

Ratchet Rockers

Team 1706



Pit Writeup

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Problems With The Previous Solution

Old Pit Analysis

Strengths - Branding - Availability of Tools - Plenty of Storage - Lighting - Overhead Fan	Weaknesses - Tight space - Setup and Teardown time - Number of pieces to move - Limited work space - Cost of banner each year
Opportunities - Partnerships with local businesses - Manufacturing growth - New trailer	Threats - Need to remake/update battery and spare parts cart - Tool Chest replacement - Age of Pit - Power outlet limitations

There were a number of reasons that our team decided to design a new pit. Some of the reasons included:

- The old pit was difficult to move in and out of the trailer in a timely manner.
- The pop-up canopy got extremely uncomfortable to work under at times.
- Organization was poor due to a lack of centralized storage components.
- Designing and branding was outdated and unprofessional.
- Sponsor board was expensive to maintain.
- Battery chargers continually fell onto the ground and became a tripping hazard



Brainstorming and Inspiration

While brainstorming ideas for our new pit, we used multiple other teams' pits as inspiration. We also took time to check out the best pits at IRI and FIRST Championship. The teams we took most inspiration from are:

- [118 Robonauts](#)
- [503 Frog Force](#)
- [4414 HighTide](#)
- [5436 Cyber Cats](#)

Early Design Criteria

After brainstorming, we had a specific set of requirements for a new pit. These requirements were intentionally chosen to account for different venues we may visit, ease of use, and functionality.

- Must fit in a 9x9x10 foot space
- Can be quickly and easily packed, unpacked and transported
- Can hold all tools, spare parts, and raw materials needed for competitions
- Adequate primary lighting with accent LEDs
- Ergonomic and comfortable to work in
- Looks stylish and eye-catching
- Integrate battery storage and charging
- Minimize items for quicker load-in

Concept CAD [CAD Link](#)

We landed on a design we were happy with. This design incorporates two large toolboxes with added storage mounted above. One of the toolboxes would hold three 32" monitor screens for our sponsor panels, slideshow, or match videos.



Pit Top Design

The design for the top storage was based on the type of organizers that will be used. It would be strong enough to support the weight of the organizers and their contents. The open front would give easy access to robot parts. The entire thing will fit within the vertical height constraints of doorways and trailers.

Part Organizers

The type of organizers we decided on for the pit would determine the final design of the pit top. If they are too heavy, the entire toolbox will be too heavy for people to easily roll, especially in and out of our trailer. We decided on the [STOREHOUSE Parts Storage Cases](#) from Harbor Freight Tools in the 20 (12x), 8 (6x), and 15 (8x) bin sizes. Each side has 26 organizers total.



Heavy-Duty Base Cabinet

The pit top will need a sturdy base cabinet to mount onto. It should have strong wheels to be able to roll, as well as have enough storage for all of our tools and spare parts. We landed on two of the [Husky 72-inch workbench with adjustable height solid wood top](#) from The Home Depot.

LED integration

The pit top will be equipped with LED lights for illumination. LEDs will be energy efficient and provide good work lighting.

Whiteboards

The pit top may include whiteboards for writing notes or displaying information. The whiteboards can be used to keep track of tasks, safety information, robot information, or for [leaving and receiving notes](#)

Manufacturing and Finishing

Adjustments to our design, manufacturing of the pit tops and corner cabinet, and painting of the whole assembly was generously done for us by our sponsor, [Custom Machine Works LLC](#). The paint applied is [Benjamin Moore D.T.M. Alkyd Low Lustre](#) in a custom color matched to our Husky workbenches. LEDs were wired and attached in-house. The colored LEDs are generic WS2811B on a generic controller from Amazon. Wiring for the LEDs was run through a split loom where necessary. Branding was applied to the tabletops, back, and sides of the pit for brand recognition and style. Decals were supplied and applied by our sponsor [STL Printworks](#)



Final Design [CAD Link](#)

The final pit design slightly deviated from our original concept CAD. The main changes made were the method of packing away the pit tops, and switching from three monitors to two TVs. The pit tops are mounted on gas shocks, which are mounted with bolts to the workbench table. This allows a few people to easily pack and unpack the pit in a timely manner. The shocks on the left and right workbenches are rated 100 lbs and 50 lbs, respectively. ½ inch lock collars were added to the gas shocks for safety. T-Handle bolts on each end lock the pit tops down.



Design Highlights

Battery Drawer System

A main issue from the previous pit that was fixed in the new pit is battery charging. Sixteen total batteries can be carried in our pit with twelve being charged at a time. Each charger has a DSN-VC288 display connected to it for monitoring the voltage and amperage going to each battery. This allows us to more quickly choose a battery that is done charging. All 16 batteries are in the lower drawer where all 12 chargers are in the upper drawer. A 3D-printed cable chain is used to route the wires. To help deal with the weight of 16 batteries, a piece of delrin was attached underneath the drawer to help relieve stress without making it difficult to open and close.



TVs & TV Mounts

The addition of TVs to our pit allows us flexibility in their uses. They are used to display our sponsor slideshow and robot reveal video, and sometimes used to show an event's Twitch stream. When we're not at competitions, they are used to watch other events. Using screens to display our sponsors' logos saves money on reprinting a new banner each year, which was the previous solution.

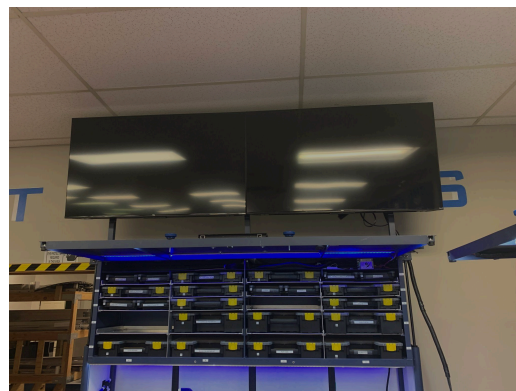


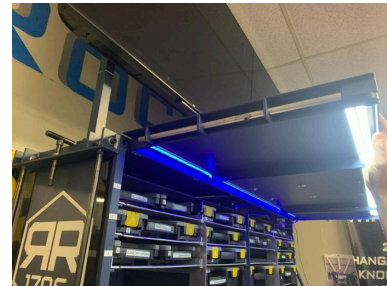
Table-Raising Crank

The Husky Workbenches serve as the base for this pit. These toolboxes have a small crank on the ends used to raise and lower the tabletop. This ability allows us to store raw materials up to ~70 inches in length.



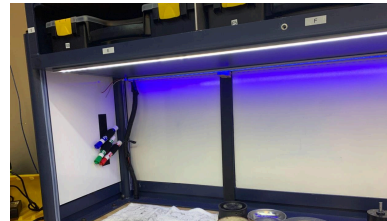
Folding Pit Top Doors

To hold all of our organizers in the pit top while being transported, a door was added to the design to keep everything safe. It locks down using two bolts. It also doubles as a lighting holder, locking horizontally with round aluminum stock.



Whiteboards

Whiteboards were added to the back of the pit. These are used for accents to light the area up more, as well as writing match schedules, information about the robot, or to-do lists.



Corner Cabinet

The corner cabinet is used to hold personal items such as backpacks or coats. It has one shelf in it toward the top where a power strip and the computer are stored. A tinted lexan door was added with magnets to keep it closed. Blue LEDs were added inside to illuminate our logo on the backside of the door.

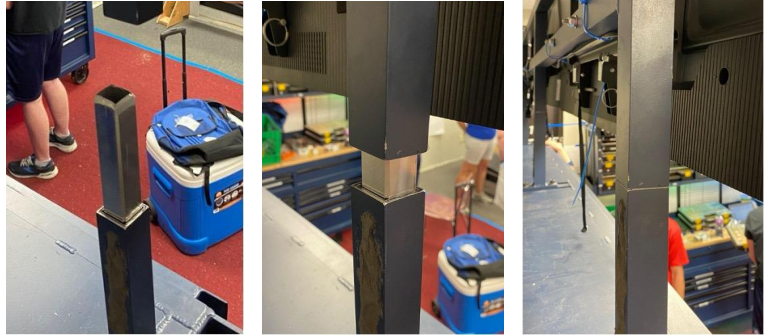


Deviations From CAD

Multiple changes were made to the final design that are not represented in CAD. This section outlines these changes.

Collapsing TV Mount

The display mount on top of the pit box was modified to allow the entire pit to fit through a normal size doorway.



Shelf Supports

The original design planned to have two parts organizers slide out at once similar to a drawer. We decided this was going to be inefficient, and modified the pit tops to hold organizers like shelves. This was done with a piece of aluminum riveted into place.



Corner Cabinet Door

A door was added to the opening on the corner cabinet. This is to hide any clutter and display our logo, which is engraved into the back.



Teflon and Lexan Guides

We added strips of lexan and teflon on parts that slide against each other. This helps make the tops move up and down more smoothly.

TV Transportation and Mounting

We added TV mounts to the pit doors to hold TVs while being transported. This keeps everything safe and easy to move.



Transportation

The entire pit is transported in our dual-axle enclosed trailer and hauled by a mentor or parent. The trailer has ratchet strap mounts along the side walls as well as a side door for access when

fully loaded. The first part of our pit to go into the trailer is the robot cart. The robot is strapped to the top of the cart, and the cart is attached to the wall. Both of the pit workbenches roll into the trailer and strap to the walls. To keep the drawers closed while driving, the drawers are



locked. We found the locks originally on the workbenches to be sufficient, even for the heavy battery drawer. The last part



of the pit to go in is the corner cabinet. Any extra things that need to be hauled (stadium seats, scouting backpacks, coolers) are put between the workbenches or at the front by the robot cart.

Price Breakdown

# of Components	Component	\$ per unit	Total
12	12v 6 amp charger	\$25	\$300
12	Charging Displays	\$7.00	\$84
2	55-inch Roku TV	\$300	\$600
1	WS2811B Strip Lights	\$24	
2	Lower Cabinets	\$1,358	\$2,716
24	Small Organizers	\$7	\$168
12	Medium Organizers	\$8	\$96
16	Large Organizers	\$10	\$160
1	Sponsor Donated Pit	\$24,000	
Total		\$28,169	
Cost After Sponsor Donations		\$4,169	

Lessons Learned and Recent Improvements

Corner Cabinet Wheels

The final product of the corner cabinet had very small casters on it. This made it difficult to roll around on uneven surfaces, like concrete at a venue or into our trailer. Recently, we had the cabinet shortened and larger casters added to the bottom.

LED Installation

Installation of the LEDs in the pit was difficult. We did not account for wires being ran top to bottom and ended up drilling many holes. A future design would leave room for wires and have built-in LED tracks.

LED Brownouts

An issue we had for a while was colored LEDs flickering or changing colors, especially when set to a solid color. We fixed the issue by running the 12 volt power for the strips separate from the controllers, using them only for the digital pin.

Gas Shock Ratings

The original gas shocks we received were rated for 200 lbs each, which was far too much. We replaced those as described before, with 100 lb and 50 lb on the left and right, respectively.

Difficulty Raising and Lowering Pit Tops

Raising and lowering the pit tops is difficult if people on each side are not properly coordinated. This happens because there is no mechanism ensuring even movement of the left and right sides of a pit top, letting it go down at an angle and bind. We added teflon tape and lexan as slides to help mitigate the issue, but a future design will provide a fix for this.

Battery Drawer Stress

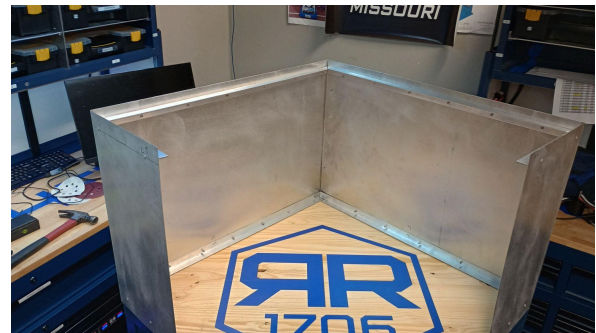
Due to the huge weight of 16 batteries in a drawer, we have seen some flexing in the drawer slides on the workbench. We are working to find a solution to this issue in the offseason of 2024.

Lack of Seating For Pit Crew

A huge oversight in our design is the lack of room for the pit crew to sit between matches. We have since fixed this issue with telescoping stools from Amazon.

Corner Cabinet Pit Top

We knew at some point we would be adding a pit top to the corner. This was done during the 2024 season, before the FIRST Championship. A thin aluminum sheet was formed to fit around the outside of the cabinet. It is reinforced with 1 inch angle and square tubing, with a top made of $\frac{3}{8}$ inch thick Arboron. It is painted in flat black spray paint, as we do not have capabilities to spray the matching paint in-house. Whiteboards and white LEDs were added for aesthetics. A single pair of wires with an Anderson Powerpole connector is run between the dimmer on the right pit and the corner. We also accounted for the height of our Bambulab X1 Carbon, with the AMS system on the Arboron shelf above. Decals were also applied by our sponsor [STL Printworks](#). We added a dual-hdmi wall plate to the back and mounted the computer to the bottom of the Arboron shelf. This allowed us to clear a large amount of the wires from the lower cabinet, making more room to store backpacks and water bottles.



Links and Resources

Sponsors

- [Custom Machine Works LLC](#)
- [STL Printworks](#)

Inspiration

- [118 Robonauts](#)
- [503 Frog Force](#)
- [4414 HighTide](#)
- [5436 Cyber Cats](#)

Purchased Products

- [72-inch Husky Workbench](#)
- [STOREHOUSE Parts Storage Cases](#)
 - [15 bin - Small](#)
 - [20 bin - Medium](#)
 - [8 bin - Large](#)
- [Benjamin Moore Paint](#)

Onshape Documents

- [Original Pit Concept CAD](#)
- [Final Design CAD](#)