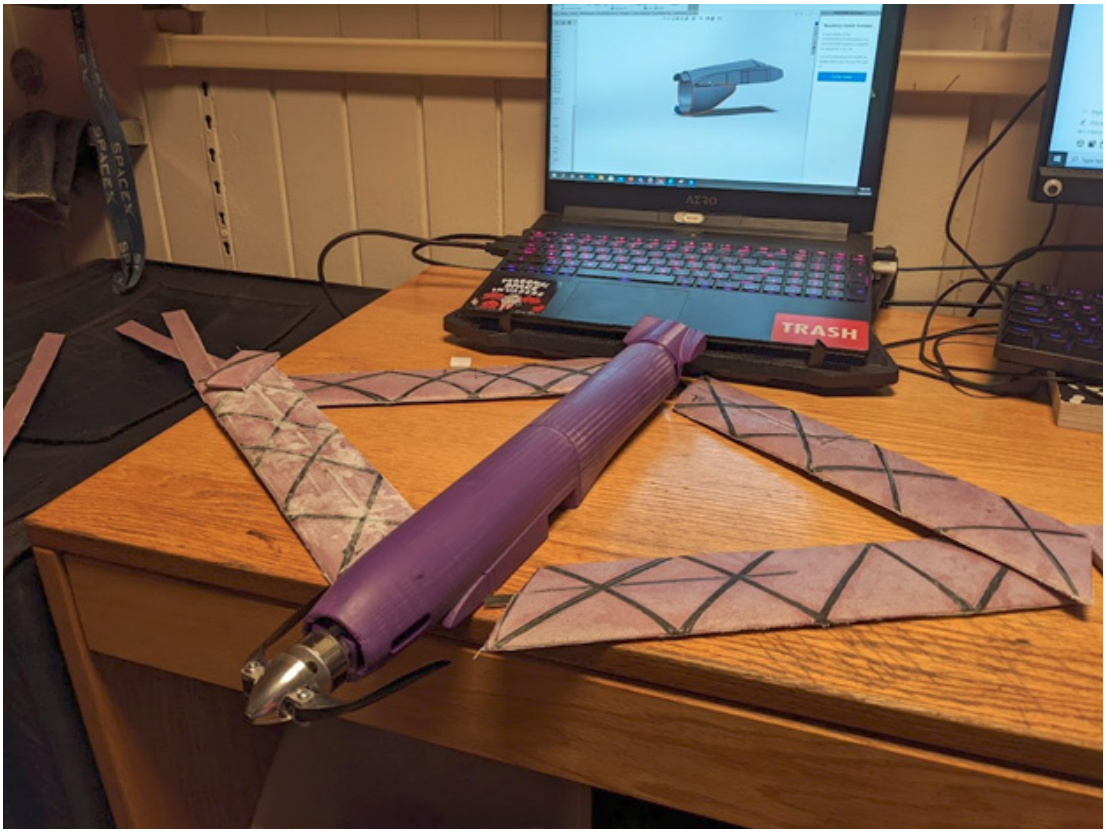
# *Box Wings: A Quest for Success*

A bit of background: Box wings are an experimental aircraft type that use a continuous wing surface to avoid wingtip vortices and get higher efficiency. Spoiler alert: they are kind of tricky to get to work sometimes: QED:

*The og^ Made out of foam board and scrap styrofoam, met its fate one sad evening in high crosswinds :( rip in pepperoni*

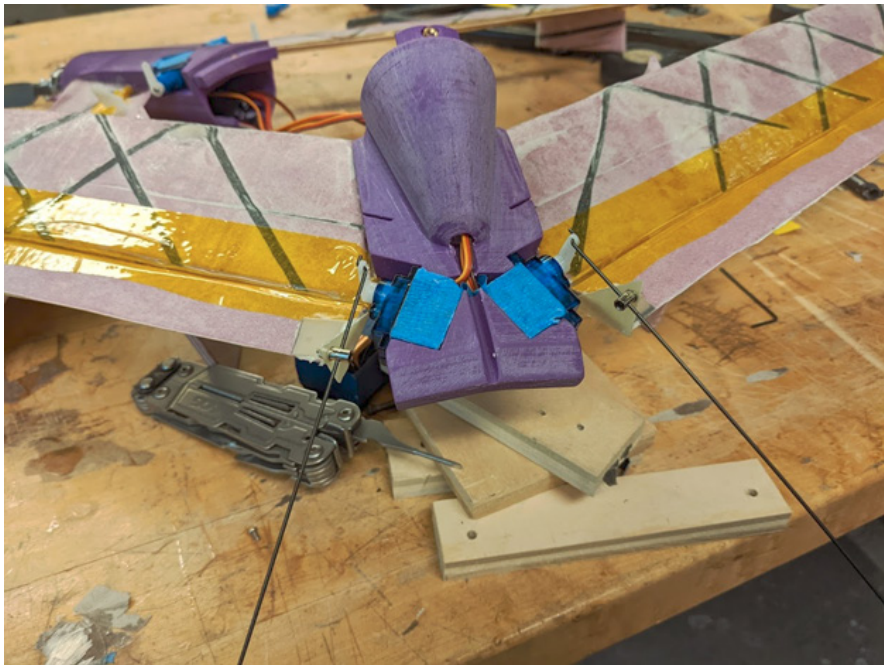



Mk. 3 (we dont talk about 2) getting ready for final assembly

The fuselage of mark 3 was 3d printed and a bit overweight, mtow was 500g, which is kinda hefty for something this small, so it needed to fly fast. 3D printing the fuselage meant built in servo mounts was very easy, and motor mounts were equally nice.

The white stuff on the wing is a custom developed composite filler made out of cotton flux, shredded fiberglass, and epoxy, sanded down to shape.

Using carbon shims I was able to attach the wings to the fuselage with 5 min epoxy
well as the raspberry pi and the power supply. Next, I created brackets to hold everything together, which were laser cut.



*Totally not sketchy control surface setup nothing to see here*

Mk 3 a few minutes before it slams into the ground 10 times during flight attempts

Mk 4 is where things get real spicy. I made all new wings using mylar wraps during the layup to get super smooth wings. For better stability I used neutral airfoils on the rear wing, and opted for elevons (elevator ailerons) on the rear wing only). To keep the weight down I used 1 layer thick 3d prints for the fuselage, printed in 3 parts and bonded with superglue. Along with my custom preloaded motor mount, steel rod landing gear, and lots of epoxy holding the wings together, I was able to cut the weight down by 50%, from 600g to 300g. Flight tests were somewhat successful, with 2 takeoffs that unfortunately were scrubbed due to poor pilot visibility (I couldn't even see the plane it got too far away during ground roll) and so we wait for next semester where the box wing saga continues.

Reagan Ferguson
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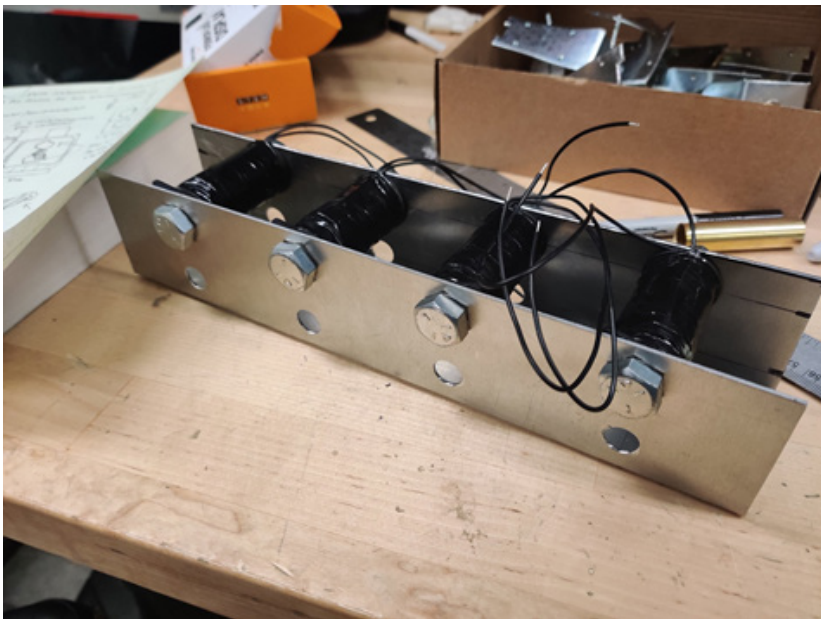
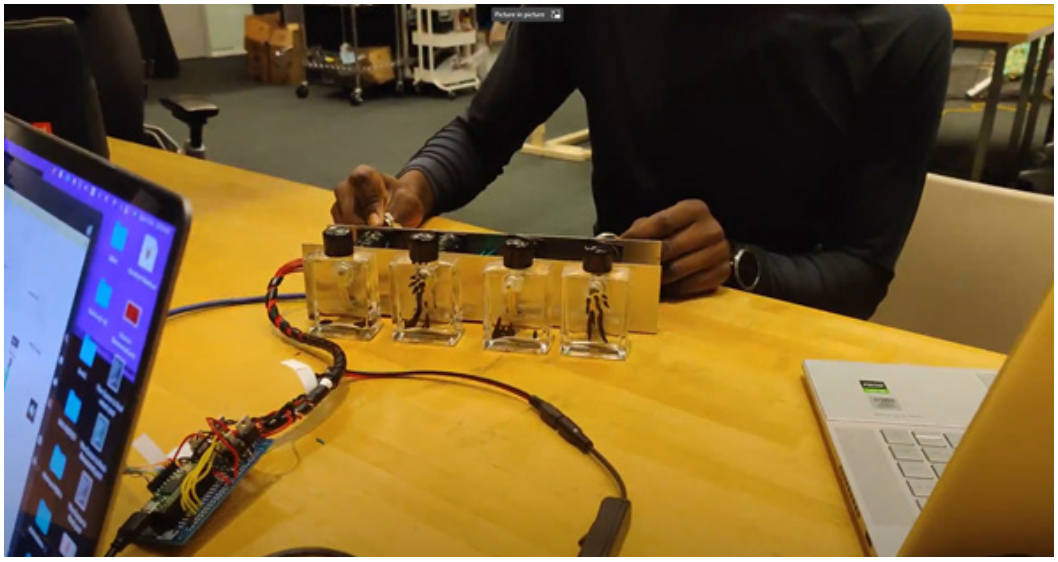
## *The Ferro-Instrument*

The Ferro-Instrument is a hyperinstrument — an instrument designed to enhance performance and a musician's virtuosity using technology. It makes ferrofluid respond to music by altering the magnetic field strength of 4 coils based on the music input and measures the magnetic field strength around the coils so that magnets can be used to alter the sound.



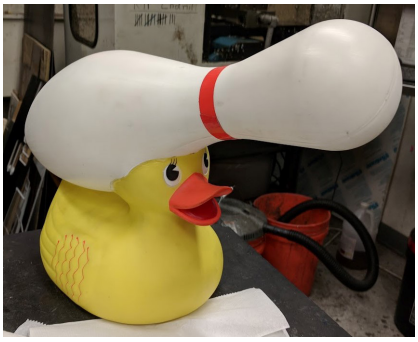
The brains of the operation is a Teensy microcontroller which takes audio over usb, does frequency analysis to change the voltage of electromagnets in response to the volume, bass, mids, and highs (from left to right) in the music (as seen here), and sends the magnetic field strength detected by hall effect sensors on each of the coils over MIDI. This allowed me to use the device as an instrument by moving neodymium magnets near the coils and placing them on the coils to change into different modes. I made the structure for the device in MITERS using a single sheet of aluminum and soldered and programmed all the electronics myself.



I worked on a team with Yuval Gur, Mitchell McDermott, Cindy Yang, Xuwei Wu, and Titus Kim, where we designed a Concerto for Ferrofluid and 7 String violin for the conclusion of my Reimagining Hyperinstruments class in fall 2021. I performed a duet with Berklee musician Yuval Gur, who played a 7 string violin that was the input to the Ferro-Instrument. The instrument has no voice of its own, so its "voice" was made by freezing the audio from the 7 string violin and extending it to be modulated in various ways as shown in this performance video. We used the data from the hall effect sensors sent over midi to a MAX Patch (gui based musical processing software) designed to give me the ability to freeze the sound of Yuval Gur's violin and also have the ferrofluid as a visual. So now when anyone asks me what it means to be a mechanical engineer with a focus in musical robotics — the Ferro-Instrument is the answer :).

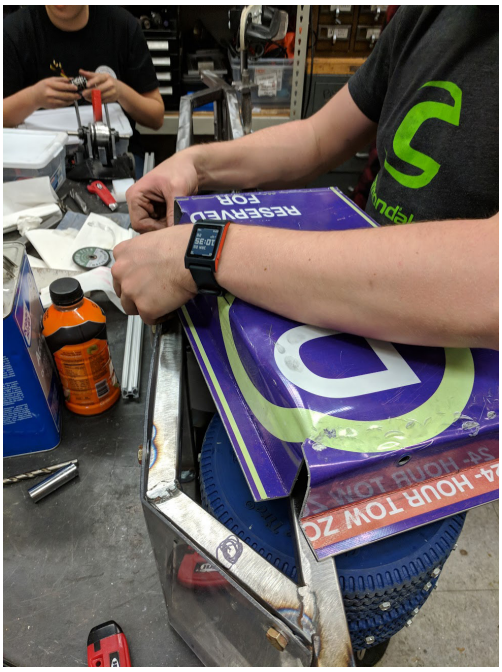
Joseph Ntaimo
*jntaimo.com*

# MITERS: Build Beyond what the Classes Requires!



## Build Things!

## Hack things together or apart!



*Austin dividing a battery with a hacksaw*

## Hang-out and Socialize!

*Birkel's Milkshakes with a Refurbished Milkshake Machine*

COMPUTERS—ELECTRONICS—HAM RADIO

# All Summer FLEA at MIT

## Third Sunday, April thru October

## *Swapfest; The Flea at MIT RETURNS!*

The MIT Radio Society, in conjunction with the MIT UHF Repeater Association, the MIT Electronics Research Society, and the Harvard Wireless Club, sponsors a Swapfest on the third Sunday of each month, April through October. This is a place to buy, sell, and swap amateur radio, electronic, and computer equipment. Hams and non-hams alike are welcome.

For more up to date information, reference: w1mx.mit.edu/flea-at-mit/

### 2022 Swapfest Dates

- April (Past)
- May (Past)
- June 19, 2022
- July 17, 2022
- August 21, 2022
- September 18, 2022
- October 16, 2022

**Acquire Cruft, then take it apart with friends!**

*Dane and Steve Reverse Engineer a SEVCON by force!*

*How does the Swapfest relate to MITERS and its operation?* Over the years, members of MITERS have been an integral part of the success and operation of the MIT Swapfest. Through our contributions we were able to find new and interesting cruft, as well as fund various new tools and equipment. Right now, it's one of the primary methods for MITERS to raise money for purchasing new tools and equipment is through the man-hours worked to run the Swapfest. The Swapfest runs from 9am to 2pm, with selllers setting up at 7am. As a student volunteer you will raise money for MITERS, be the first to peruse the vendors' wares before the gates open (for free), and hangout/socialize with fellow makers! So consider volunteering!

Swapfest
*w1mx.mit.edu/flea-at-mit/*

A MITERS publication:
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