Research of Existing Solutions:

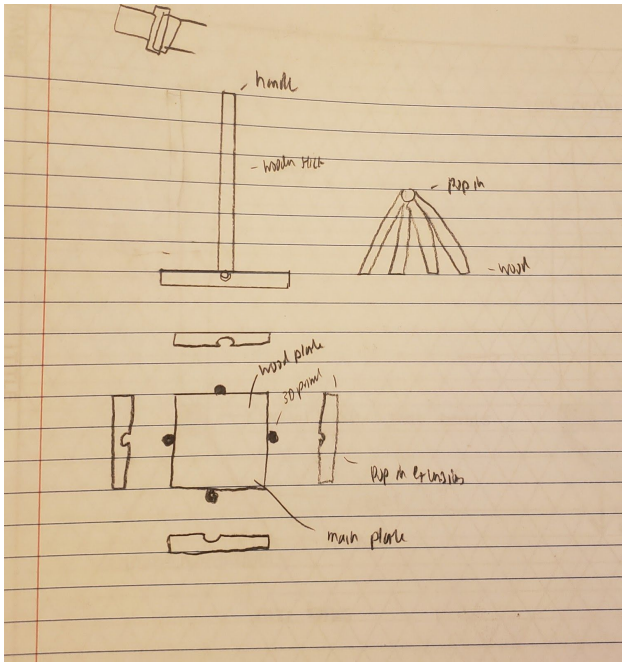
A. Amazon offers a wide variety of products, which is roughly representative of what is available in the majority of name-brand stores. Searching on Amazon yielded no results for such a project, and only $100+ designs that involved complicated mechanics:

https://www.amazon.com/s?k=leaf+compactor&i=lawngarden&ref=nb_sb_noss

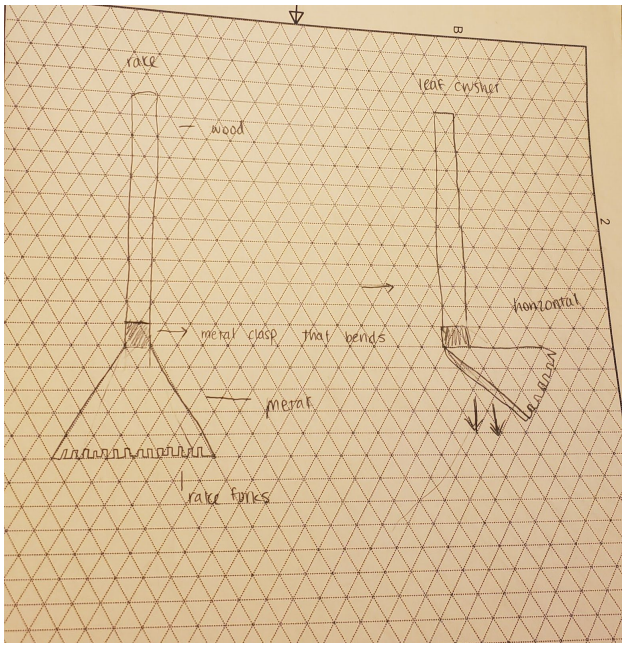
B. Asked real-life students and workers about their leaf collecting habits and whether or not a tool like the one idealized would be useful. Most agreed that they spent a lot of time collecting and packing together leaves and that such a tool would be useful towards cutting down on wasted time and space.

C. Google (the search engine) provides a wide range of products available to the everyday consumer. Searching on google for "leaf compactor" yielded no similar designs, and similar to Amazon, only had complicated leaf shredders and balers that cost in excess of hundreds of dollars.

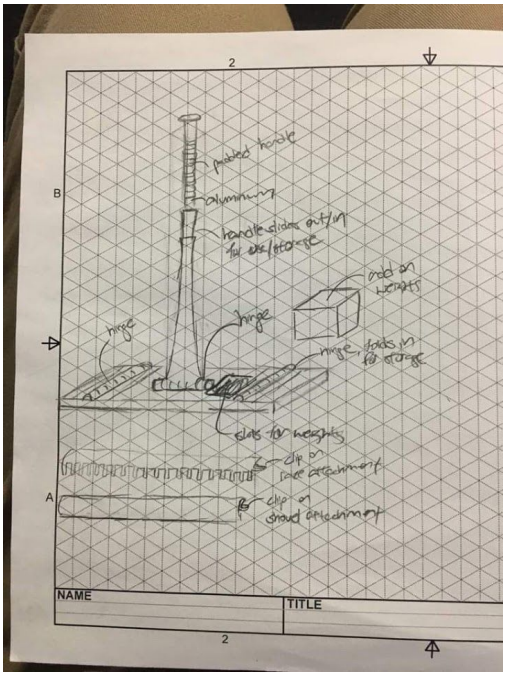
Brainstorming



Design 1



Design 2

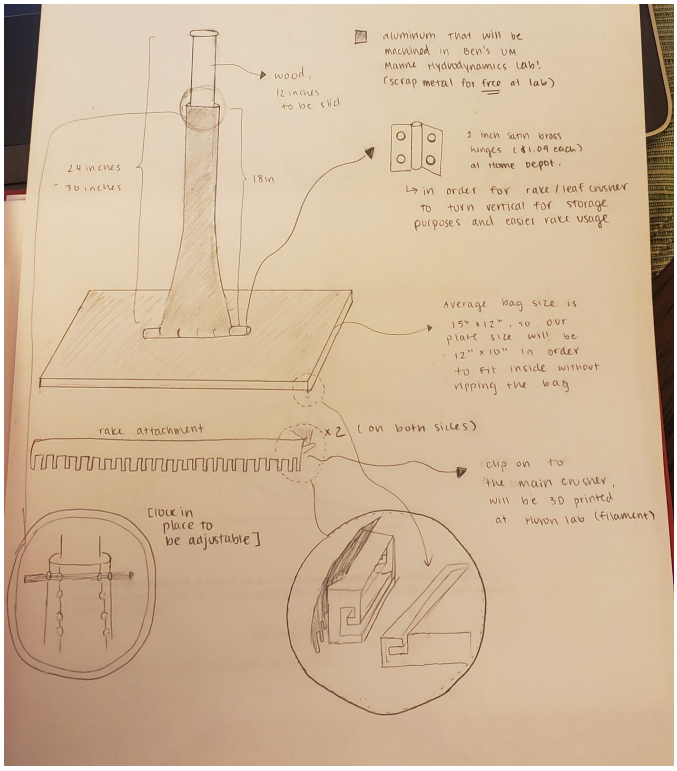


Design 3

Ideas	Time to build	Material Cost	Ease of Use	Comfort	Reliability	Aesthetics	Versatility	Totals
Design #1 (Young Seo)	8	8	9	7	8	6.5	4	50.5
Design #2 (Ben Zhao)	7	7	6.5	7	7.5	7.5	9	51.5
Design #3 (Ben Zhang)	7	8	7	8	8	5	10	53

The final design was chosen through a design matrix. We chose idea number 3 because the decision matrix score was the highest. Also in this project, we highly valued versatility, which was rated the highest out of the three ideas. We liked how his design was adjustable in size, transforming to a rake and a shovel. This, in fact, was the only design out of the three that could be adjusted to be a shovel as well as a rake. We believed that this would be the most valuable to the consumer for our needs.

From here, through talking with the team, we created a detailed sketch of our final design, shown below.



This design satisfies all of the detailed design constraints listed below. Having an adjustable handle allows users to be able to adjust from having a shorter leaf crusher to a longer rake. The total cost of the prototype we calculated to be around $20, and with the average cost of a rake being $15, the total of a multitool acting as a rake and leaf crusher is reasonable for consumers. We decided to use aluminum as our lightweight material in order to satisfy this criteria.

Design Constraints

1. Easy to access for all homeowners
2. Compact device that can multifunction as a rake and leaf crusher
3. Reliable (doesn't malfunction)
4. Lowest weight
5. Lower cost than the combined average cost of a rake and shovel

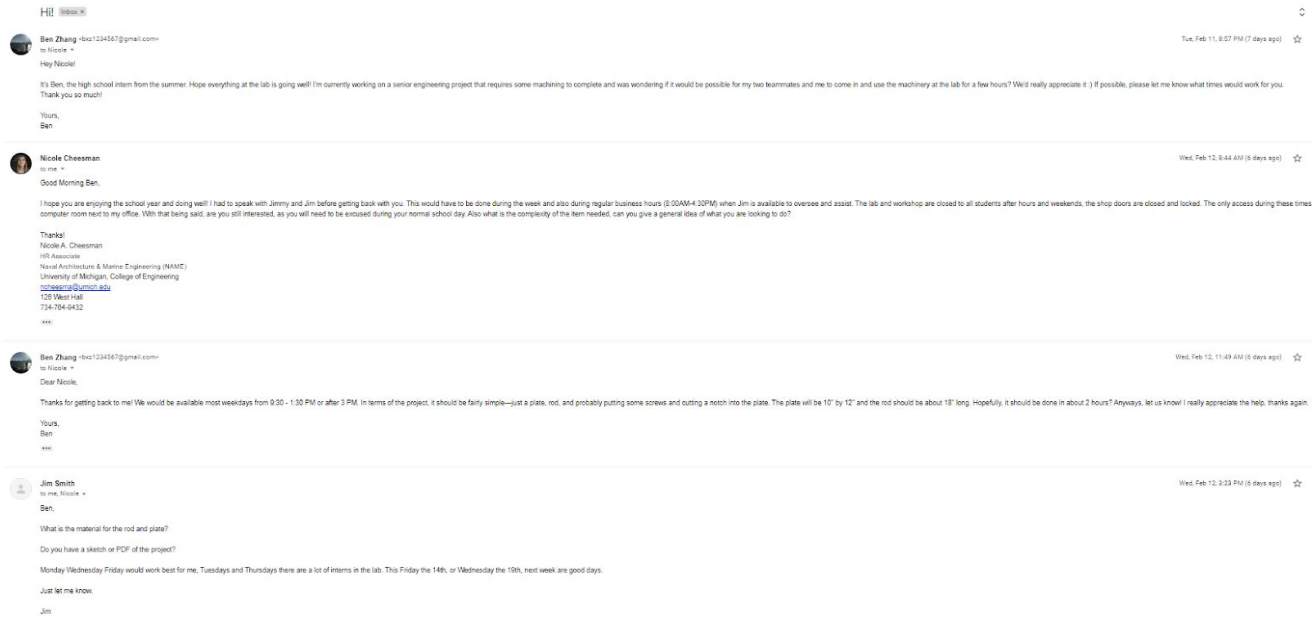
CAD Model of Design

The created CAD assembly file for our initial prototype. The assembly file is fairly consistent with our designs in terms of the design and layout of parts. The design is fairly simple, with two main parts. The first is the handle. It is adjustable and attached to the base in a socket of sorts. This socket is attached to the other major part, the base plate. The base plate is attached to the socket by an hinge, allowing it to fold up for storage as well as conversion between different tools. The handle is encased in a comfortable padding that allows the user to hold the tool at any angle without discomfort. The rake and shovel attachments have been designed to slide onto the base plate to ensure a secure fit and solid build quality.

Working Illusion Prototype:

The images on the left depict the “working illusion” of the selected design, which involves a simple handle attached to a base. Additionally, a “rake” attachment was included. Notably, the handle can fold down in order to allow for efficient storage. However, the actual design will utilize a hinge in order to achieve this folding whereas the working illusion relies on the bendable property of cardboard in order to simulate this folding.

Constructing Final Design:



Hi! Inbox ×

Ben Zhang <bxz1234567@gmail.com> Tue, Feb 11, 8:57 PM (7 days ago)
to Nicole

Hey Nicole!

It's Ben, the high school intern from the summer. Hope everything at the lab is going well! I'm currently working on a senior engineering project that requires some machining to complete and was wondering if it would be possible for my two teammates and me to come in and use the machinery at the lab for a few hours? We'd really appreciate it :) If possible, please let me know what times would work for you. Thank you so much!

Yours,
Ben

Nicole Cheesman Wed, Feb 12, 8:44 AM (6 days ago)
to me

Good Morning Ben,

I hope you are enjoying the school year and doing well! I had to speak with Jimmy and Jim before getting back with you. This would have to be done during the week and also during regular business hours (8:00AM-4:30PM) when Jim is available to oversee and assist. The lab and workshop are closed to all students after hours and weekends, the shop doors are closed and locked. The only access during these times computer room next to my office. With that being said, are you still interested, as you will need to be excused during your normal school day. Also what is the complexity of the item needed, can you give a general idea of what you are looking to do?

Thanks!
Nicole A. Cheesman
HR Associate
Naval Architecture & Marine Engineering (NAME)
University of Michigan, College of Engineering
ncheesma@umich.edu
126 West Hall
734-764-9432

Ben Zhang <bxz1234567@gmail.com> Wed, Feb 12, 11:49 AM (6 days ago)
to Nicole

Dear Nicole,

Thanks for getting back to me! We would be available most weekdays from 9:30 - 1:30 PM or after 3 PM. In terms of the project, it should be fairly simple—just a plate, rod, and probably putting some screws and cutting a notch into the plate. The plate will be 10" by 12" and the rod should be about 18" long. Hopefully, it should be done in about 2 hours? Anyways, let us know! I really appreciate the help, thanks again.

Yours,
Ben

Jim Smith Wed, Feb 12, 3:23 PM (6 days ago)
to me, Nicole

Ben,

What is the material for the rod and plate?

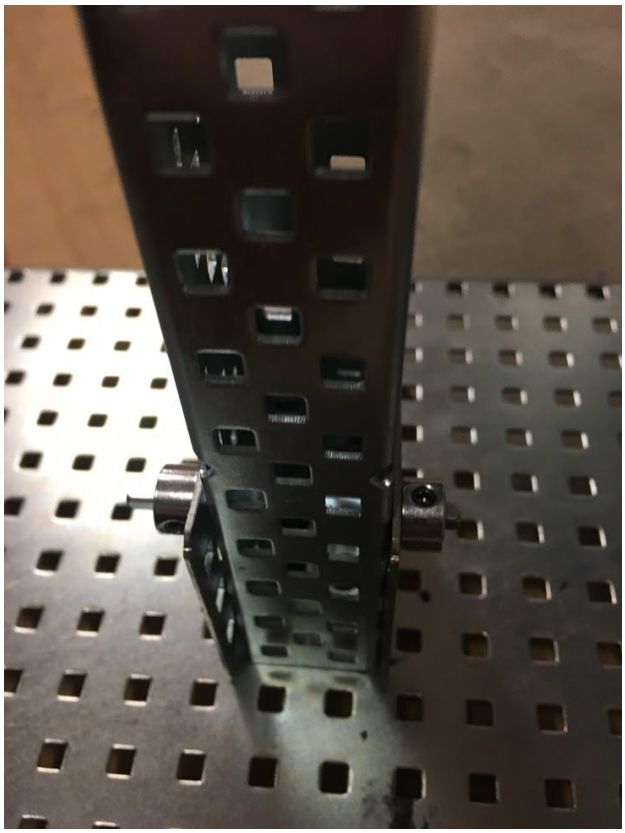
Do you have a sketch or PDF of the project?

Monday Wednesday Friday would work best for me, Tuesdays and Thursdays there are a lot of interns in the lab. This Friday the 14th, or Wednesday the 19th, next week are good days.

Just let me know.

Jim

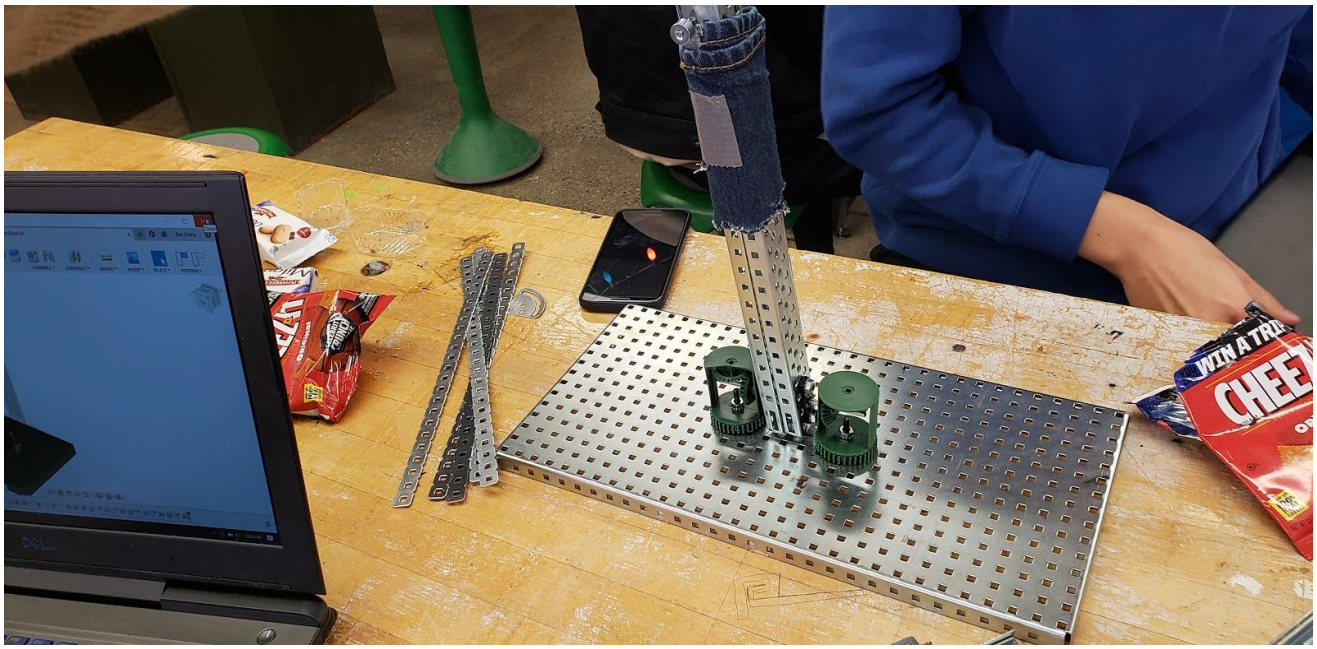
We contacted the head of the UM Marine Hydrodynamics Lab in order to access the aluminum and machinery to build our final design



Final design--original VEX with added ergonomics (padded corners and grip); grip along denim and underneath dowel, with additional denim and duct tape to pad corners of the base; additional denim and duct tape to pad corners of the base.

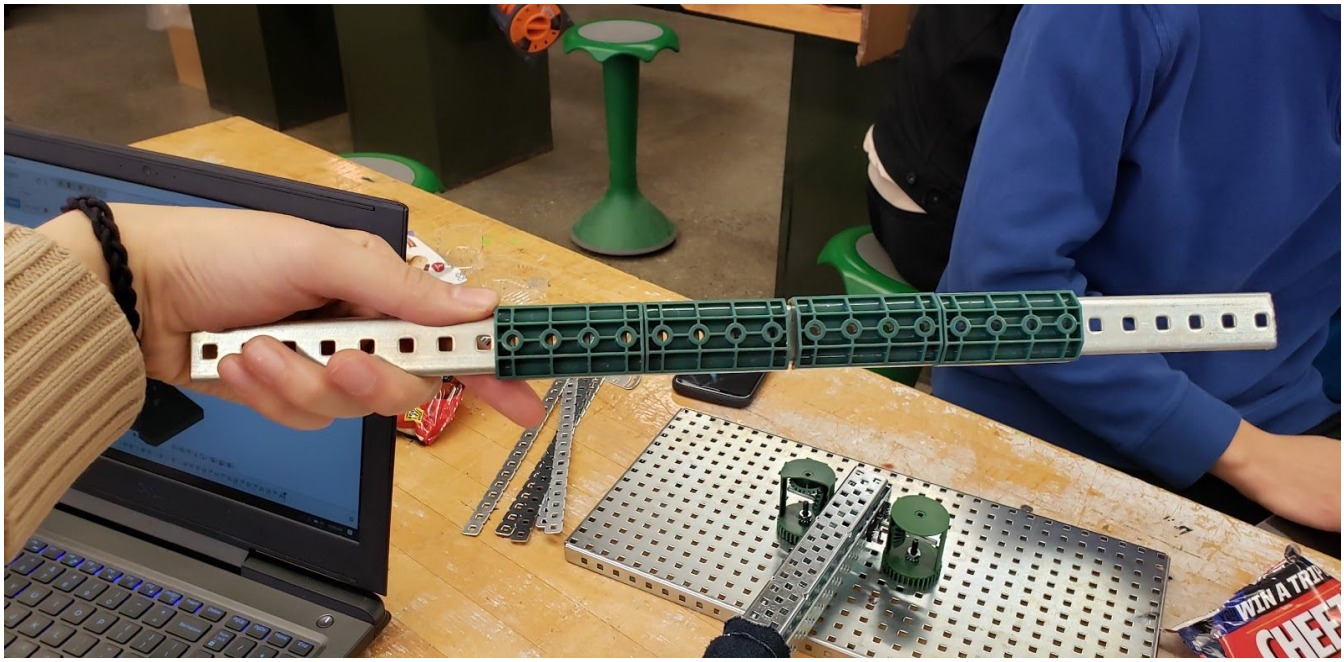
The most notable change from the original VEX prototype is the addition of the extendable handle as well as the rotatable base. The handle is a paint pole that was repurposed to be used as a shaft. It has several advantages over machining our own handle: better build quality, built in egonomics, and notable the screw at the base. This screw means it will be easier to integrate this part with the socket, since all we have to do is add threads to the base and then screw in the handle to the base. Apart from this base screw, the handle also has integrated ergonomics. The handle is covered in a foam-like material that allows for high comfort no matter the weight and length of the tool. The handle is also extendable, meaning that the user can use a shorter handle for the leaf crusher version of the tool

while extending the tool means it can be used as a rake or shovel, essentially allowing the tool to cover the whole process of leaf collection.



Above is a more detailed picture of the hinge mechanism on the initial prototype. The final prototype will hopefully have a more solid, hinge-based design

Below is a more detailed image of the sliding mechanism as visualized using VEX parts. This design will allow for a more sustainable and solid build quality, meaning our parts will work for longer and will not need frequent replacement. Additionally, the build mechanism is simple.



We took trips to Home Depot in order to explore different options for the lock and hinge mechanism in order to secure the tool as it adjusted from a rake to leaf crusher. We also found the mechanism that we used to extend the tool's handle, as the length of a leaf crusher and rake were different, for the convenience of the user.

Final design Building will be completed 2/19/20 at the Marine Hydrodynamics Lab, where parts can be acquired and machined for the final design.