
Lunar Regolith Extruder
Warren Technical Center
Instructor: Nate Olsen
Group Members: Cole Bickell, Josh Kempe, Brody McGrath
Project Info
Auger Temp Calculations & Graph
Materials Used
• Modeling ABS
• Aluminum Piping
• 12V Motors
• Blending Motors
• Various Circuitry Components
Mixing Chamber Outlet
Material Feed System Expanded
Physical Mixing Chamber Outlet
Auger Drive Motor Circuit
First Complete Iteration Design
Hopper 1 / 2
Mixing Chamber
Material Extruder
Material Transportation Pipe
Material Transportation Pipe
Volumetric Feed System
Feeding Chamber
Project Background
Lunar Habitats require level ground and a solid foundation. Materials such as bricks and wood are too heavy to transport to space for this purpose.
Solution
By mixing leftover/extra plastic packaging and lunar soil in a high temperature chamber, we are able to produce small foundation bricks.
Goals/Constraints
• Produce 100 1x1x5in bricks per 24 hours
• Create our own input with filtering system
EPSON

Project Info

Calculation for Auger Width Temp (1 m^2 solar surface area)

Materials Used

- Modeling ABS
- Aluminum Piping
- 12V Motors
- Mixing Motors
- Various Circuitry Components

Google Slides additional information

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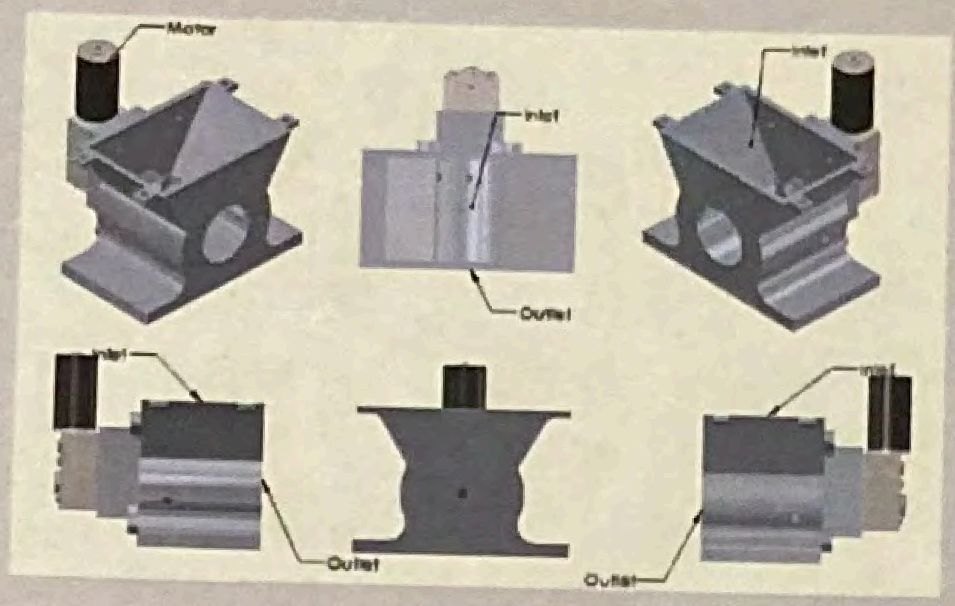
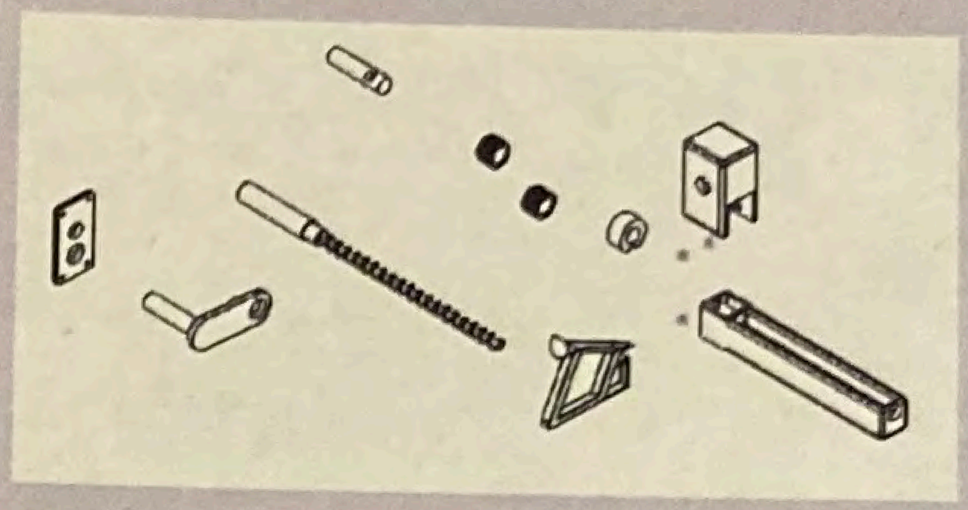
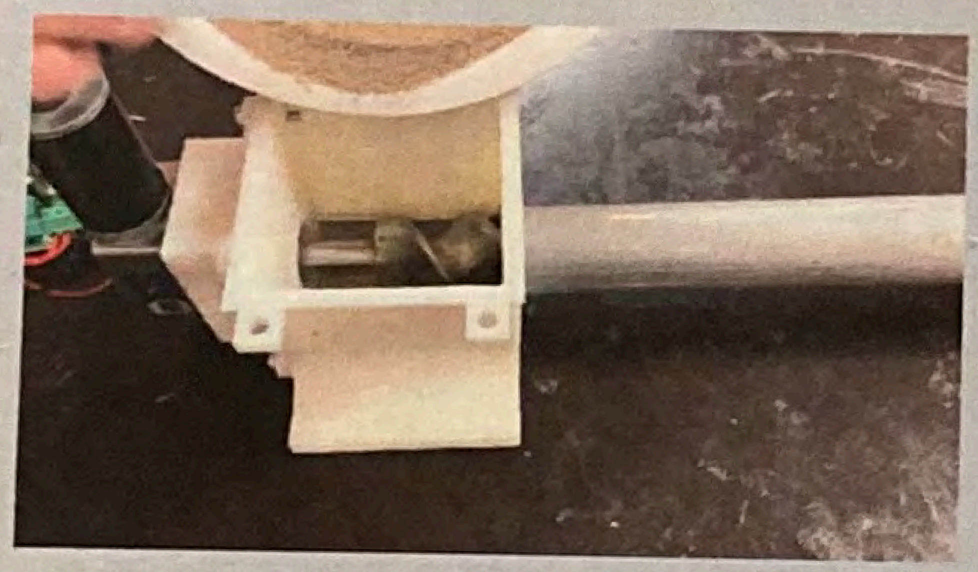
Mixing Chamber Outlet



Material Feed System Expanded

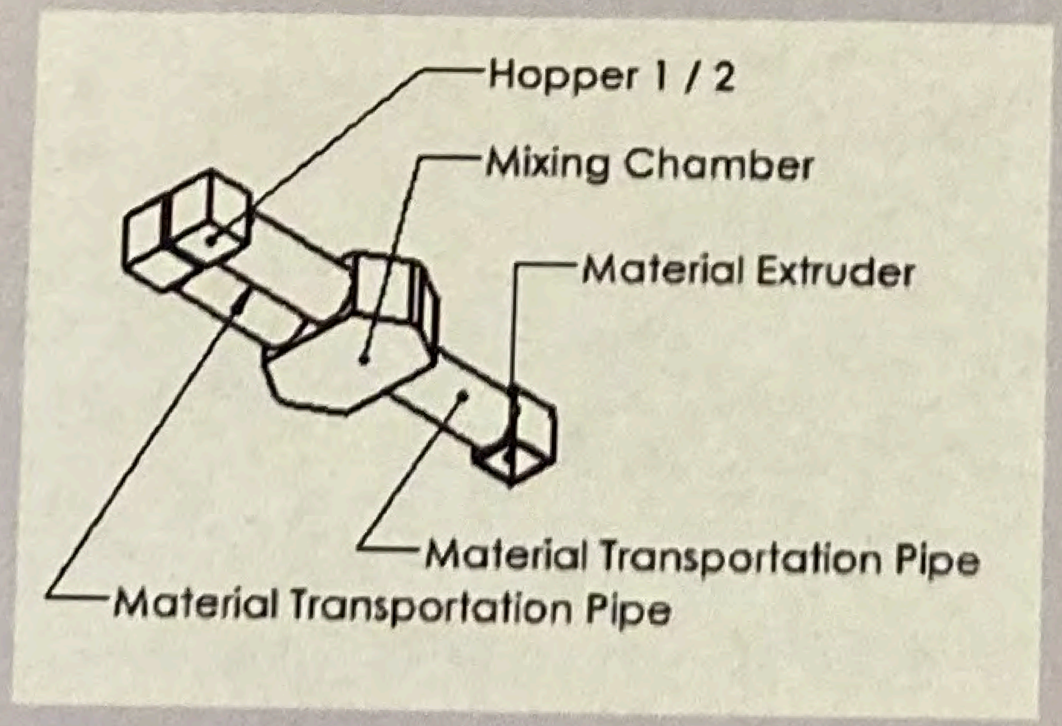


Physical Mixing Chamber Outlet

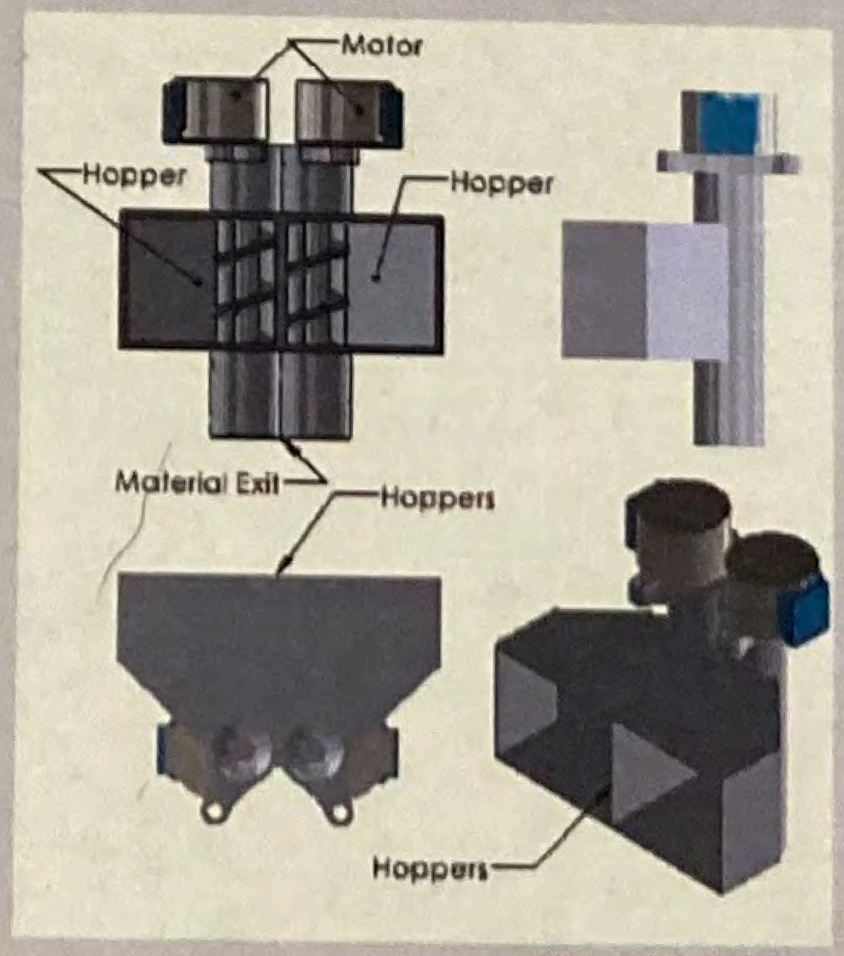


Auger Drive Motor Circuit

First Complete Iteration Design



Volumetric Feed System



Project Background

Lunar Habitats require level ground and a solid foundation. Materials such as bricks and wood are too heavy to transport to space for this purpose.

Solution

By mixing leftover/extra plastic packaging and lunar soil in a high temperature chamber, we are able to produce small foundation bricks.

Goals/Constraints

- Produce 100 1x1x5in bricks per 24 hours
- Create our own input with filtering system, mixer, and extruder.
- Determine ideal lunar regolith to plastic mix ratio.
- Produce in a low gravity environment
- Must be heated by Parabolic mirror

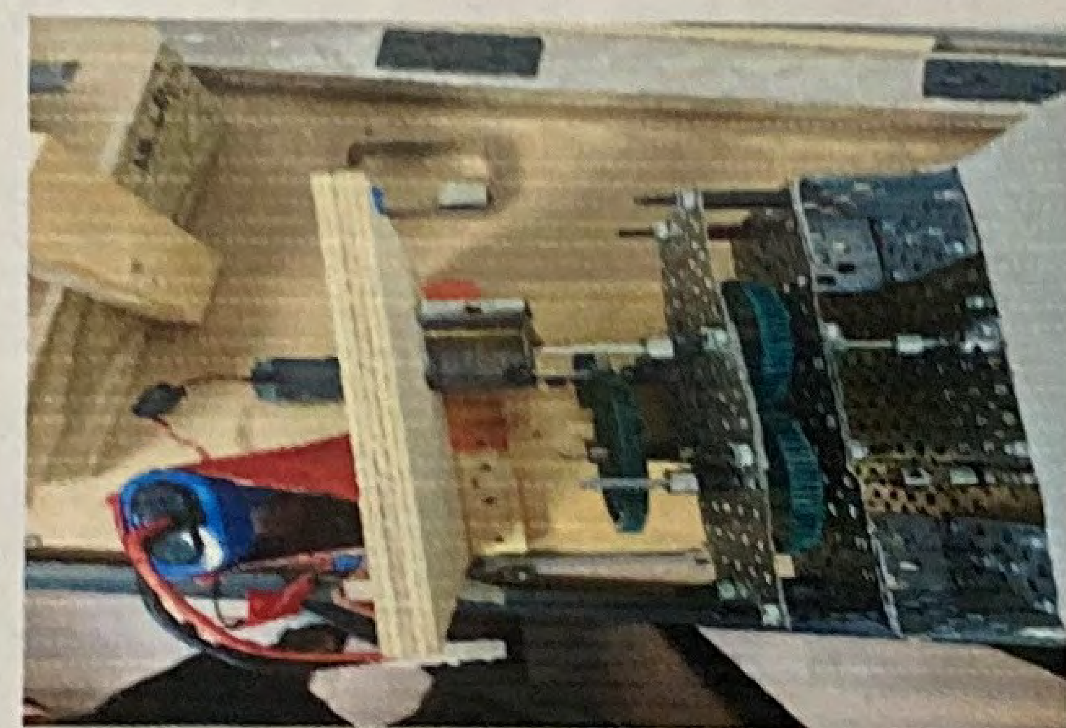

Aluminum Piping
12V Motors
Blending Motors
Various Circuitry Components
Google Slides additional information
Hopper 1 / 2
Mixing Chamber
Material Extruder
Material Transportation Pipe
Material Transportation Pipe
Feeding Chamber


3D Design
AUGER
PROJECT
MODEL PROGRESSION
PROBLEM STATMENT
RESEARCH
NEW PERSPECTIVES
Sun
Track

Explanation

We received the Auger Pipe, Extruder project. When researching we stumbled upon a hopper that is used to mix concrete. We took inspiration then started creating the hopper system out of foam boards. To make the auger spin we decided to use vex as it was the only platform available. That's when we made our 3-part transmission. After the NASA visit, we received valuable information on how we could improve the transmission. We torqued up the transmission by manipulating the gears to output more torque. After we were done with the transmission we started to focus on the extruder and knife assembly of the auger. We also received advice on how we could cut the bricks to preserve the shape of the brick. We decided to make a windmill cutter to preserve the shape of the brick. Michael did calculations to find the exact rate that a brick would come out. Then we found out the gear rations needed. And assembled the cutter system.

Final Designs



Auger Project

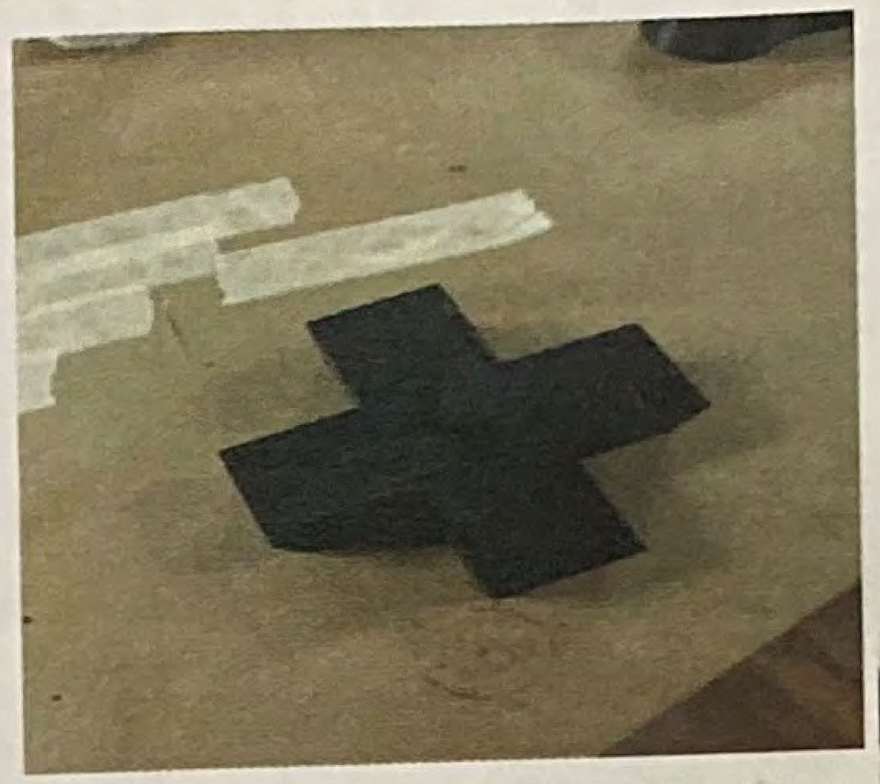
By

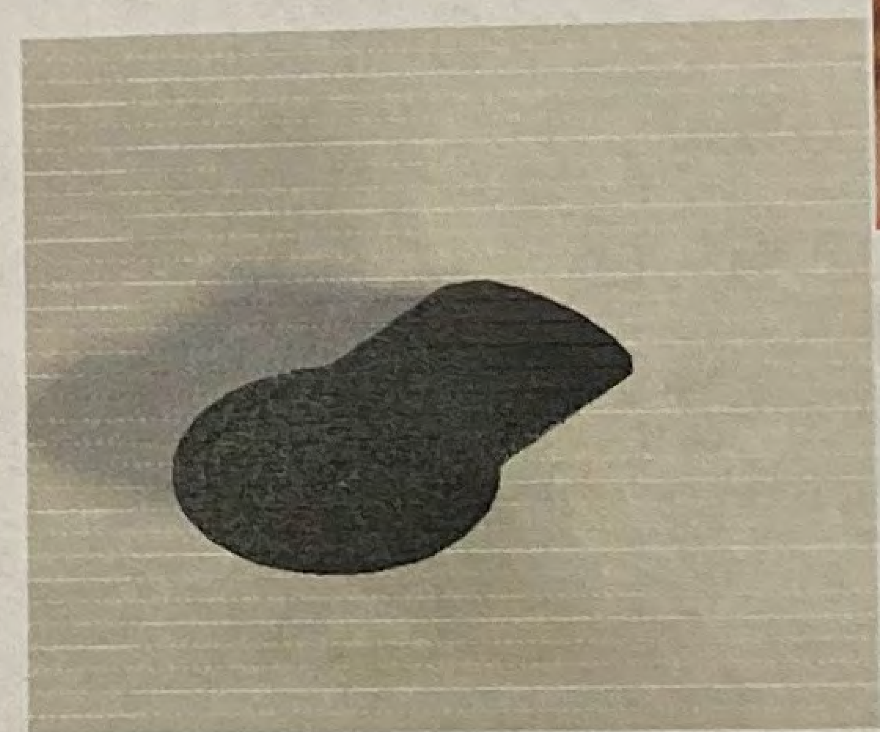
Aadi Hasmukh, Michael Silinsky
and Jayden Rinser
For
Mr. Merritt
Architectural Civil Engineering
Clear Creek High School
Clear Creek ISD
League City, Texas 77573

Problem Statement/Video

THE GOAL IS TO MAKE A PIPE, AUGER, AND EXTRUDER. MAKING THEM LIGHTWEIGHT, HEAVY-DUTY, PACKABLE, DURABLE, AND FLEXIBLE. A MECHANICAL BEAST. IT WILL MOVE MARS/MOON SOIL MIX IT WITH PLASTICS, HEATS IT, AND CRAFTS BRICKS. THE PROBLEMS ARE GOING TO BE HEATING AND MIXING THE SOIL AND PLASTIC TO THE RIGHT CONSISTENCY. THE RIGHT BUILDING MATERIAL IS NEEDED THAT CAN TAKE UP TO 200°c.

Printed Designs





Materials

- Plywood
- 4 Small Vex Gears (12T)
- 2 Medium Vex Gears (36T)
- 2 Big Vex Gears (60T)
- 4 Large Vex Gears (84T)
- 1 Servo Motor (100rpms)
- Breadboard
- 8 Vex Axels
- 3-D Printed Parts
- 4 3-D Printer Augers
- 3 Copper pipes
- Foam Board
- Plexiglass
- White duct tape
- Screws
- PVC Pipes

Contact Us

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2W7
FIRE
pe, Auger, Extruder
rian Winandy, Christopher Newton, Colin Wong
Technical Difficulties
Plano ISD Academy High School
Technical Difficulties Website
Project Objectives
Requirements
Design, build and test a pipe, auger and extruder system that can be heated to 200 C that will mix sand and shredded plastic to a consistent slurry and extrude out into a 1" x 1" x 5" brick.
The goal is to make 100 bricks per 24 hours. Since a lunar day is about 14 days, around 1400 bricks per lunar day.
Constraints
Extruder must be able to resist heat of 200°C
Micro-gravity is inaccessible
How can we build a pipe, auger, and extruder mechanism
solar-powered brick-making lunar rover to produce 100
every 24 hour
ALL-VEGETABLE SHORTENING

Problem Statement

How can we build a pipe, auger, and extruder mechanism into a solar-powered brick-making lunar rover to produce 100 bricks every 24 hours?

Requirements

Design, build and test a pipe, auger and extruder system that can be heated to 200° C that will mix sand and shredded plastic to a consistent slurry and extrude out into a 1" x 1" x 5" brick.
The goal is to make 100 bricks per 24 hours. Since a lunar day is about 14 days, around 1400 bricks per lunar day.

Constraints

- Extruder must be able to resist heat of 200°C
- Micro-gravity is inaccessible
- Auger screw and pipe must be abrasion-resistant

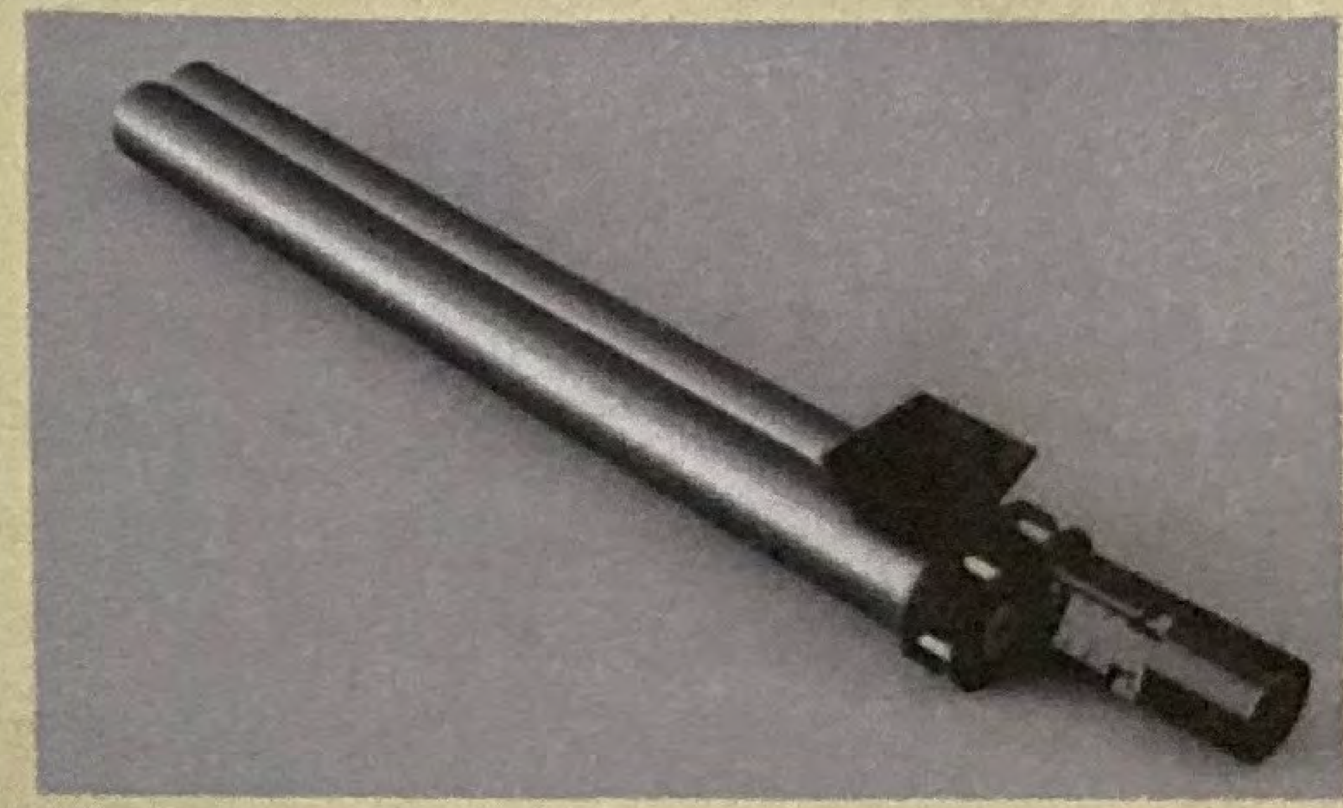
Plano ISD Academy High School
Mrs. Gunnels
Design and Prototyping
Brian Winandy, Colin Wong,
Christopher Newton

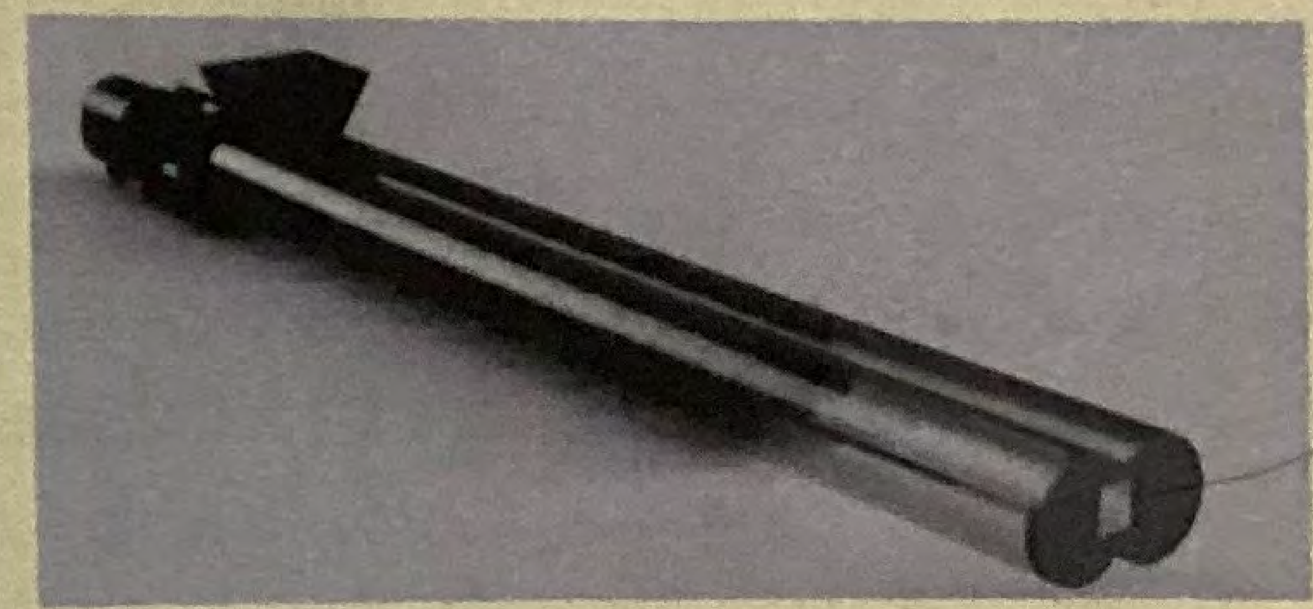
For More Photos and Videos

Our Website

NASA LUNAR Rover

PIPE, AUGER, AND EXTRUDER





Our Solution

The Pipe Auger Extruder mechanism is the plastic-brick-making sub-system on the lunar rover. We created a dual screw system to maximize mixing and extrusion. The mechanism is driven by a 12v brushless motor at a 60 to 1 gear reduction.

The motor runs an auger through the gearbox and translates the rotary motion to a mirrored parallel auger using two gears. The pitch distance between each flight on each auger decreases, so that all material is compressed for extrusion. The augers have end screw tips. These are placed into 2' steel pipes that are welded together with an overlapping cross-section. At the end of the pipe are 3 inches of space and a 1 x 1 die. We used Micro Python on a Raspberry Pi Pico to control the motor over PWM.

Data Collection

Ingredients	Shortening and Silica Sand	Beeswax and Silica Sand
Simulant Mass	101.01 g	103.69 g
Binder Mass	399.46 g	400 g
Ratio	3.95 to 1	3.86 to 1
Temperature	No External heating	60 - 95 ° C
Brick Consistency	Sludge	Solidified
Homogeneity	Slightly mixed	Even distribution

Preliminary Design Prototype

Limitations	Improvements
There was insufficient power to conveyor, compress, and extrude simulant.	We added a 60 to 1 gear reduction and replaced a brushed CIM motor with a brushless Neo.
There was no compression.	We changed screw geometry to have a spiral tip and created a gap between the screw and die.
There were no binds made between materials.	We replaced the pipe material with conductive steel and the screw material with heat-resistant carbon-fiber nylon so we could melt the binder in the compression process.
There was insufficient mixing.	We changed our design to a dual screw system.


NASA HUNCH - Pipe, Auger, Extruder
iSchool Of Lewisville
TEAM P.A.X.
PROJECT DESCRIPTION
CONSTRAINTS & PART EXPLANATION
PROJECT REVIEW FEEDBACK
Research
PRODUCTION EFFICIENCY
Final Testing: Brick #7, February 20th
Silicone Mold
FAQ
Next Steps
TESTING
Testing: Brick #3, November 15th
Testing: Brick #4, January 6th

PROJECT OVERVIEW

The Pipe, Auger, and Extruder project constructs a device that turns lunar soil and recycled plastic into bricks.

Making the bricks on the moon instead of sending them up would significantly decrease the amount of materials NASA would need to send up to the moon, providing more room in rockets at a cheaper cost.

Team P.A.X. has the goal of creating an automated device that produces strong 1"x1"x5" bricks made of plastic and regolith.

P.A.X. TEAM

Krish, Daniel, and Hogan

Team Website

NASA HUNCH

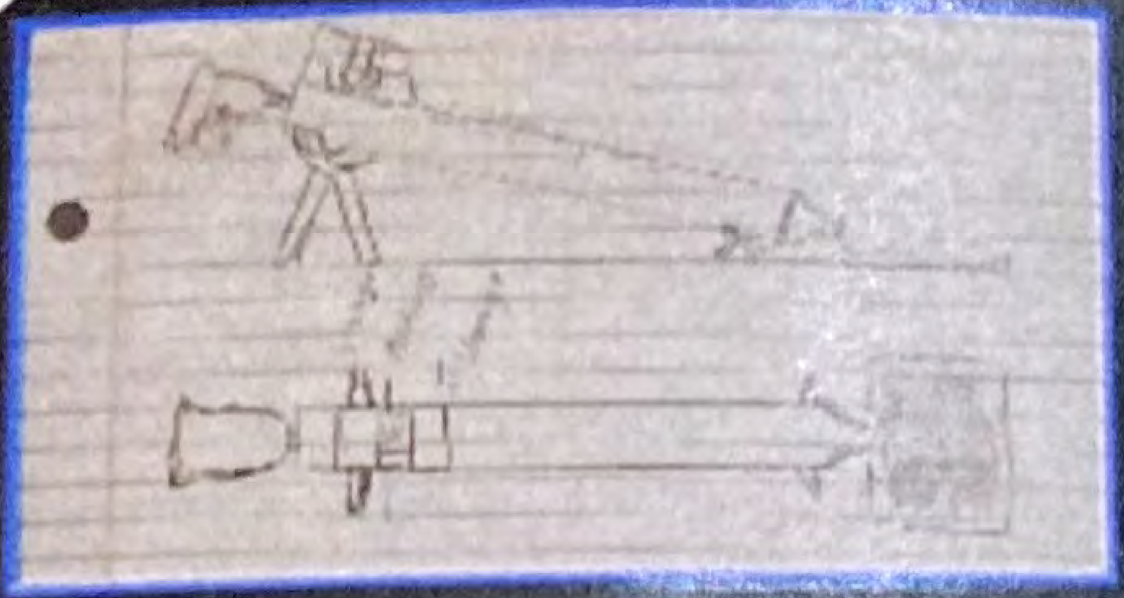
PIPE, AUGER, EXTRUDER

TEAM P.A.X.

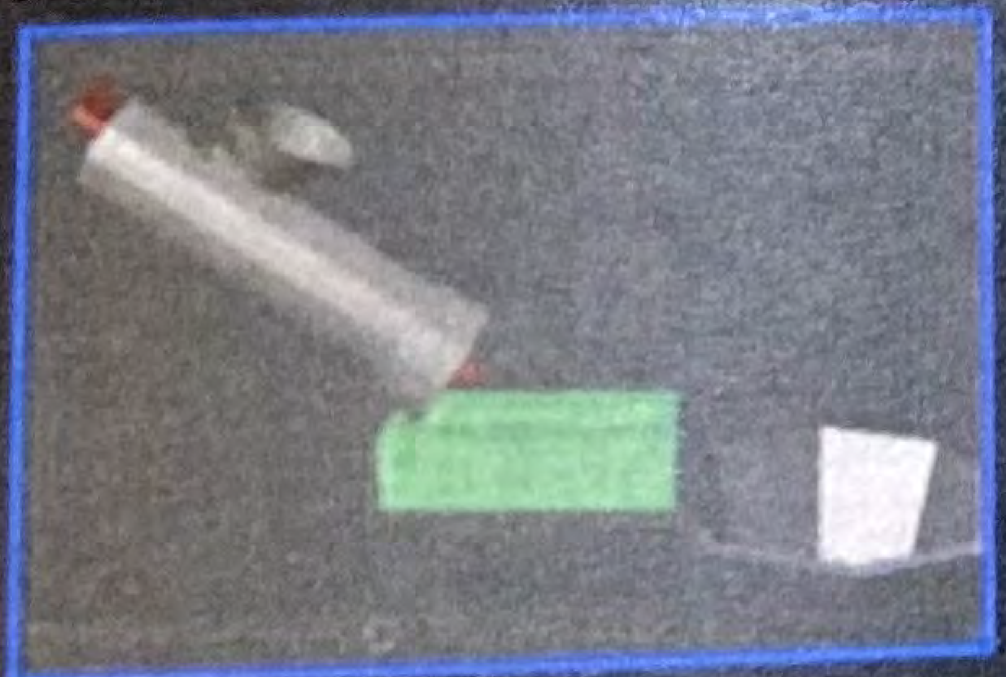
32

Our Design Storyboard

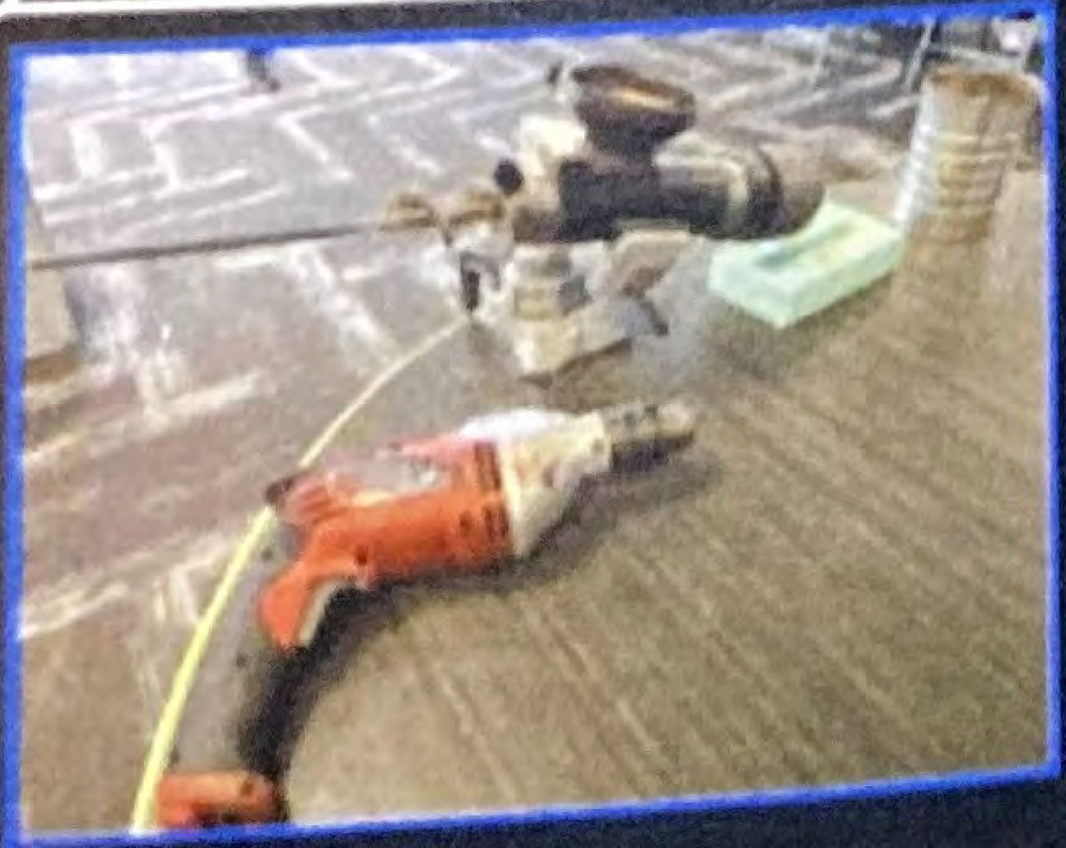
1 Sketches



2 CAD Drawing



3 Prototype



Testing Results

Test #4 and Test #6 were conducted using a heat source of 200-240°C.

Brick #3 *Brick #7*

Ratios

70:30 ratio of sand to plastic made our Brick #3 sturdy and stiff, but with too much plastic waste, at too high of a temperature, making it inefficient. The 80:20 ratio had similar problems, but was more efficient. The 90:10 ratio was the best, as we still had a sturdy brick, with minimal plastic.

Automation

Our drill can be set up to work with an arduino to turn forwards AND backwards. In the future we strive to automate the entire process with the press of a button. The automation process will not be affected by lesser gravities, similarly to the rest of our design.

NEXT STEPS/ FUTURE PLANS

1

Compactness

Making the prototype move in unison.

2

Automation

Fully integrated Arduino program to automate the process.

3

Connectivity

Redesign the molds to allow the brick to connect smoother and more efficiently.

4

FINAL PHASE

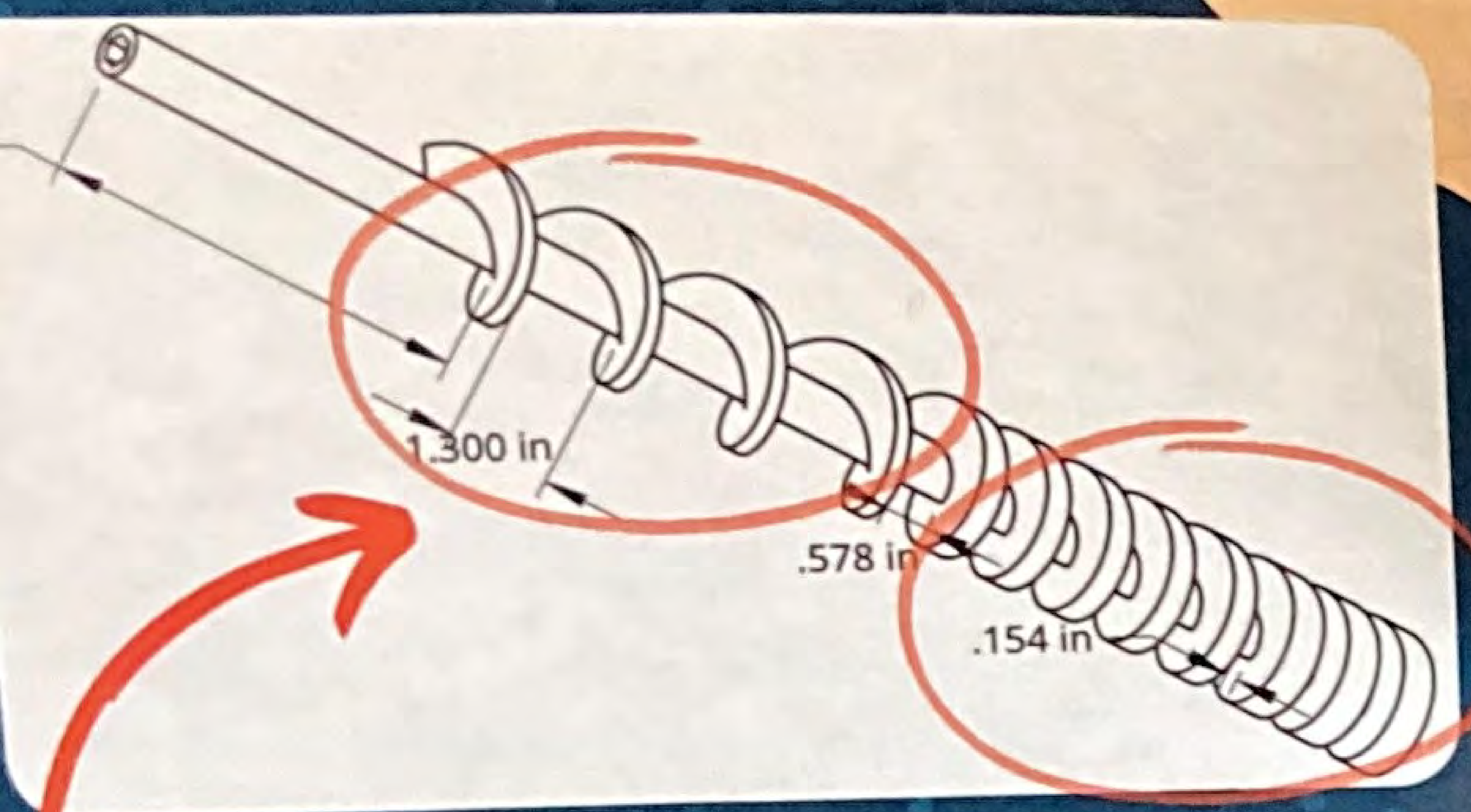
Completely Automated Machine

Pipe Heating: 4 minutes and 57 seconds
Drill Mixing & Extrusion: 1 minutes and 1 second
Manual Extrusion: 3 minutes and 10 seconds
minutes and 29 seconds
Space Brick Output: ~240 Bricks Per Day
design the molds to allow the brick to connect smoother and more efficiently.
Brick #1 | 55:45
Brick #5 | 80:20
Brick #6 | 80:20
Brick #3 | 70:30
Brick #7 | 90:10
Brick #4 | 80:20
NASA

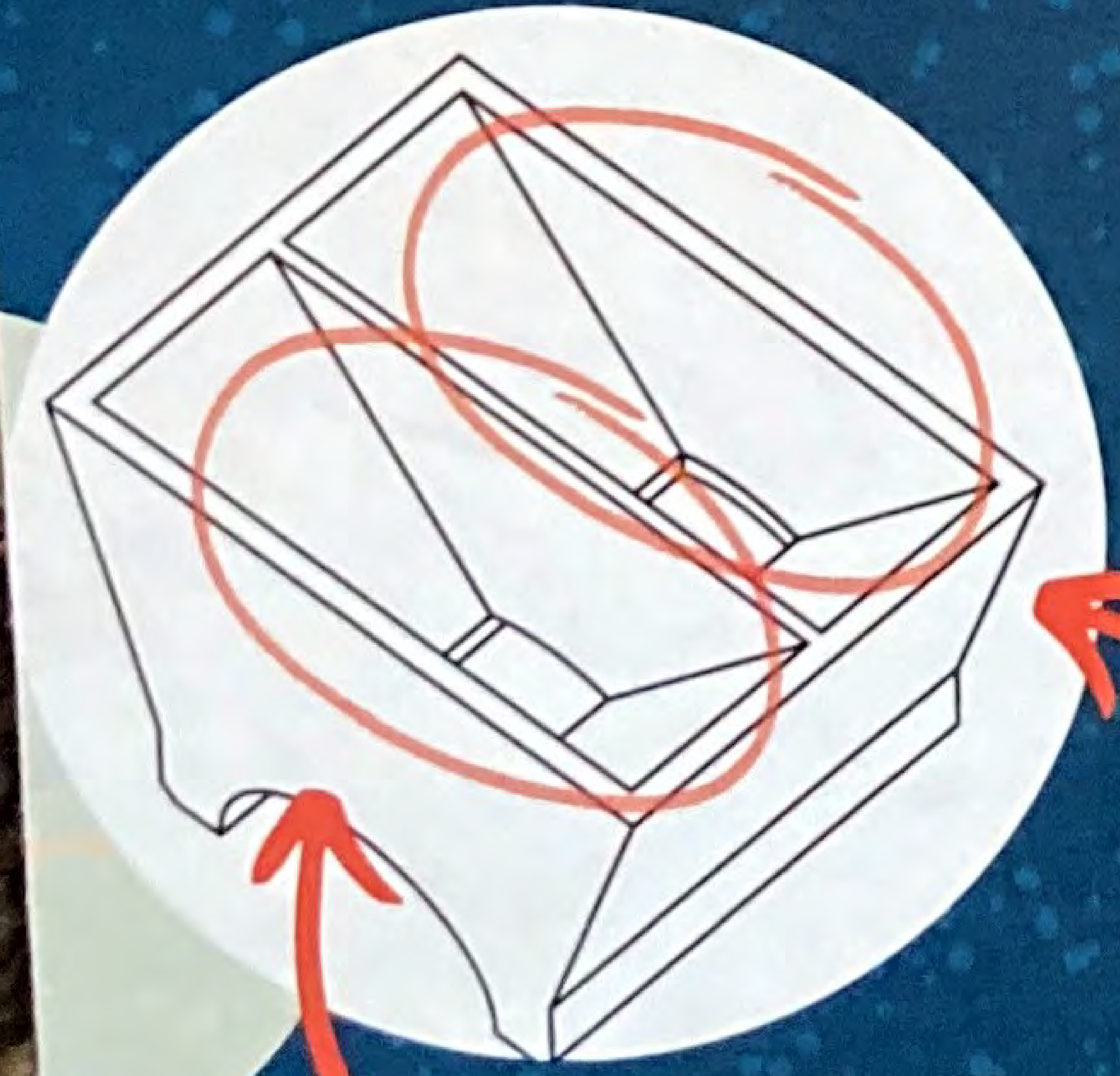

PLASTIC
PROTOTYPE
METAL
PROTOTYPE
Make Your Title Pop
Stabilize Your Trifold
Get Noticed!
RIFOLD
LAY BOARD


PLASTIC PROTOTYPE
PIPE AUGER EXTRUDER
GALLATIN HIGH SCHOOL
CODY W, CHRISTIAN M, GREYSON W, KENNY T.
GLENN BRADBURY
METAL PROTOTYPE
We used an acrylic pipe and 3D printed parts to construct a prototype.
Testing of the prototype was based on how well particulates are mixed by our auger design.
For each test, we changed the size of the particulates. We used sand and sawdust; the sawdust was sifted to obtain finer particulates. One test was done with sand and wax to simulate the difference in density between the lunar regolith and plastic.
These tests highlighted that large particulates would get caught in between the auger flighting. Smaller particulates mix together well for our auger design. The observations of the test with the sand and wax indicated that although a few of the particles combined together, a greater quantity of heavier density particles lingered in the pipe.
Brainstormed methods to compress the lunar regolith and plastic mixture in the machine.
Initial idea for a basic extruder machine.
CAD drawing of an auger with decreasing flighting length adhering to the brainstormed ideas.
CAD drawing of a double intake hopper to allow two materials to be added at the same time.
Given our limited resources, we could not obtain the materials we desired for the final machine. If we had the resources, we would ideally want silicon carbide for the pipe and titanium carbide for the auger and the other components.
Silicon Carbide was chosen because it is cheap, relatively thermally conductive, and hard enough to resist abrasion from lunar soil. Additionally, it is naturally dark in color allowing it to absorb sunlight
Titanium Carbide was chosen because it has a high melting point of 3,140°C and is hard enough to resist abrasion from lunar soil.
We used steel parts to make components like the pipe and auger. Additionally, we 3D printed a hopper to construct a prototype.
Testing of the prototype was based on mixing, compression, and extrusion of a sturdy brick.
-0.9°C
76.7
FLIR
-12.6
PARAFFIN WAX

AD
ODELS



Individual sections for mixing and compression



Separate intakes for plastic and lunar regolith

FLIGHT-READY HARDWARE MATERIAL

Silicon Carbide:
Pipe
Titanium Carbide:
Auger, Hopper, Backplate, Extruder Die

PIPE AUGER EXTRUDER

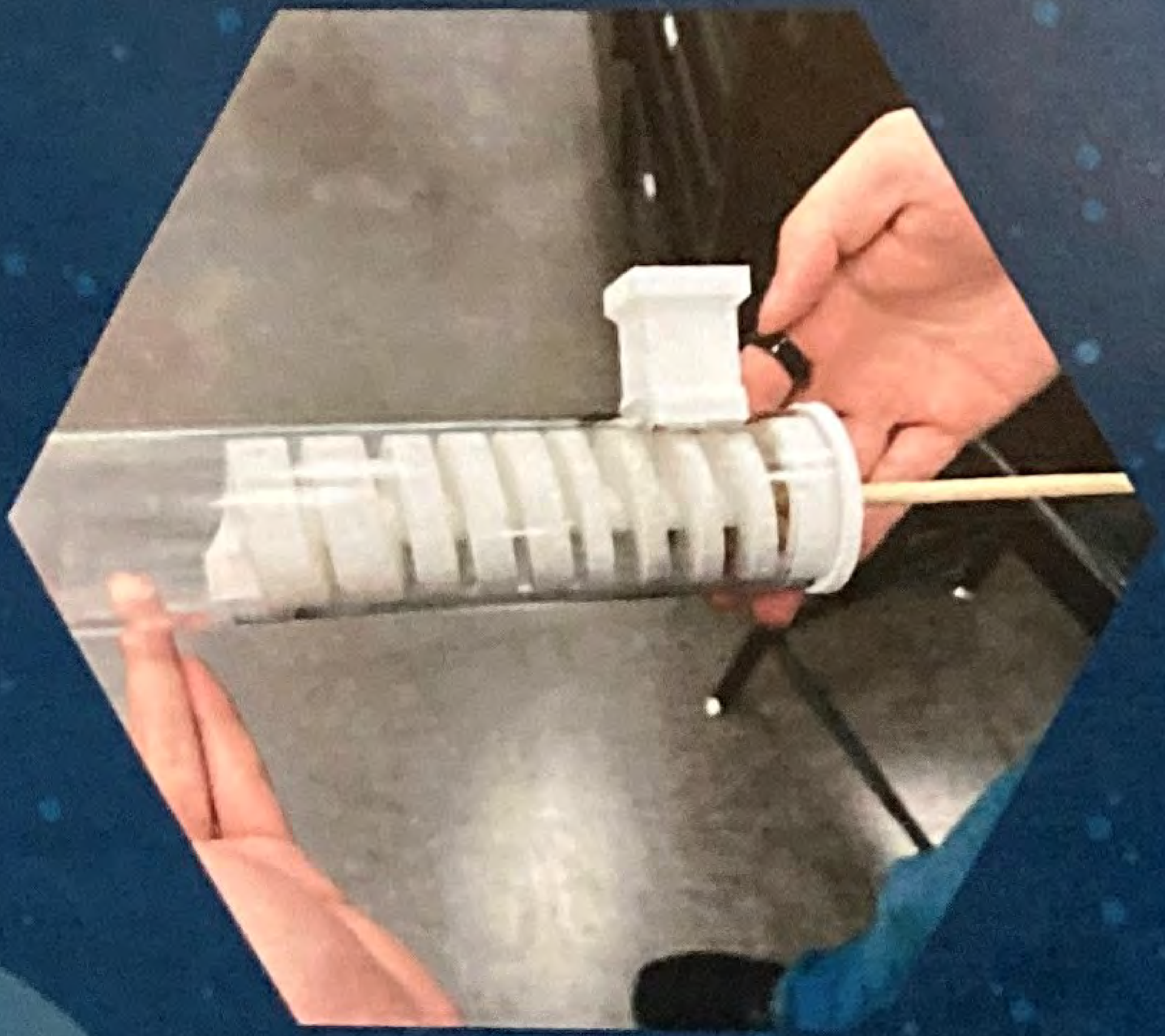
GALLATIN HIGH SCHOOL

CODY W, CHRISTIAN M, GREYSON W, KENNY T.

GLENN BRADBURY

PLASTIC PROTOTYPE

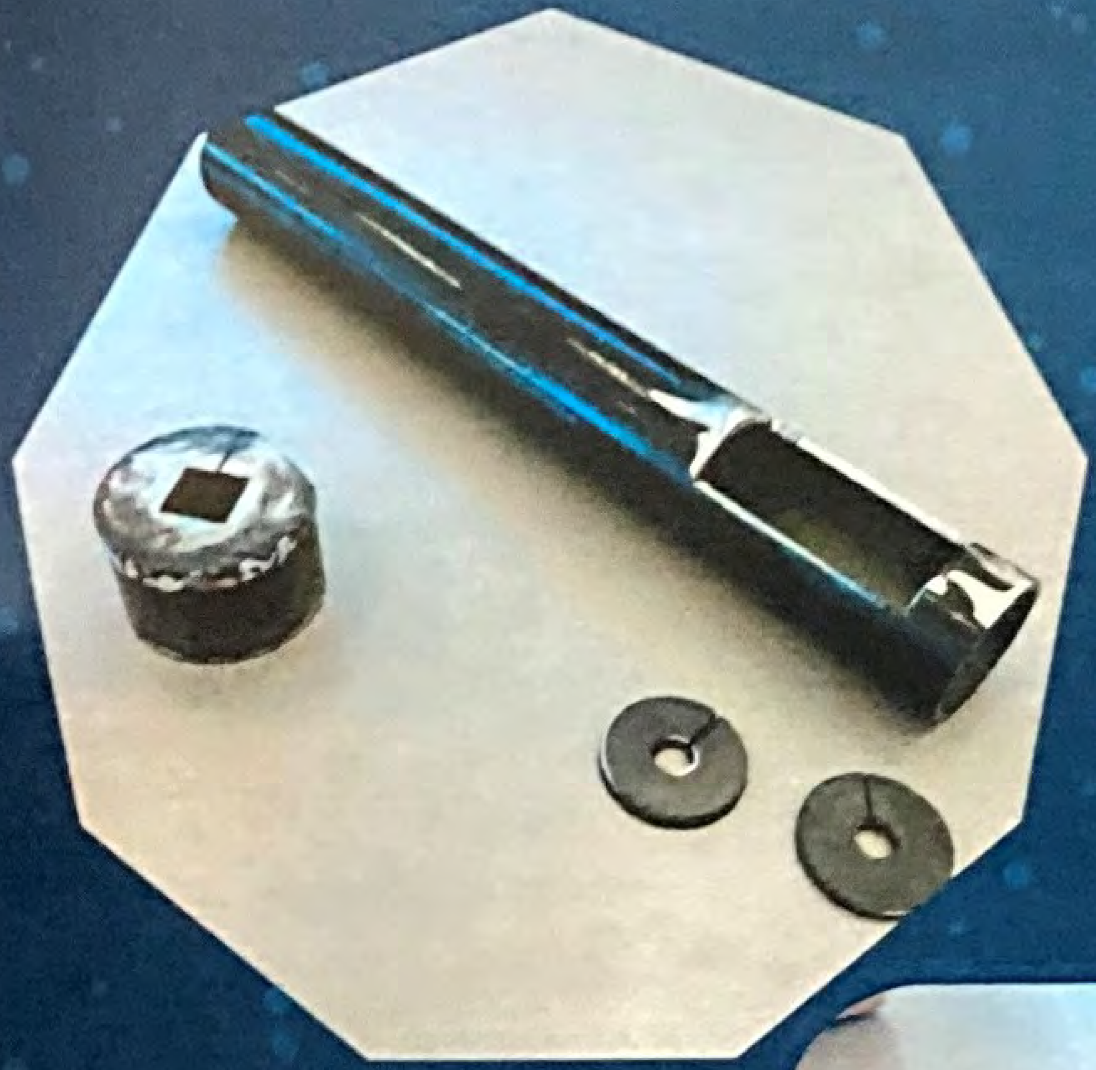
Components:
3D printed auger, hopper, and backplate. Clear acrylic pipe.



This prototype has certain limitations, including the inability to heat the pipe, the lack of an extruder die, and the fact that it is not to scale.

METAL PROTOTYPE

Components:
All parts are made of steel. Auger flighting bent with a jig



Some limitation of this prototype include its weight and the fact that the components are not made with ideal materials

TESTING

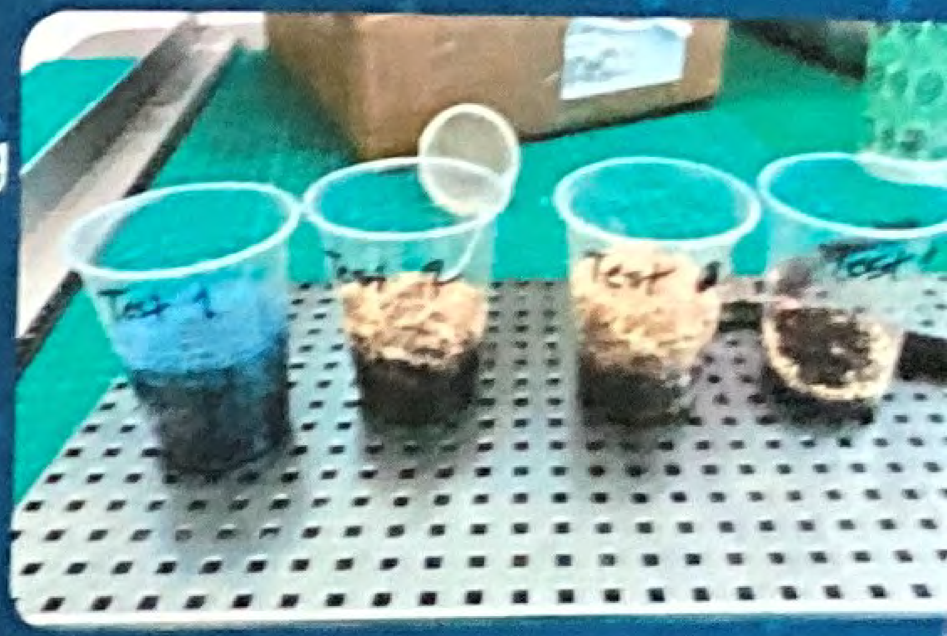
Plastic

Procedures

Pour each proportioned particulate on by one and mi by auger

Results

The auger mixing portion works well; small particulates mix evenly, larger particulates clog the auger.



Metal

Procedures

Pour each proportioned fly ash and paraffin wax into the auger via hopper

Results

A full brick was not extruded, but the paste that was extruded was malleable similar to play doh