To: EGR Corporation
From: Bright Aboah, Morgan Chu, Madison Jaffrey, Mallika Kenkare
Subject: Mousetrap vehicle
Date: February 14, 2022

EXECUTIVE SUMMARY

This report aims to address the iteration and design of a quantum sand machine as requested by EGR Corp. We were commissioned to create a sand machine that generates power from a mousetrap, triggered by cutting a string or other material that's easily reset, that propels a vehicle across a 72-inch sand surface. Our team was constrained to a size within a 12-inch by 24-inch starting zone as well as materials already accessible to us as provided by our sponsor the Pratt School of Engineering at Duke University.

The team designed and built a vehicle to travel a given distance over sand with the only power supplied from one mousetrap. The team iterated over various versions of the vehicle, eventually deciding on a traditional car that used 4 wheels and a chassis, complete with 2 axles and a weight that pulled the car forward when the mousetrap was triggered. We went through several design ideas and ultimately decided on a design that would give us the maximum length traveled, along with enough weight to score high based on the given criteria.

APPROACH DESCRIPTION

Ideation Techniques Used

The team approached this design challenge by starting with idea generation. For 15 minutes, each individual member of the team wrote down and drew various ideas for different parts of what we believed the mousetrap car vehicle would entail from how to power it to how the vehicle would move across the sand. After the allotted time period, we shared our ideas with the team and hitchhiked off each other's brainstormed ideas to generate additional ideas. At this point, we used common sense to screen certain ideas that were unrealistic or wouldn't work with our design constraints.

Morph Matrix

After idea generation, we had a plethora of ideas for individual aspects of our vehicle but no “complete” solutions. In order to generate complete solutions we put our partial ideas into categories within a morph matrix and took turns generating various ideas (Figure 1).

Figure 1: Morph Matrix

	#1	#2	#3	#4	#5
Transportation	Wheels	Sled	Projectile	Sail	
Base	Foam Core	Foam Block	Wood	3D Print	Pool Noodle
Mousetrap Location	Under base	Behind Back	In front of base	On top of base	
Primary Materials (if wheels)	3D print	Foam	PVC	Wood	Pool Noodle
Shale (if wheels)	Round	Triangle	Tank Treads	Square	
Primary Materials (if sled)	Foam Core	Wood	3D Print	PVC	

Through the use of our morph matrix, we brainstormed 9 ideas for this project. The nine ideas were as follows:

1. Projectile with sled
2. Projectile with four round wheels
3. Projectile with tank treads, which have two wheels inside on each side of the machine
4. A machine that has four triangular wheels, and a rope strung to the mousetrap
5. A machine that has four round wheels directly attached to the mousetrap
6. Sled with sail, with rope strung to the mousetrap
7. A machine with a tank tread of four round wheels, with rope strung to the mousetrap

8. A machine with a tank tread of four round wheels directly attached to the mousetrap
9. A machine with three wheels, which rope strung to the mousetrap

Ideation Selection and Refinement Techniques Used

In order to efficiently go through our brainstormed ideas we first defined and weighted design criteria. In order to do this we created a pairwise comparison chart (Figure 2) in which we determined the level of importance of our design criteria. This PCC shows the design criteria we felt would make the vehicle go as far and weigh as much as possible. As shown below, distance traveled and weight scored the highest in terms of importance.

Figure 2: Pairwise Comparison Chart

Design Criteria	Weight	Distance Traveled	Length	Width	Total
Weight	-	0	+1	+1	2
Distance Traveled	+1	-	+1	+1	3
Length	0	0	-	+1	1
Width	0	0	0	-	0

Using the pairwise comparison chart we were able to create a weighted Pugh Scoring Matrix (Figure 3). Previously we had common sense screened to nine ideas but the scoring matrix allowed us to evaluate which ideas were the best.

Figure 3: Pugh Scoring Matrix

Design Criteria	Weight	Idea 1	Idea 2	Idea 3	Idea 4	Idea 5	Idea 6	Idea 7	Idea 8	Idea 9
Length	0.2	1	3	2	2	2	1	3	3	3
Width	0.2	2	2	1	2	3	1	3	1	2
Weight	0.4	1	1	3	2	2	1	3	3	1
Projected Distance	0.2	1	1	1	2	2	3	2	1	1

		1.2	1.6	2	2	2.2	1.4	2.8	2.2	1.6

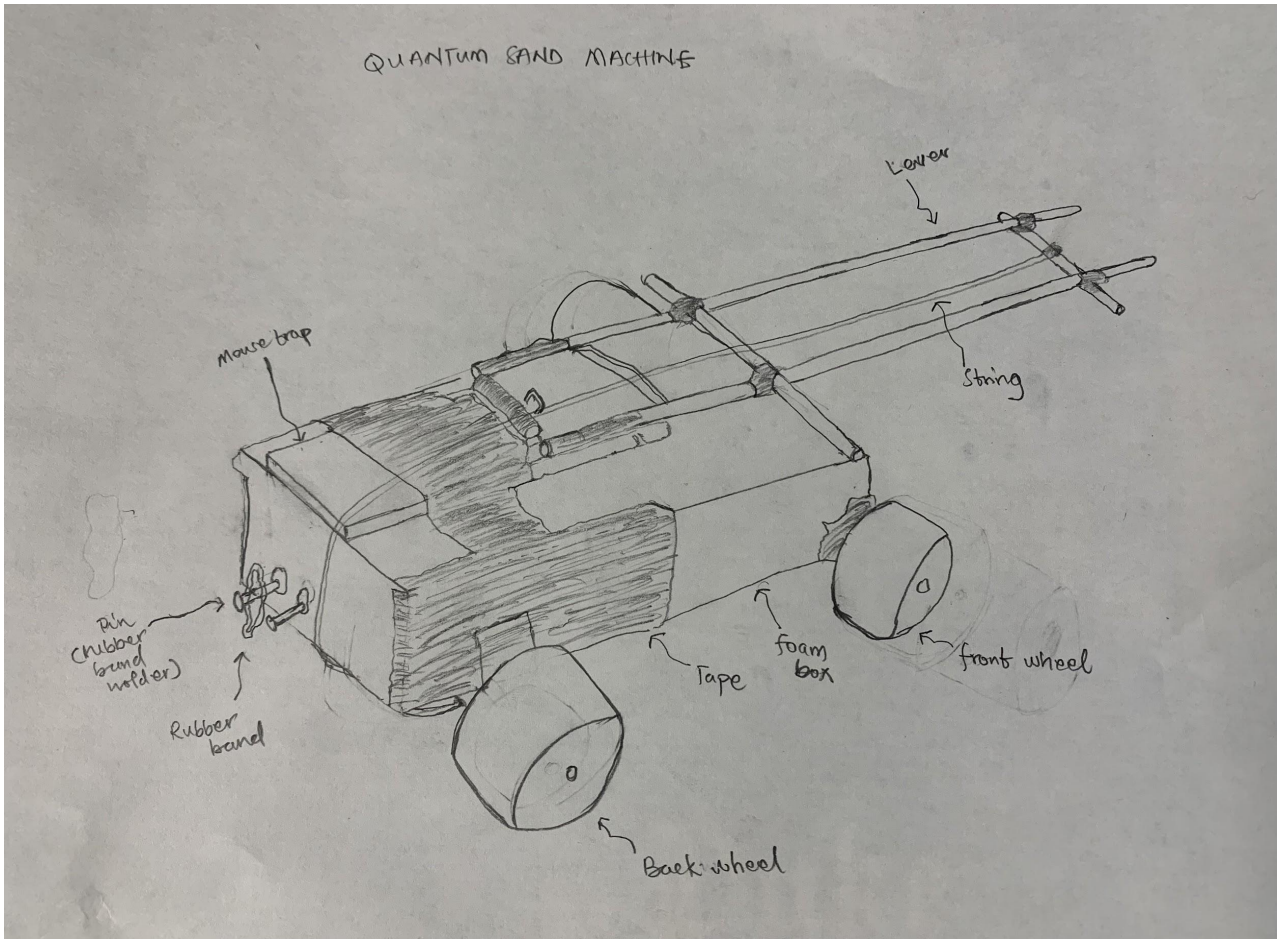
From the Pugh Screening Matrix we saw that ideas 5, 7, and 8 stood out**.** After some trial and error we ended up pursuing a combination of ideas 5 and 7**,** as it was the most feasible based on our time constraint and individual ideas. We preferred the propulsion method from idea 7, but we preferred the simplicity of idea 5.

SUMMARY AND CONCLUSION

3D Machine Sketch

This machine sketch of our vehicle highlights all the features and parts that were the most important in making our vehicle move (Figure 4). Our final design was released by cutting a rubber band which caused the lever to move forward, pulling the fishing line that was attached to the drive chain.

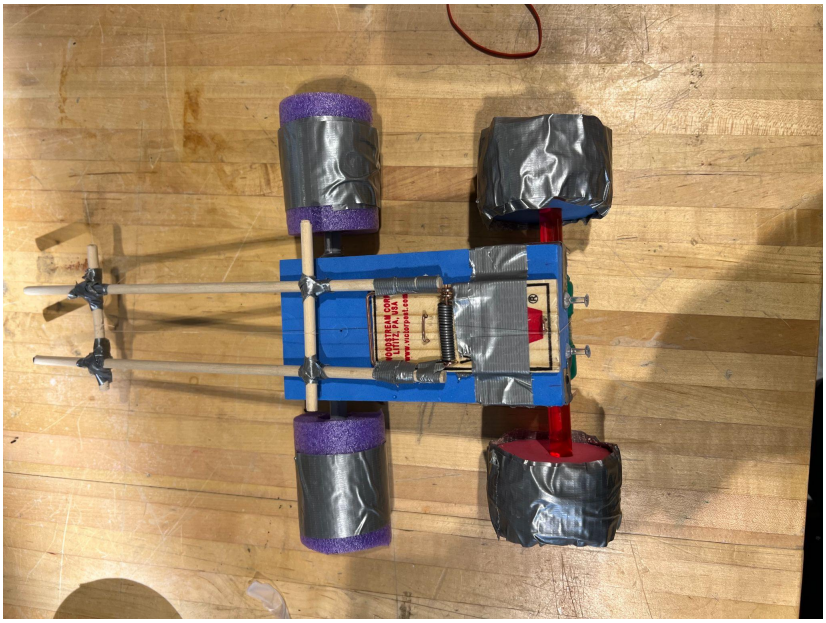
Figure 4: Mouse Trap Car Sketch



Final Vehicle

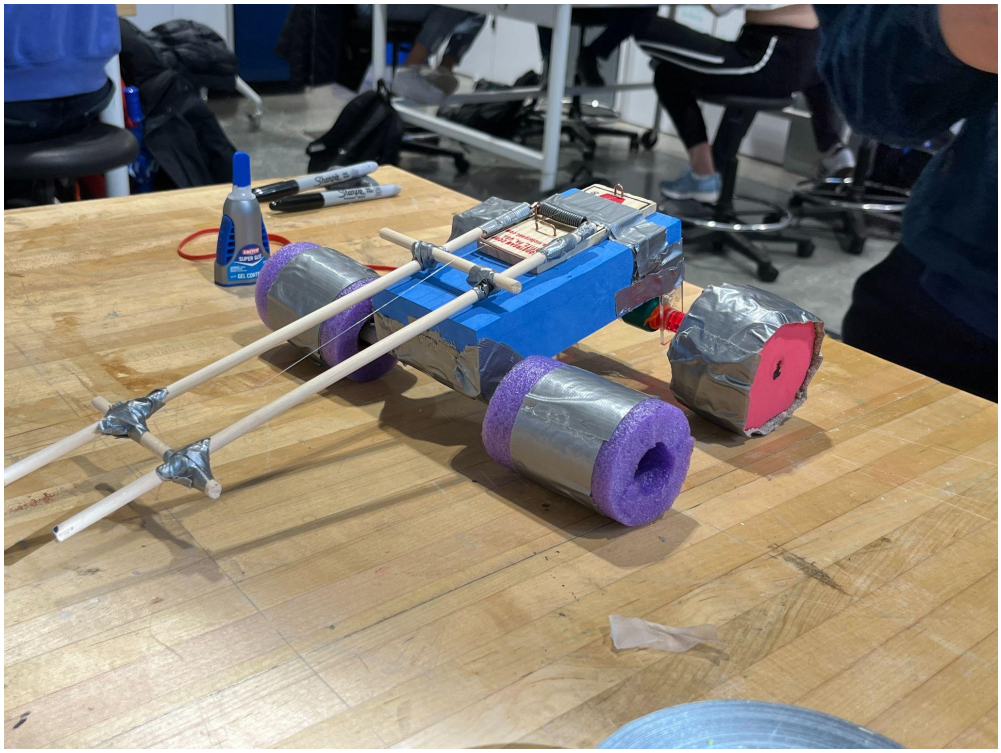
The final car was made mainly out of foam and duct tape in addition to the two axles, and an acrylic support for the back axle/drive chain. On our final test, the vehicle traveled 5 inches with a maximum weight of 268 grams.

Figure 5: Final Car

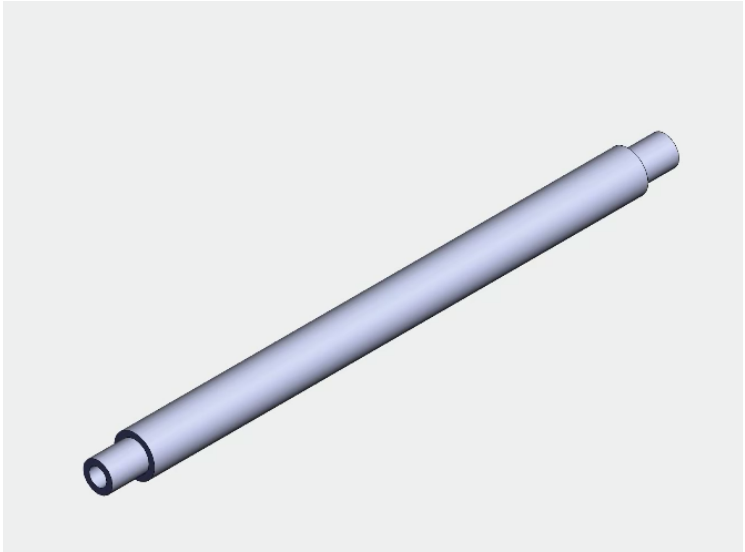


APPENDIX (Sketches, Videos, Pictures)

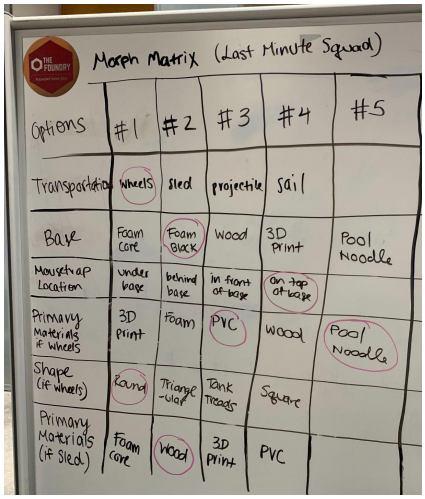
Appendix A: Picture of Final Vehicle



Appendix B: Initial 3D sketch of axle



Appendix C: Morph matrix of final design idea

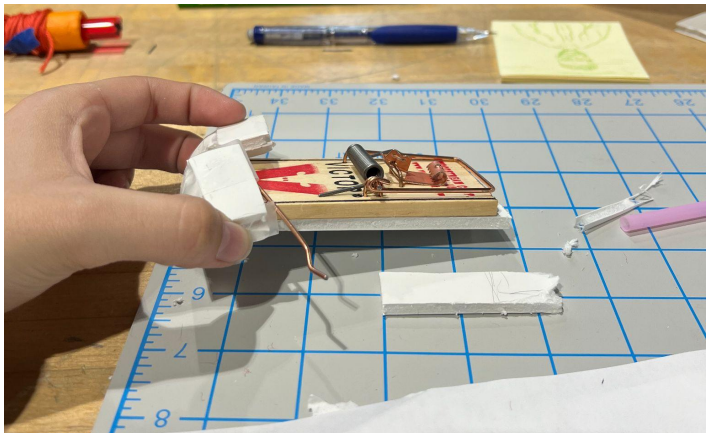


Morph Matrix (Last Minute Squad)

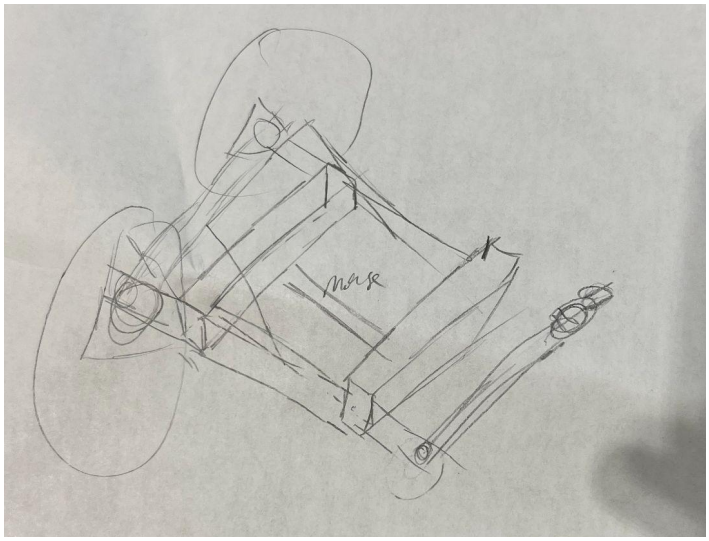
Options	#1	#2	#3	#4	#5
Transportation	Wheels	Sled	projectile	Sail	
Base	Foam Core	Foam Block	Wood	3D Print	Pool Noodle
Mousetrap Location	under base	behind base	in front of base	on top of base	
Primary Materials if wheels	3D Print	Foam	PVC	Wood	Pool Noodle
Shape (if wheels)	Round	Triangle -ular	Tank Treads	Square	
Primary Materials (if Sled)	Foam Core	Wood	3D Print	PVC	

Appendix D: First version of finished product

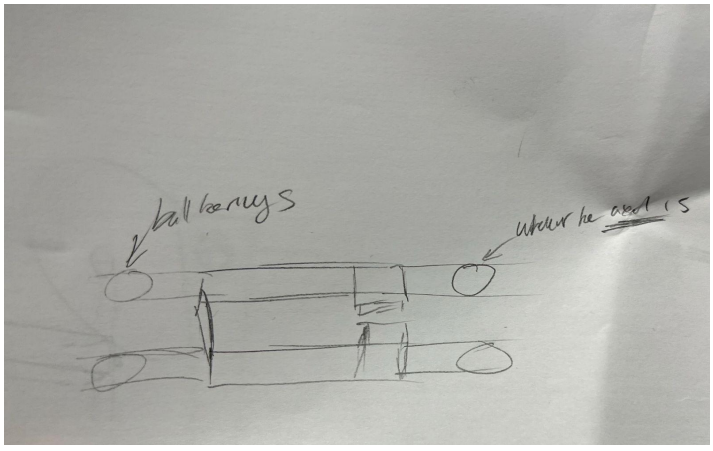
Appendix E: Foam core base prototype



Appendix F: Brainstormed Drawing A



Appendix G: Brainstormed Drawing B



Appendix H: Brainstormed Drawing C