TO: EGR Corp
FROM: EGR 121 Team 2 (Lexie Belgrad, Cody Alessio-Bunnell, Jack Wigmore, Jay Parmar)
SUBJECT: DC3 Quantum Sand Machines
DATE: 26 February 2024

2.1 Executive Summary

The design challenge is to create a sand vehicle, powered by a singular mouse trap activated once. The motion starts with a string being cut, causing the arm of the mousetrap to rotate with the goal being for the rotational motion of the mousetrap to be translated to the translational motion of the cart. Ultimately, we decided on a tricycle design with rear-wheel drive and an angled mousetrap powering the system, shown in Appendix F. We opted for a mostly PLA body to optimize weight while maintaining a strong structure, along with the option to add nuts to increase weight if desired. Our relatively lightweight design, while not gaining many points for weight, allowed us to prioritize distance and achieve a high score in that category.

2.2 Approach

We employed a culmination of techniques as a group to arrive at our final design solution. Our first step was to have a discourse regarding ideas for each component of the car concerning the design challenges. Once we brainstormed a variety of design solutions, we began making simple drawings of each brainstormed component, shown in Appendix A, B, and C. Rather than pre-emptively eliminating certain design variations, we decided to keep an open mind and only eliminate designs through testing. This allowed us to compare the performance results of each design and choose accordingly. Once each variation was tested, we would (unanimously) vote on the design we believed would work best as this seemed to be the most time-efficient ideation strategy.

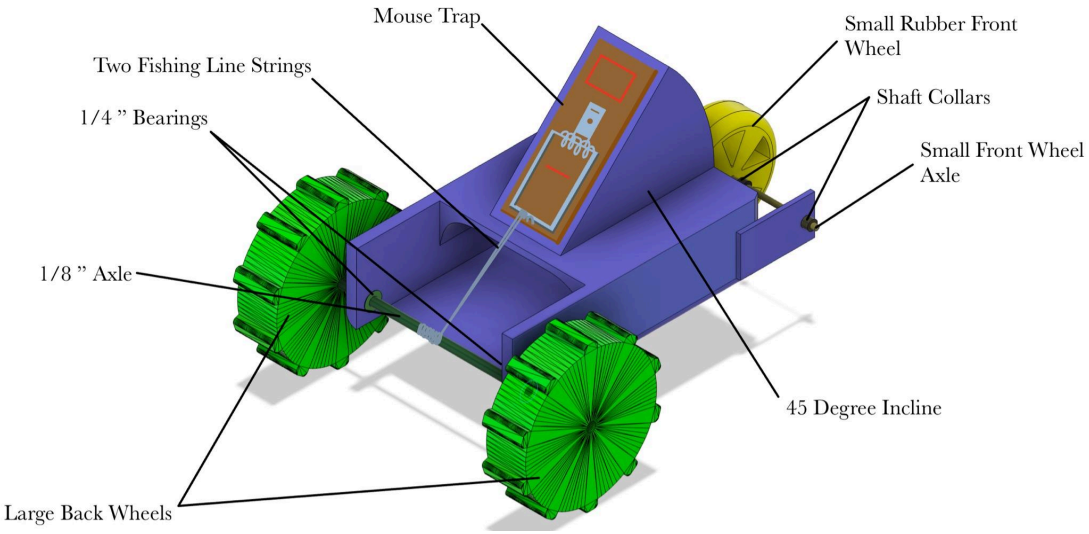
Our design underwent significant transformations as we worked through different component ideas. Initially, our team voted to use a front-mounted sled design with a rear-wheel-propelled drivetrain. Upon testing this design, it was noted significant sand collected at the front of the self, causing significant friction. We brainstormed ideas to counter this, including a front-wheel driven design with the sled in the back and a pointed sled to displace sand more effectively. We voted to use the front wheel design as it was an easy adaptation; we simply flipped the car around and wound the string the other way. We still encountered issues with movement and friction; upon further evaluation, we concurred the teeth of our medium fidelity wheels, displayed in Appendix E, were too long and created too much traction. In our next design, we used wheels with smaller teeth but otherwise similar dimensions and saw greater success with the design able to traverse a short distance.

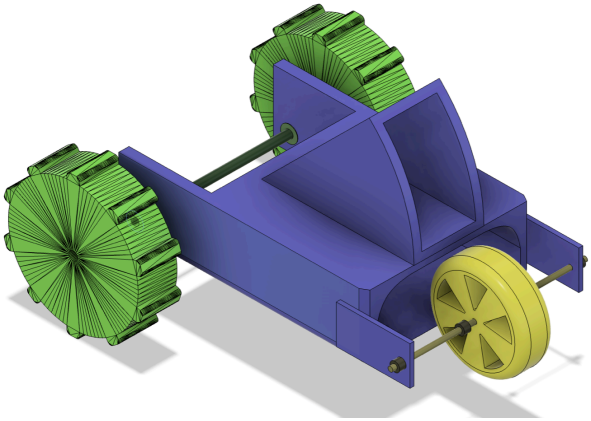
Thus, the remaining revisions were geared towards increasing its range of motion. We brainstormed potential limiting factors in our design and tested them individually. The first

criticism was with the sled design and its (still) high traction. Our group voted to temporarily replace the sled design with a central back wheel smaller in diameter compared to the front. We tested this initially using foam board and immediately saw better results, so we elected to permanently implement this using thin wood supporting boards, a steel axle, a rubber wheel, and bearings. Upon further testing, one of our group members observed that the mousetrap car would 'stall' at a consistent angle of rotation of the mousetrap. We concluded that this was due to a balance of counteracting forces and quickly remedied this by placing the mousetrap at an angle instead of sitting flat on the car.

We also tested a variable pulley ratio using a cone to wrap the string around with little success. This initially brainstormed idea is shown in Appendix C. Our final design changes involved flipping the car again so that it would be rear-wheel-driven– which we had tested by accident and noticed improved performance– and also wrapping balloons around the rear wheels to further adjust for traction. Our final design is displayed in Appendix F.

2.3 3D Machine Sketch





Rear Drivetrain (Mouse Trap and Rear Axle Wheels)

Chassis (Angled Ramp and PLA Frame)

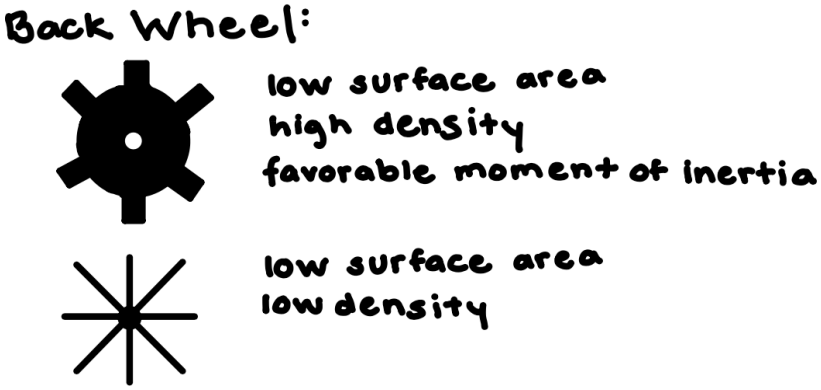
Front Drivetrain (Small Axle Wheel and Shaft Collars)

2.4 Results/Conclusion

Our car performed very well. The team developed an efficient system for the testing in which one person would tie the string, one person would flatten the sand, and one person would weigh the vehicle. This allowed us to optimize speed in the testing process and produce a lot of trials. Ultimately, our vehicle travelled a maximum distance of 40 inches with a maximum weight of 0.939 pounds. The data from all vehicle trials is shown in Appendix F, with ours shown as Team 2 in the 1:25pm section. The car had a great performance with the rubber wheels and inclined ramp proving to be very good features that distinguished our car and allowed it to have one of the best performances.

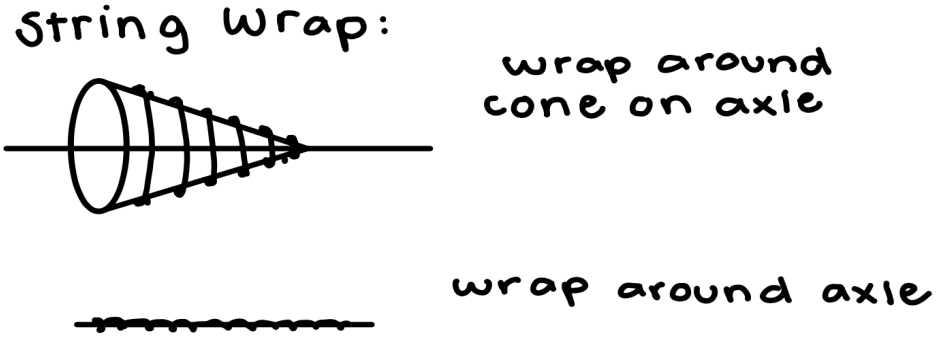
2.5 Appendix

Appendix A: Back Wheel Brainstorming

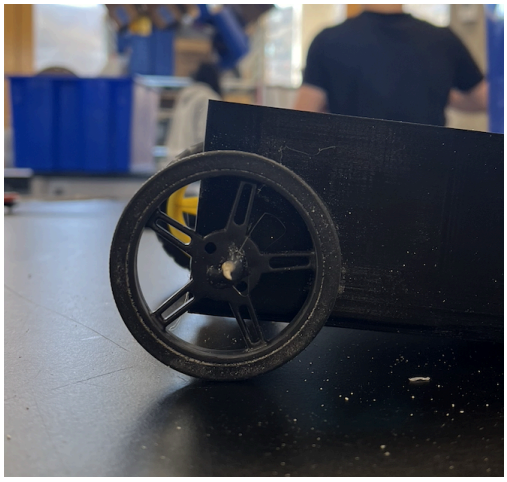


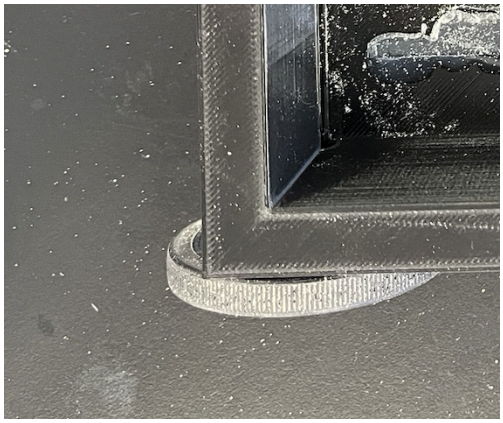
Appendix B: Front Wheel Brainstorming

Appendix C: String Wrap Mechanism Brainstorming

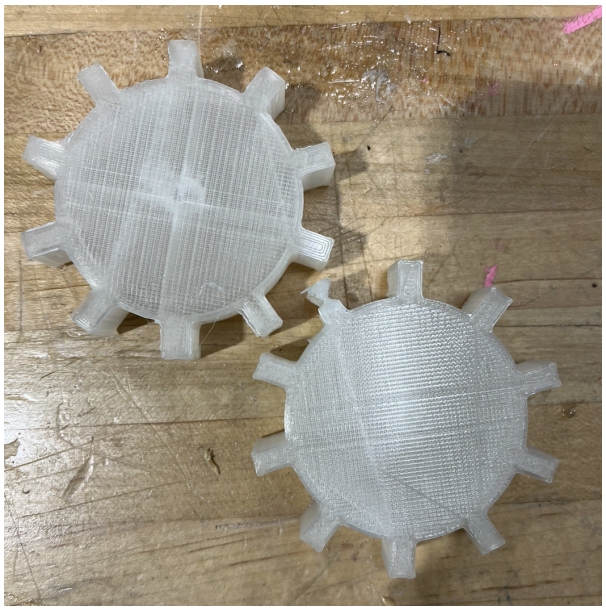


Appendix D: Narrow vs. Wide Wheel Low Fidelity Prototypes

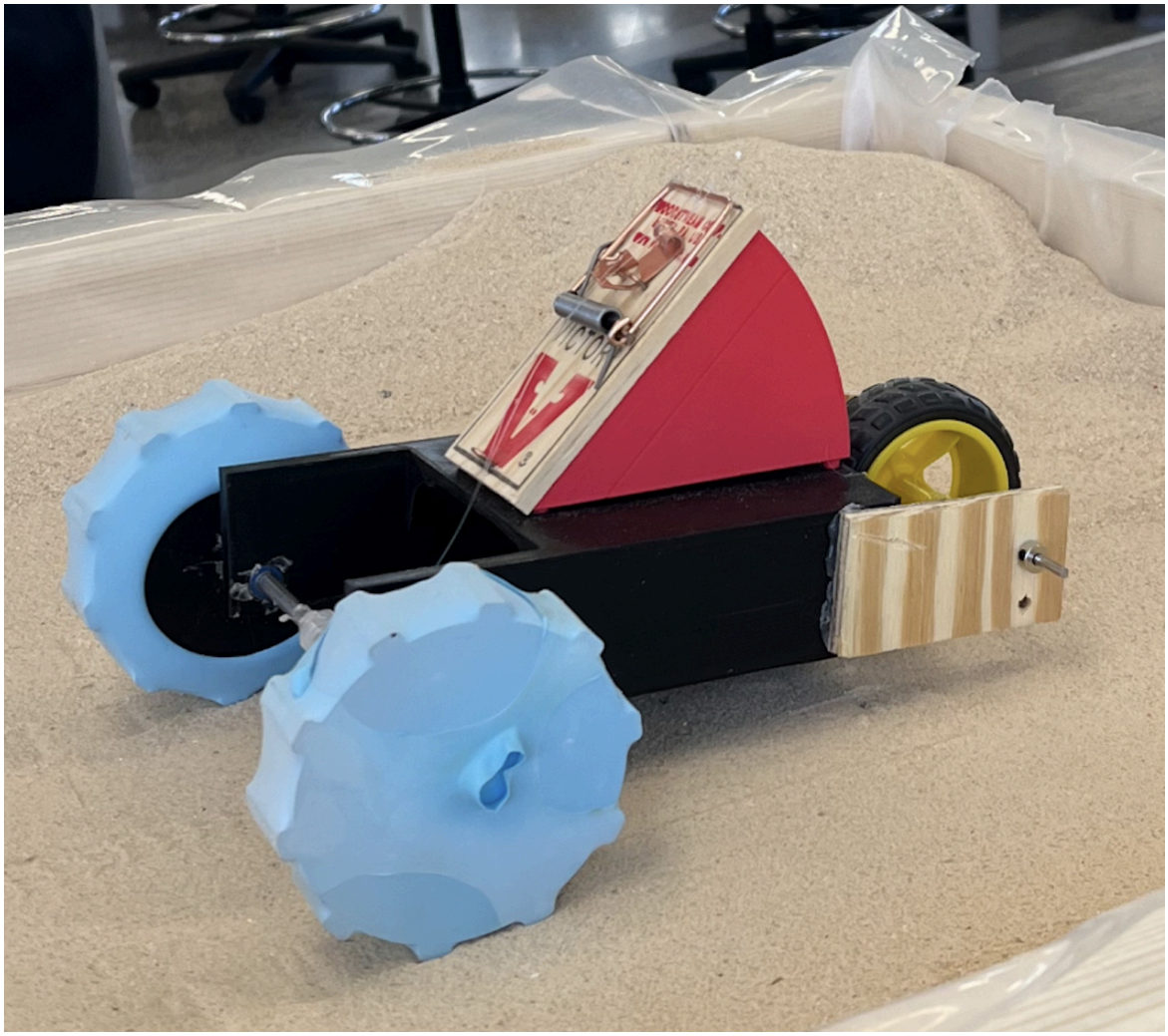





Appendix E: Medium Fidelity Wheels–Wide with Large Teeth



Appendix F: High-Fidelity Final Prototype



Appendix F: Final Scores and Data

	Team Name	Length (in)	Weight (lbs)	Score (in*lbs)
8:30 Lab				
Team 1	Phoenix	29.375	0.83	24.42
Team 2	Team 2!	36.375	0.81	29.55
Team 3	Thomas Cheddarsons	26.25	0.92	24.12
Team 4	Team IV (Ivy)	41.75	0.74	31.05
Team 5	Krustacean Automation	15.875	0.67	10.62
Team 6	Duke Blue Hamsters	24.5	0.58	14.24
Team 7	Clowns	0	2.29	0.00
Team 8	The Back Side of Wate	10.875	0.93	10.06
Team 9	NAS	38.75	0.59	23.01
10:05 Lab				
Team 1	Steamroller	30.25	1.42	42.92
Team 2	John Deer	22	1.24	27.23
Team 3	Santa's Slay	32.5	0.37	11.98
Team 4	Team Bob	34.75	1.11	38.66
Team 5	Barbie-Mobile	32.25	0.89	28.82
Team 6	Smiley	44.5	0.60	26.70
Team 7	Vlone Monster Mash	40.25	0.47	18.87
Team 8	Straws	0	1.24	0.00
Team 9	Mouse-Mobile	23.75	0.28	6.68
Team 10	Lightning McQueen	33.75	1.33	44.72
Team 11	Apollo	36.75	0.52	19.06
1:25 Lab				
Team 1	Won	49	0.624	30.58
Team 2	Dagan	40	0.939	37.36
Team 3	Dot	31	0.536	16.616
Team 4	NASA	35.75	1.622	57.987
Team 5	Twisster	48	0.82	39.36
Team 6	Point Break	50.5	0.662	33.431
Team 7	Valentines	36	1.312	47.232
Team 8	No name	0	0	0
Team 9	Turbo	48	0.612	29.376
Team 10	Tiger King	43.75	0.712	31.15
Team 11	The Mice	46	0.438	20.148
Team 12	Mad Max	46	0.476	21.896