[Team]

MS1: Intra-Park Transport

Alex Badr, Zion Carroll, Ryan Cowells, Jesse Naser

Section 8, Team 3

[Team]

Problem Statement

- Our BE 1200 amusement park needs safe, environmentally friendly, fuel-efficient transportation for its wide variety of users to travel to all the attractions faster than on foot and reduce congestion.

[Team]

The Blueprint

User Needs	Design Inputs
Accommodate handicapped visitors	Ramp attachment would be present
Quiet ride, low noise pollution	Least number of moving parts to be built
Enjoyable ride	Comical design of intra-park transportation
Speedily travel before park closes	Motors fast enough to travel length of park in cycle
Speedily travel faster than on foot	Wheels for human to skate and roll than walk
Destinations near attractions	Attachment points to transport need to interoperate with others
Multiple stops	Fine grained control is needed to precisely move vehicle
Withstand human weight	Higher infill, more distribution beams
Fit wide range of human feet	Adjustable fitting mechanism
Riders not fall off	Harness mechanism for human / mini-rider

The Requirements

[Team]

Requirements	Outcomes
Need 3D printed parts	We created 3D printed parts
Need non 3D parts	We included and modeled non 3D printed parts
Mini-Riders cannot fall	Snug fit onto front lock with legs locking
Text on one of 3D parts	LOL is on a wheel that looks like a human
Wayne state logo	Logo is on a wheel as a hole
Shafts/axels have diameter of 6mm	We do. Motor hole requires a specific smaller size.
Interface for riders to attach to park floor	Circle attachment points on front lock for future ramp
Use gearbox / electronic control	Arduino controlled motors and steering
Predicted performance on scientific principle	We predict that our shoecar can withstand a human riding on it because of the scientific principle of weight and force distribution on multiple axis and directions.
Must be no more than 35 hours of print time	We can fine tune our infill or use other printers
Must not exceed 200 mm in any direction	Platform may need to be rotated in CURA or use a different printer so that a human does not fall

[Team]

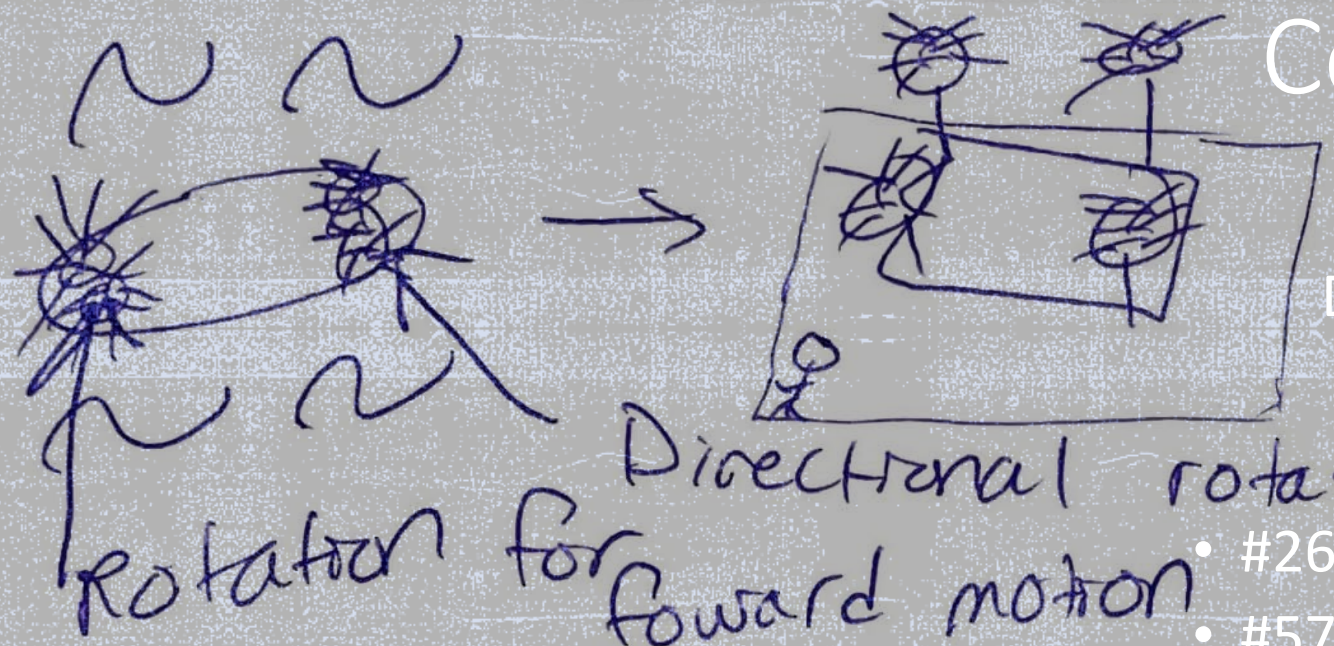
Overview

Safe	Environment/Fuel Efficient	"Variety of Users"	Speed/Congestion
Sturdy, Secure, include Seatbelts	Electrically Powered Human Powered	- Handicap Access (Ramp attachment to front lock)	Reasonable Travel Speed, Decent Capacity

[Team]

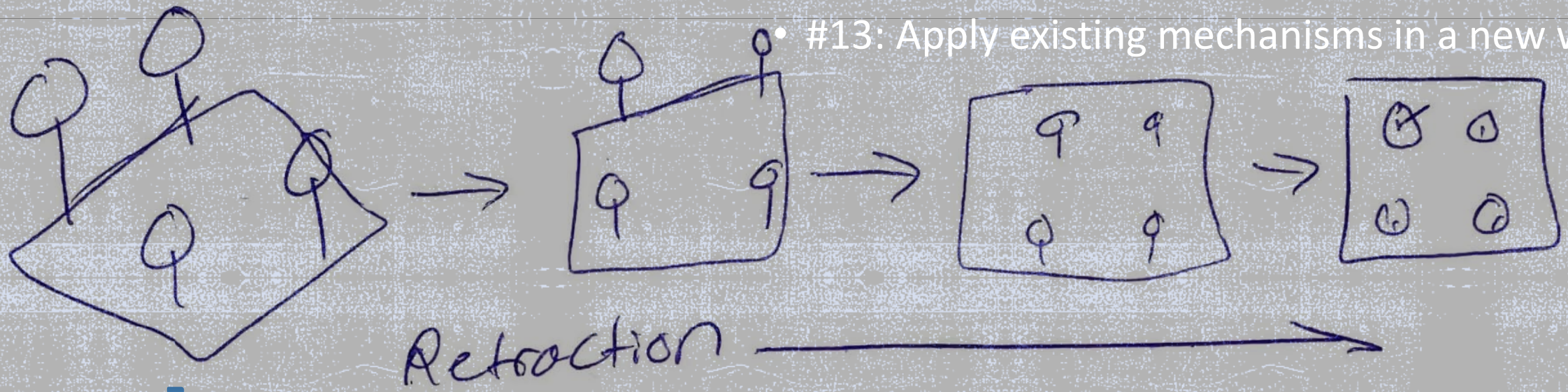
Concepts

Concept A: Boat / Drone



Design Heuristics:

- #26: Convert for second function
- #57: Rotate
- #13: Apply existing mechanisms in a new way



[Jesse]

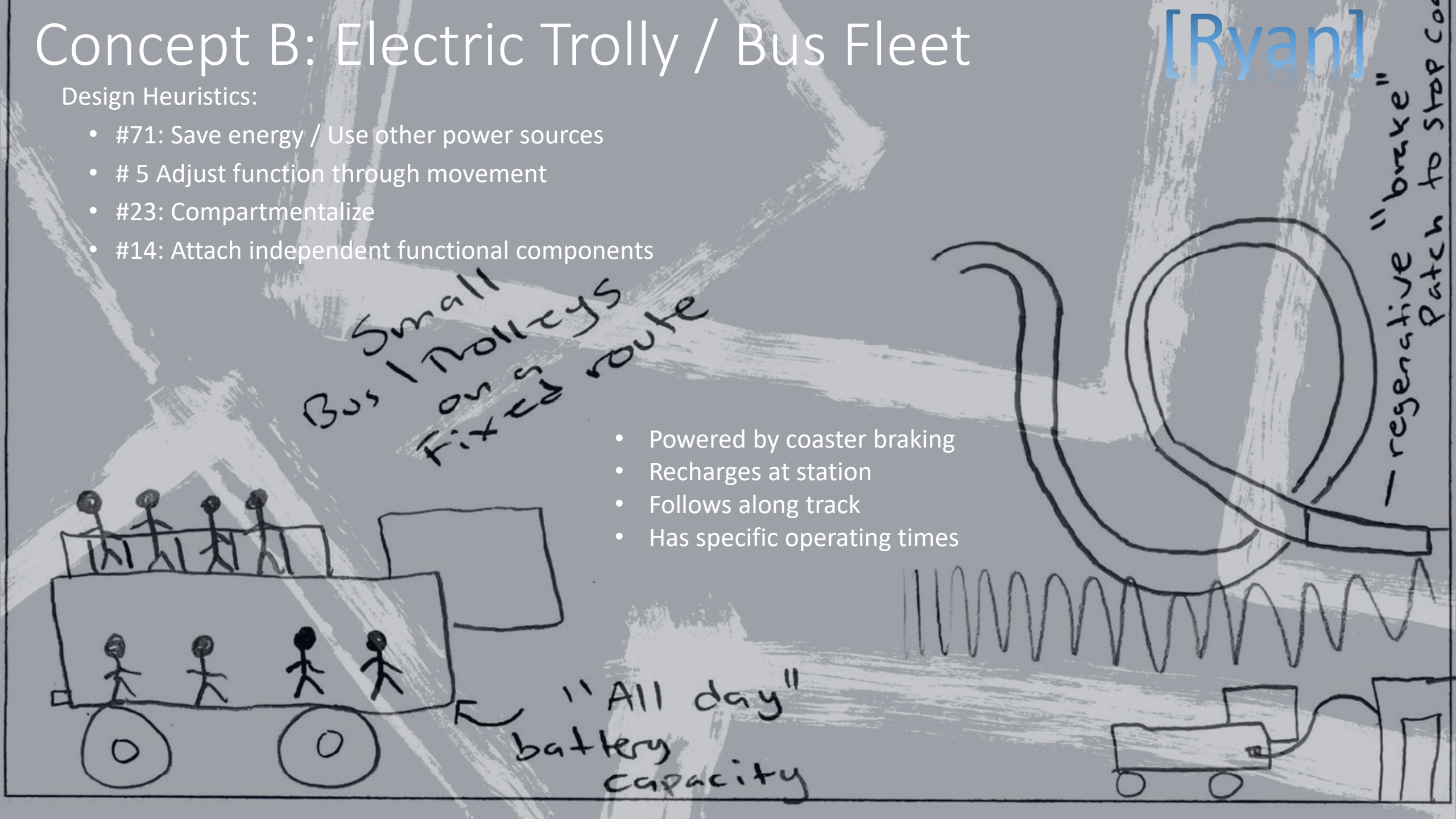
Fan propelled boat turns into drone by extension mechanism

Concept B: Electric Trolly / Bus Fleet

[Ryan]

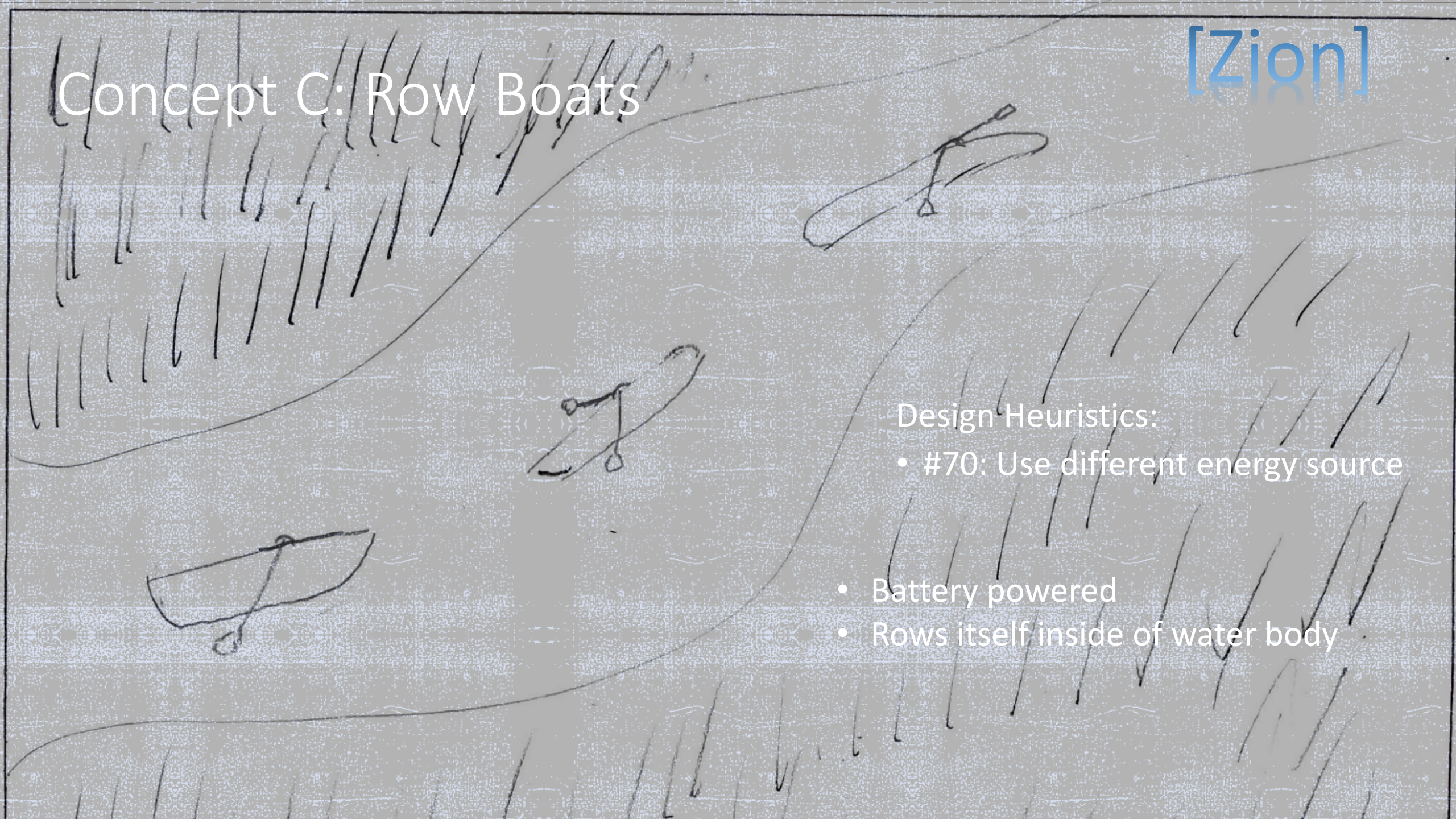
Design Heuristics:

- #71: Save energy / Use other power sources
- # 5 Adjust function through movement
- #23: Compartmentalize
- #14: Attach independent functional components



- Powered by coaster braking
- Recharges at station
- Follows along track
- Has specific operating times

Concept C: Row Boats



Design Heuristics:

- #70: Use different energy source

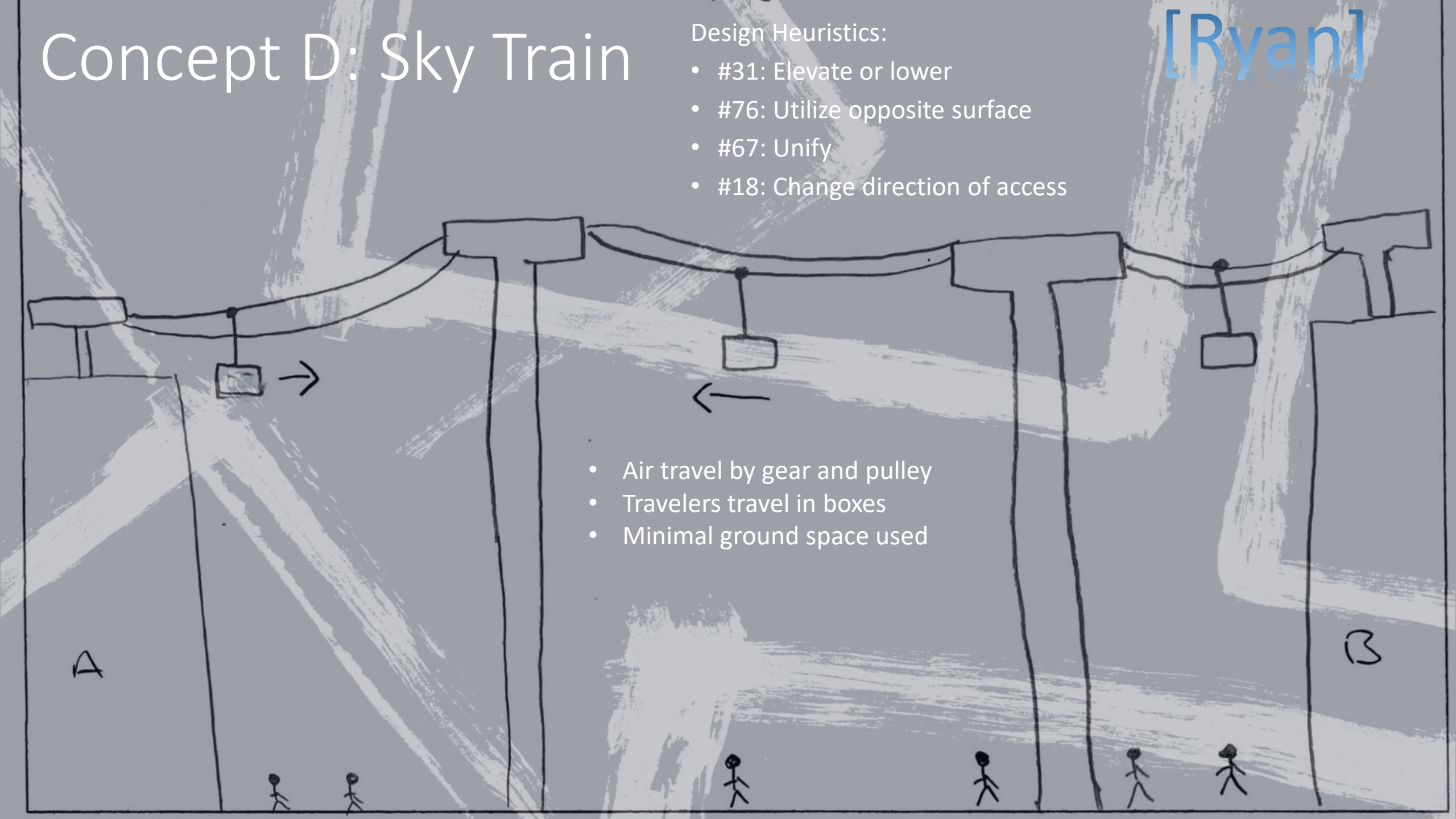
- Battery powered
- Rows itself inside of water body

Concept D: Sky Train

[Ryan]

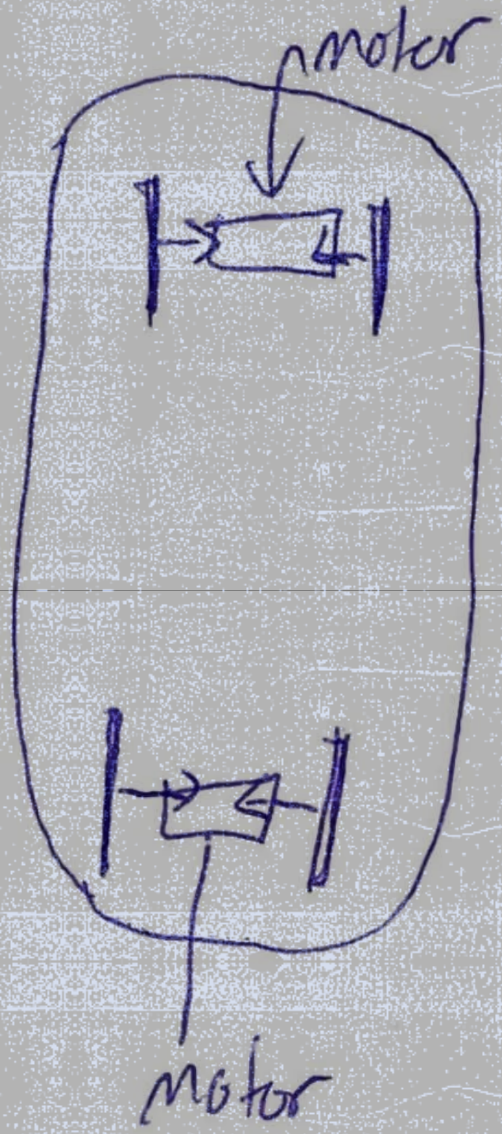
Design Heuristics:

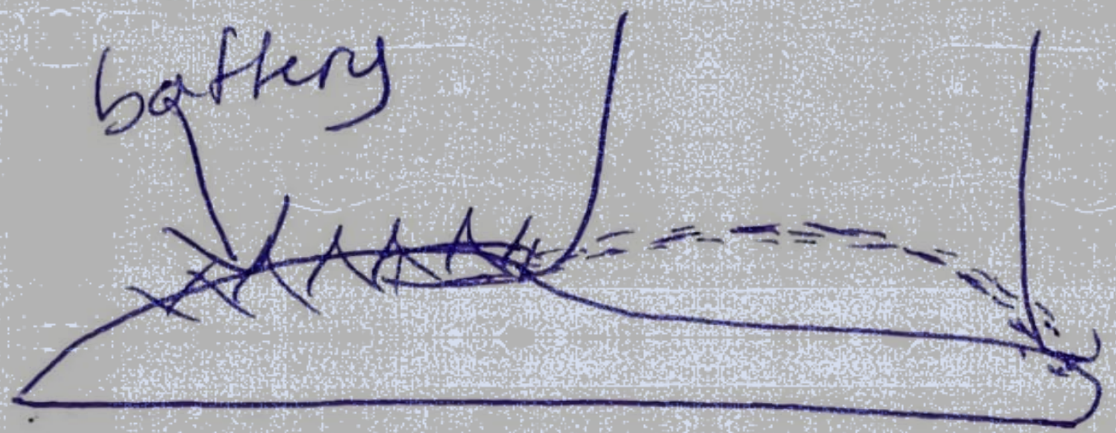
- #31: Elevate or lower
- #76: Utilize opposite surface
- #67: Unify
- #18: Change direction of access



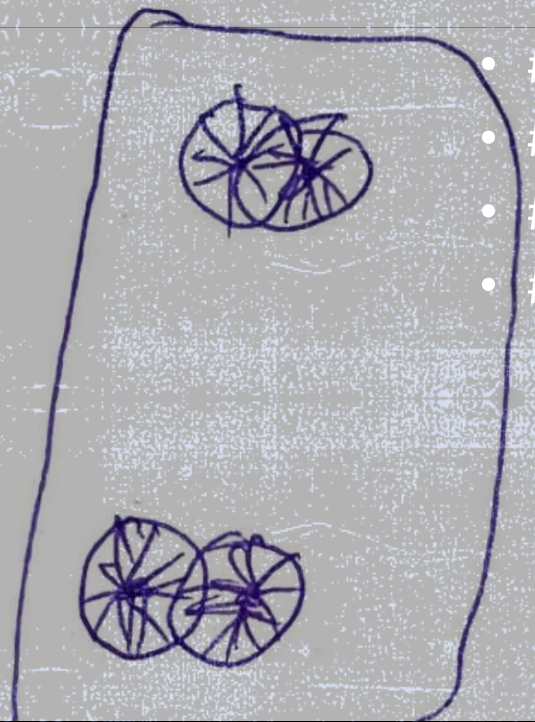
- Air travel by gear and pulley
- Travelers travel in boxes
- Minimal ground space used

[Jesse]





Concept E: Shoe Car / Rollerskates

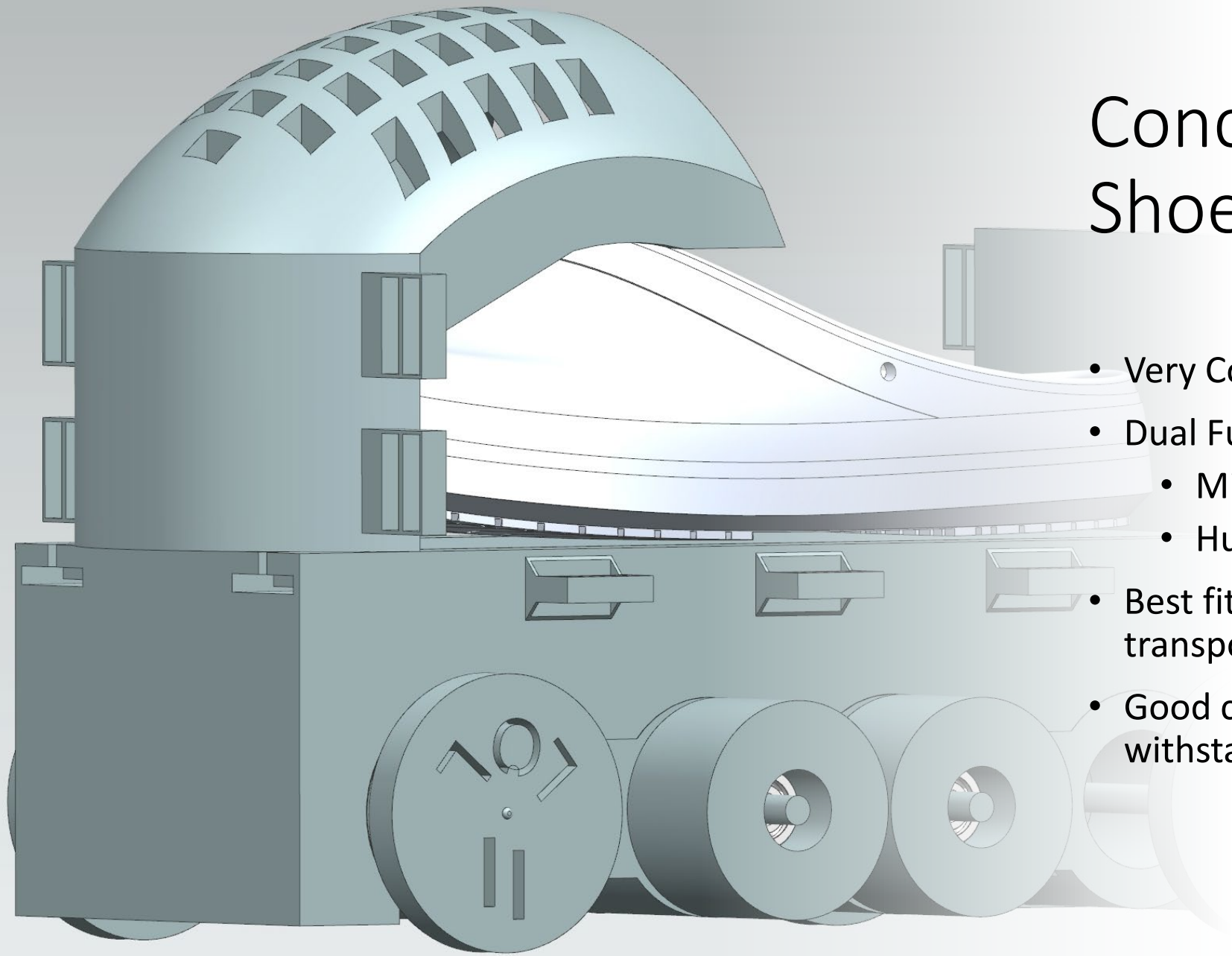


Design Heuristics:

- #15: Attach product to user
- #58: Scale up or down
- #63: Substitute way of achieving function
- #70: Use different energy source

- Becomes roller skate for a human
- Becomes car for a mini-rider
- Human skating charges battery

[Team]



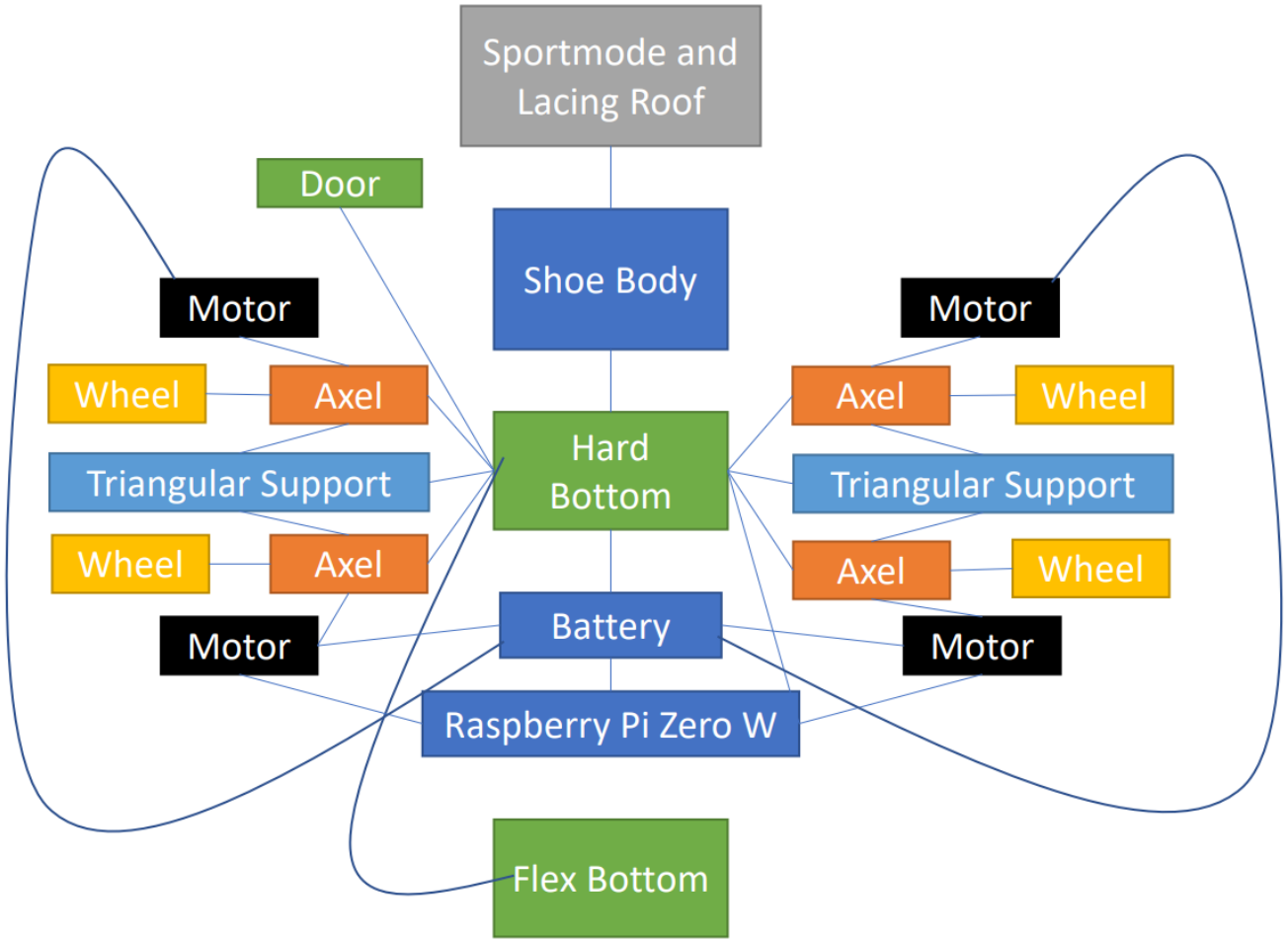
Concept E: Why Shoe Car?

- Very Comical
- Dual Function Transporter:
  - Mini-riders
  - Humans
- Best fit for speed, number of transported people
- Good challenge to engineer to withstand force of human

The OG Design

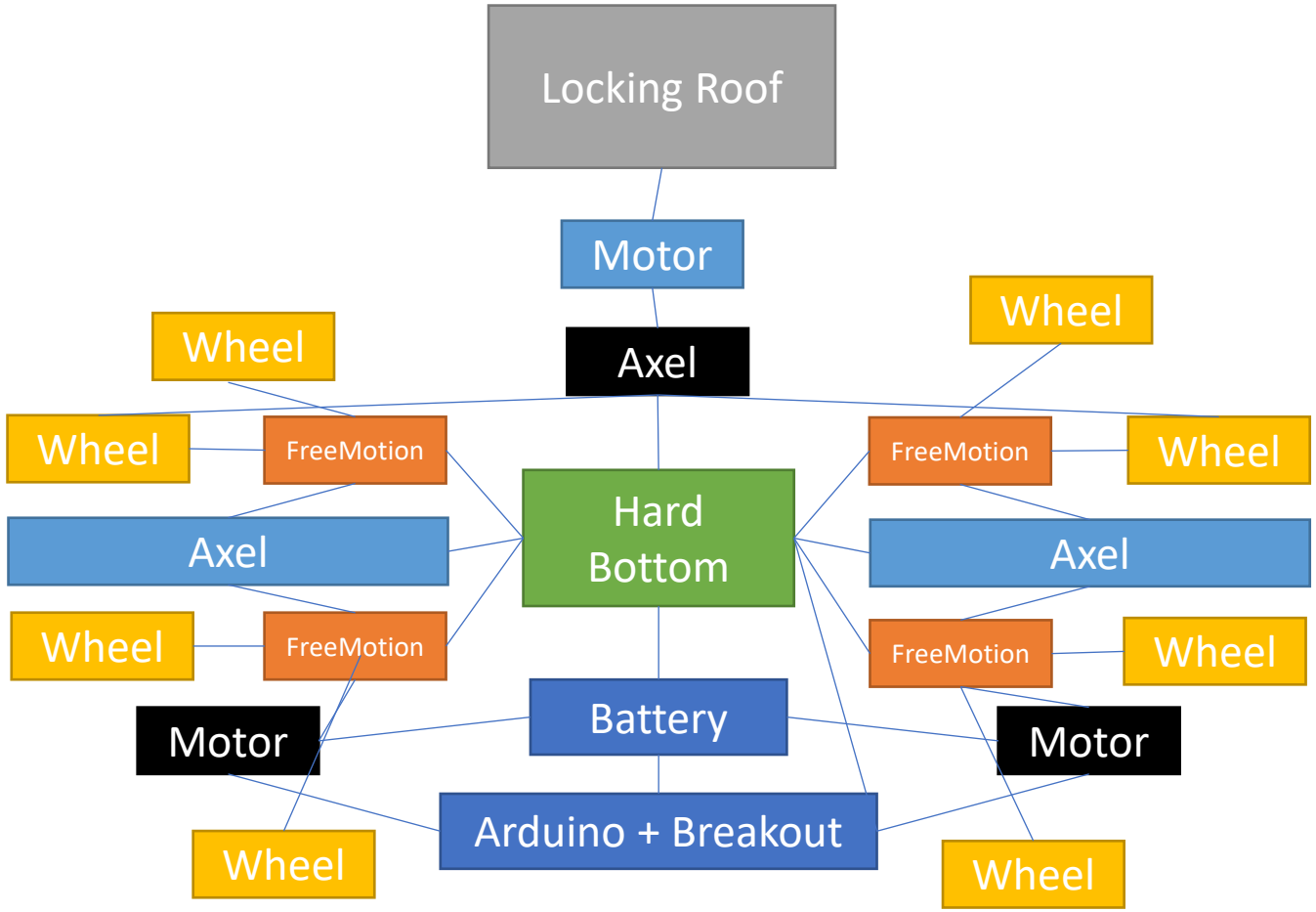
Croc-Pi Rollerskate

[Team]



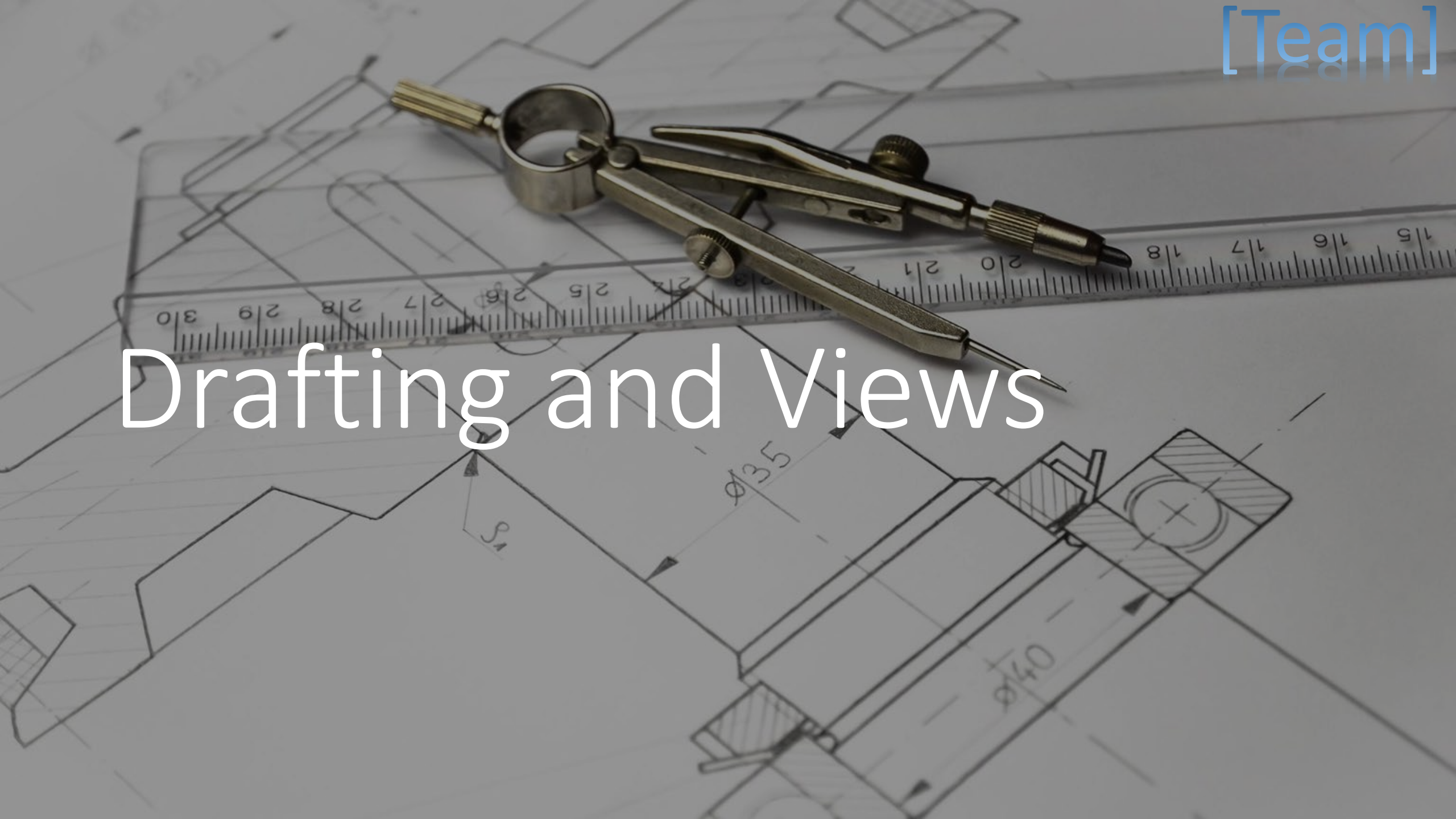
Part	Person
Roof	Zion
Shoe Body	Jesse
Hard Bottom + Door	Alex
Raspberry Pi Code	Jesse
Flex Bottom	Alex
Axel X4	Ryan
Triangular Support X2	Zion
Wheel X4	Alex
Motor Interface	Ryan

The New Design



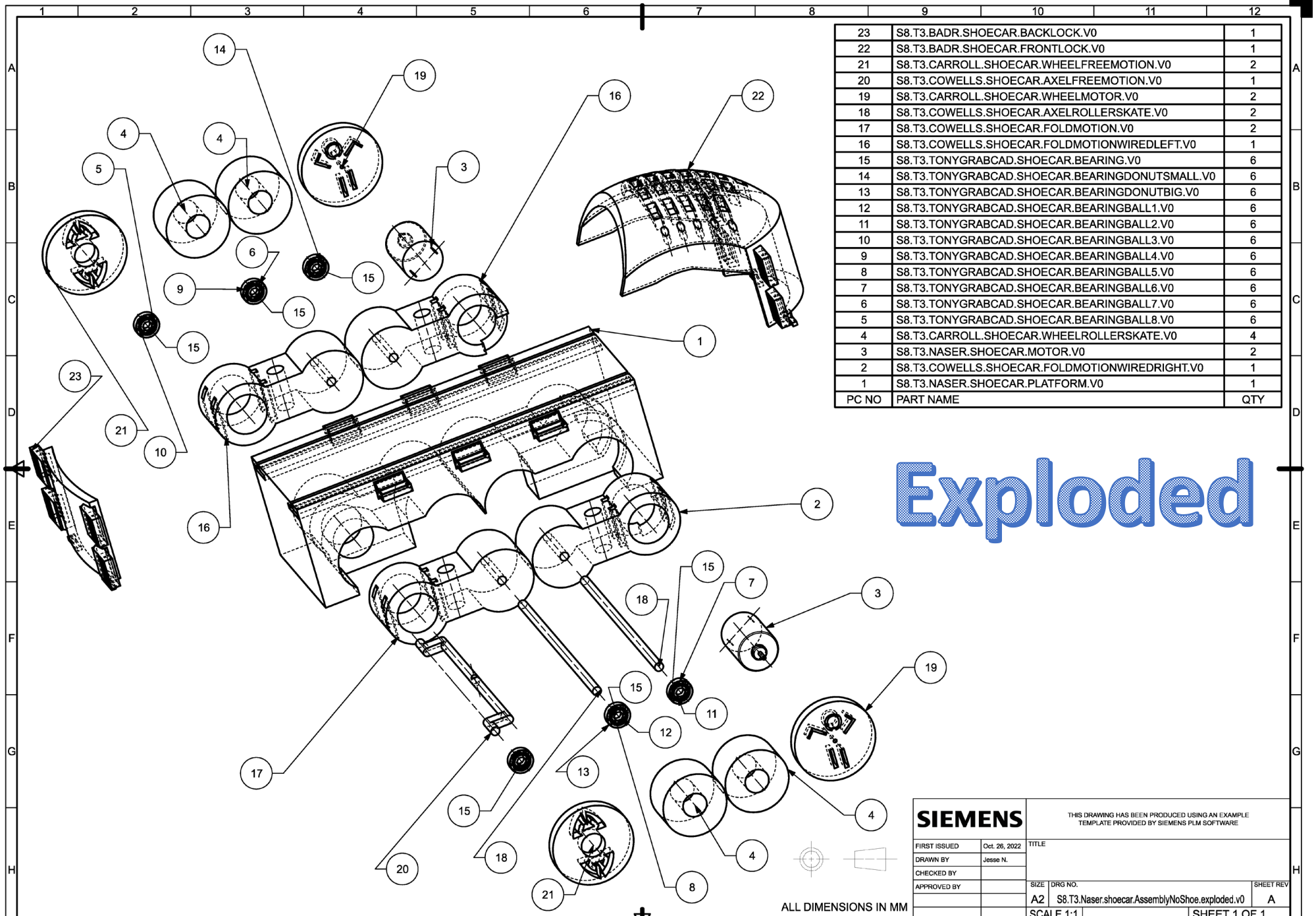
Part	Person
Locking Roof	Alex
Wheels	Zion
Hard Bottom	Jesse
Arduino Code	Jesse
Axels	Ryan
FoldMotion	Ryan
Assemblies	Jesse
Communication	Everyone
Innovation	Everyone

[Team]



[Team]

Drafting and Views



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22	S8.T3.BADR.SHOECAR.FRONTLOCK.V0	1
21	S8.T3.CARROLL.SHOECAR.WHEELFREEMOTION.V0	2
20	S8.T3.COWELLS.SHOECAR.AXELFREEMOTION.V0	1
19	S8.T3.CARROLL.SHOECAR.WHEELMOTOR.V0	2
18	S8.T3.COWELLS.SHOECAR.AXELROLLERSKATE.V0	2
17	S8.T3.COWELLS.SHOECAR.FOLDMOTION.V0	2
16	S8.T3.COWELLS.SHOECAR.FOLDMOTIONWIREDLEFT.V0	1
15	S8.T3.TONYGRABCAD.SHOECAR.BEARING.V0	6
14	S8.T3.TONYGRABCAD.SHOECAR.BEARINGDONUTSMALL.V0	6
13	S8.T3.TONYGRABCAD.SHOECAR.BEARINGDONUTBIG.V0	6
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6	S8.T3.TONYGRABCAD.SHOECAR.BEARINGBALL7.V0	6
5	S8.T3.TONYGRABCAD.SHOECAR.BEARINGBALL8.V0	6
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2	S8.T3.COWELLS.SHOECAR.FOLDMOTIONWIREDRIGHT.V0	1
1	S8.T3.NASER.SHOECAR.PLATFORM.V0	1

Exploded

ALL DIMENSIONS IN MM

SIEMENS

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FIRST ISSUED	Oct. 26, 2022
DRAWN BY	Jesse N.
CHECKED BY	
APPROVED BY	

TITLE

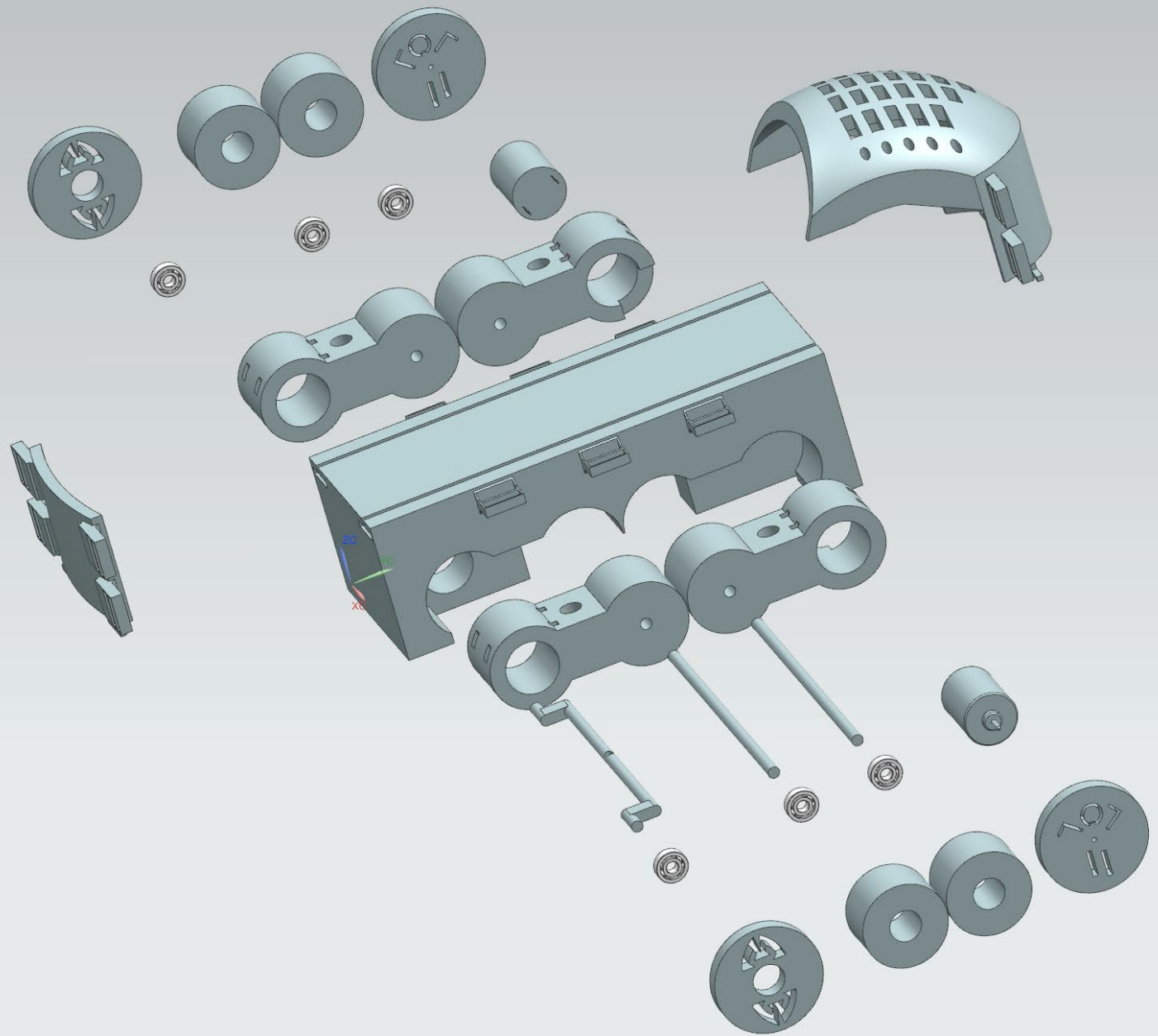
SIZE	DRG NO.	SHEET REV
A2	S8.T3.Naser.shoecar.AssemblyNoShoe.exploded.v0	A

SCALE 1:1 | SHEET 1 OF 1

A2

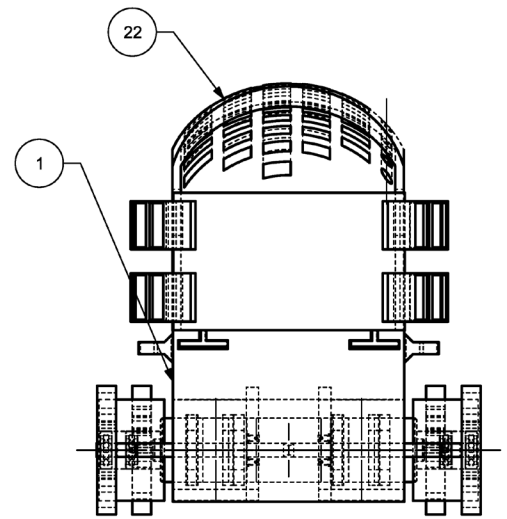
[Jesse]

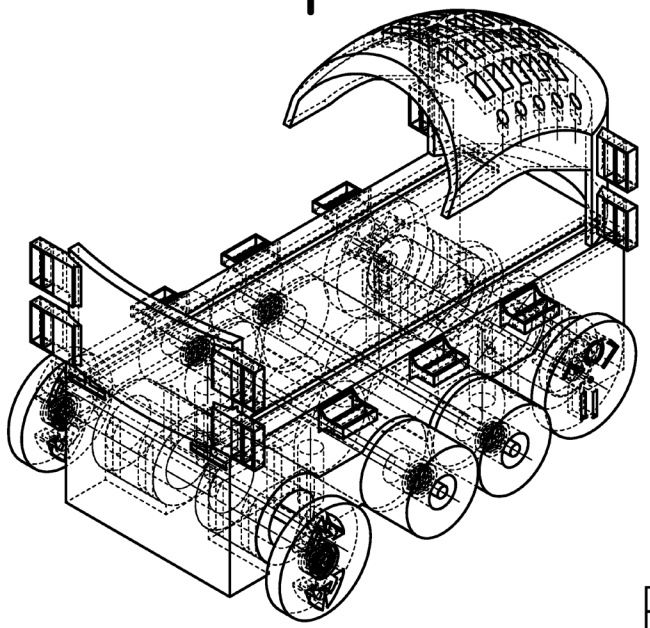
[Jesse]

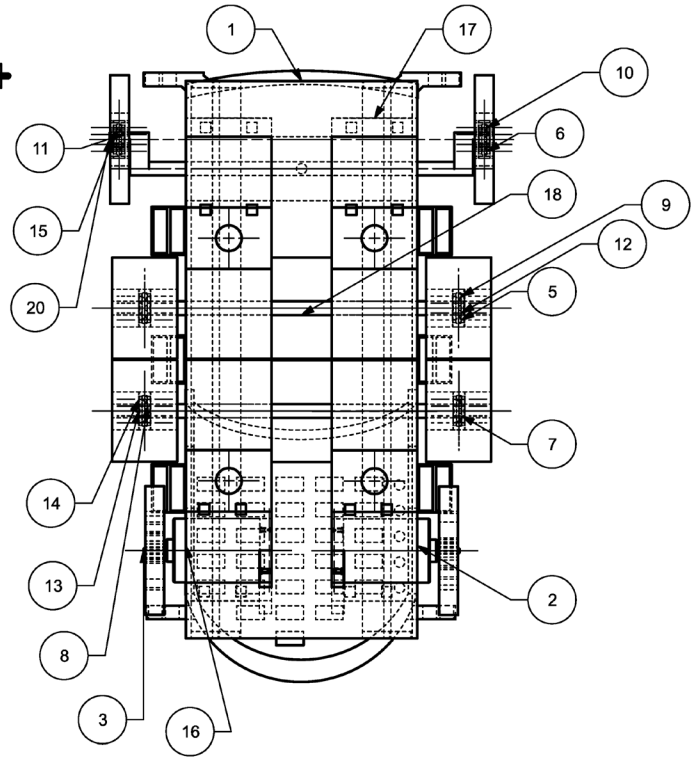


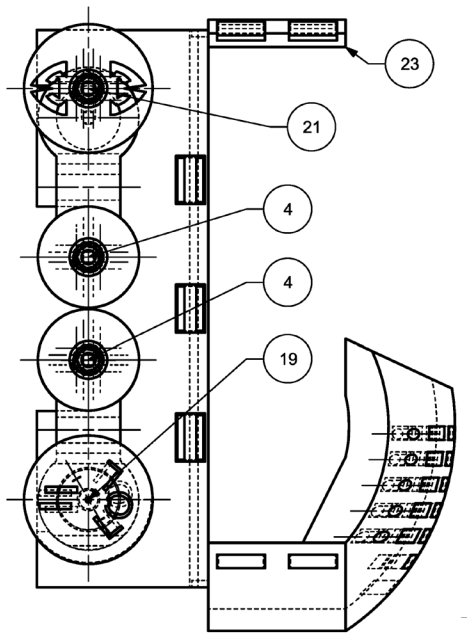
[Jesse]

ASM No Shoe









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4	S8.T3.CARROLL.SHOECAR.WHEELROLLERSKATE.V0	4
3	S8.T3.NASER.SHOECAR.MOTOR.V0	2
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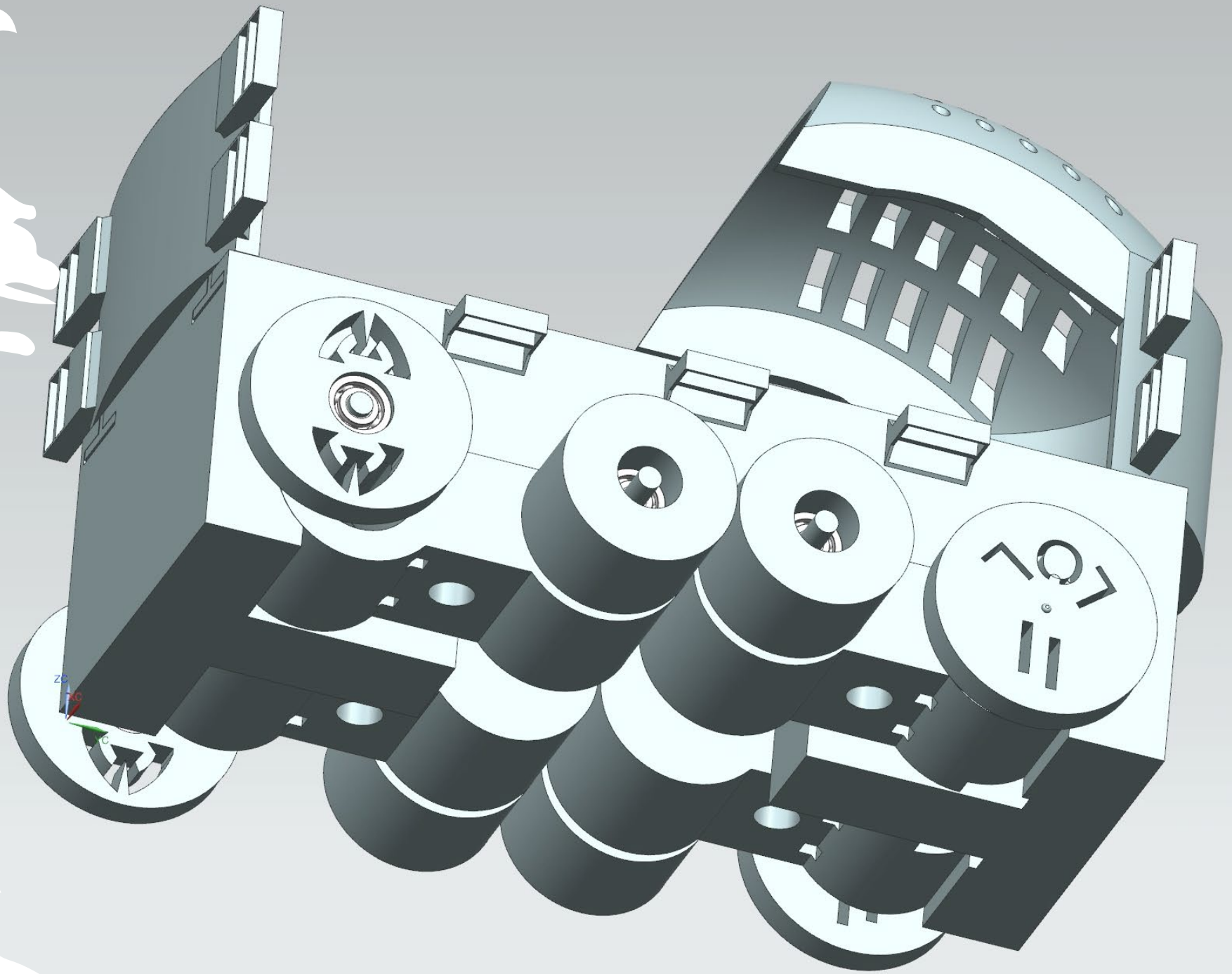
A2	S8.T3.Naser.shoecar.AssemblyNoShoe.v0	A

SCALE 1:1 SHEET 1 OF 1

[Jesse]



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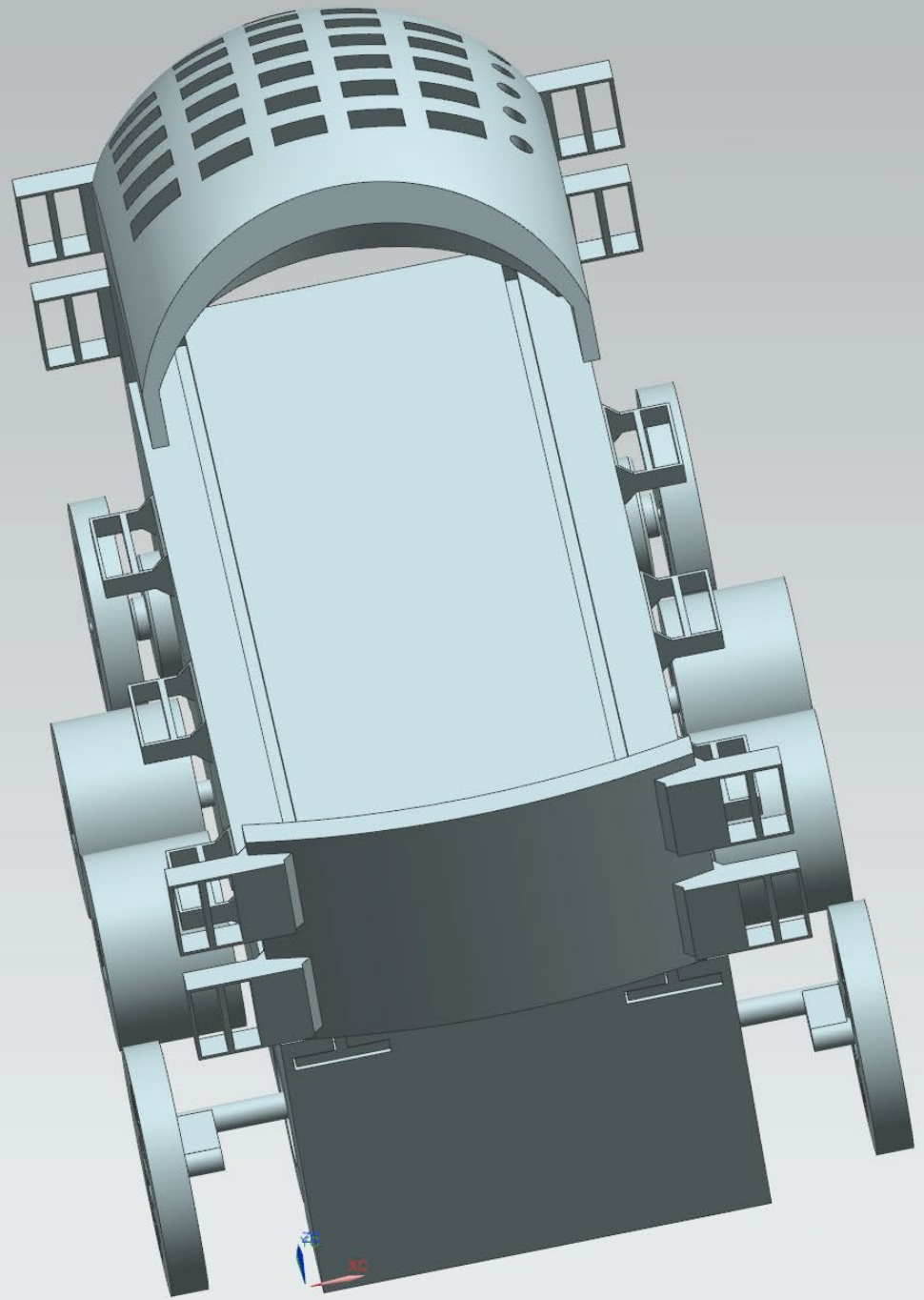

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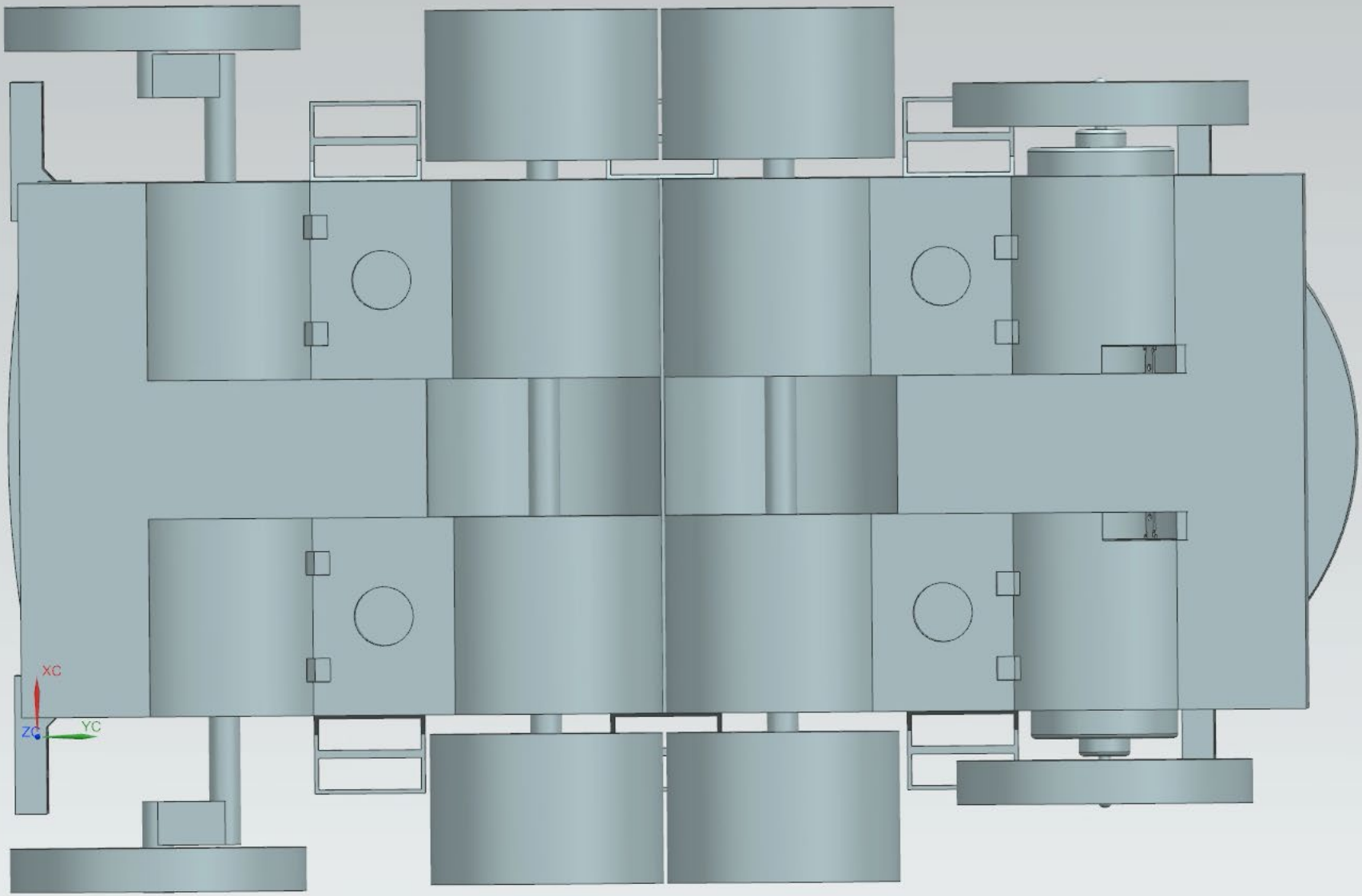
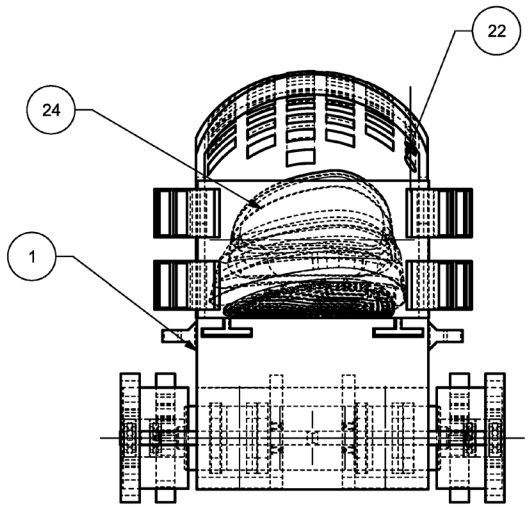
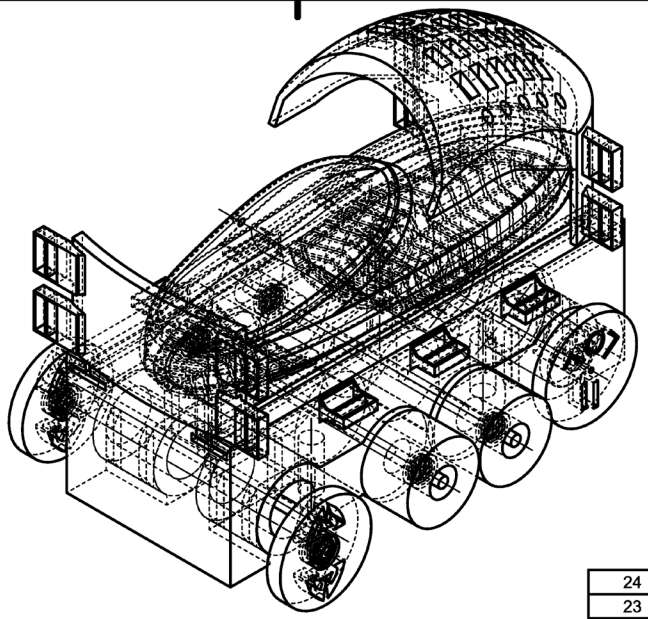
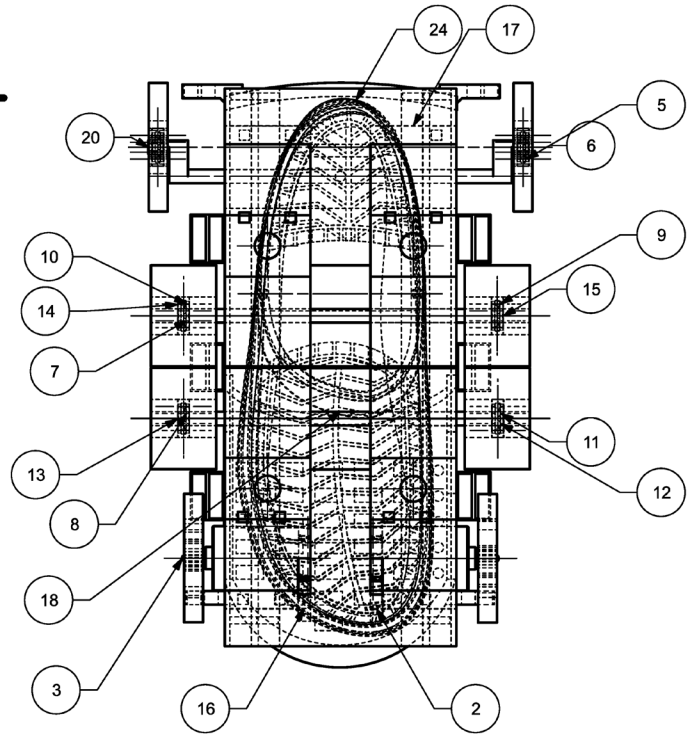
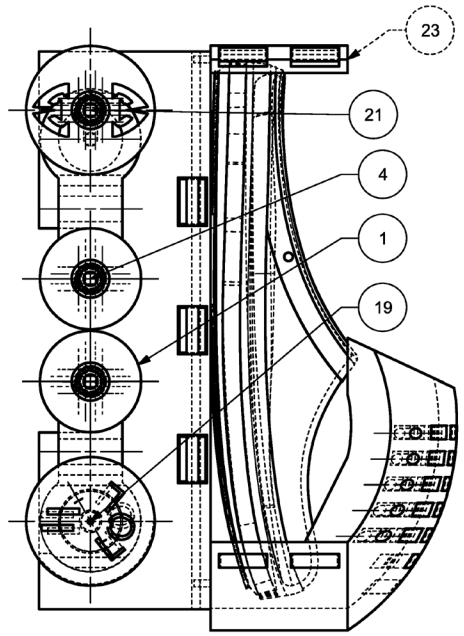






ASM
+ Shoe





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14	S8.T3.TONYGRABCAD.SHOECAR.BEARINGDONUTSMALL.V0	6
13	S8.T3.TONYGRABCAD.SHOECAR.BEARINGDONUTBIG.V0	6
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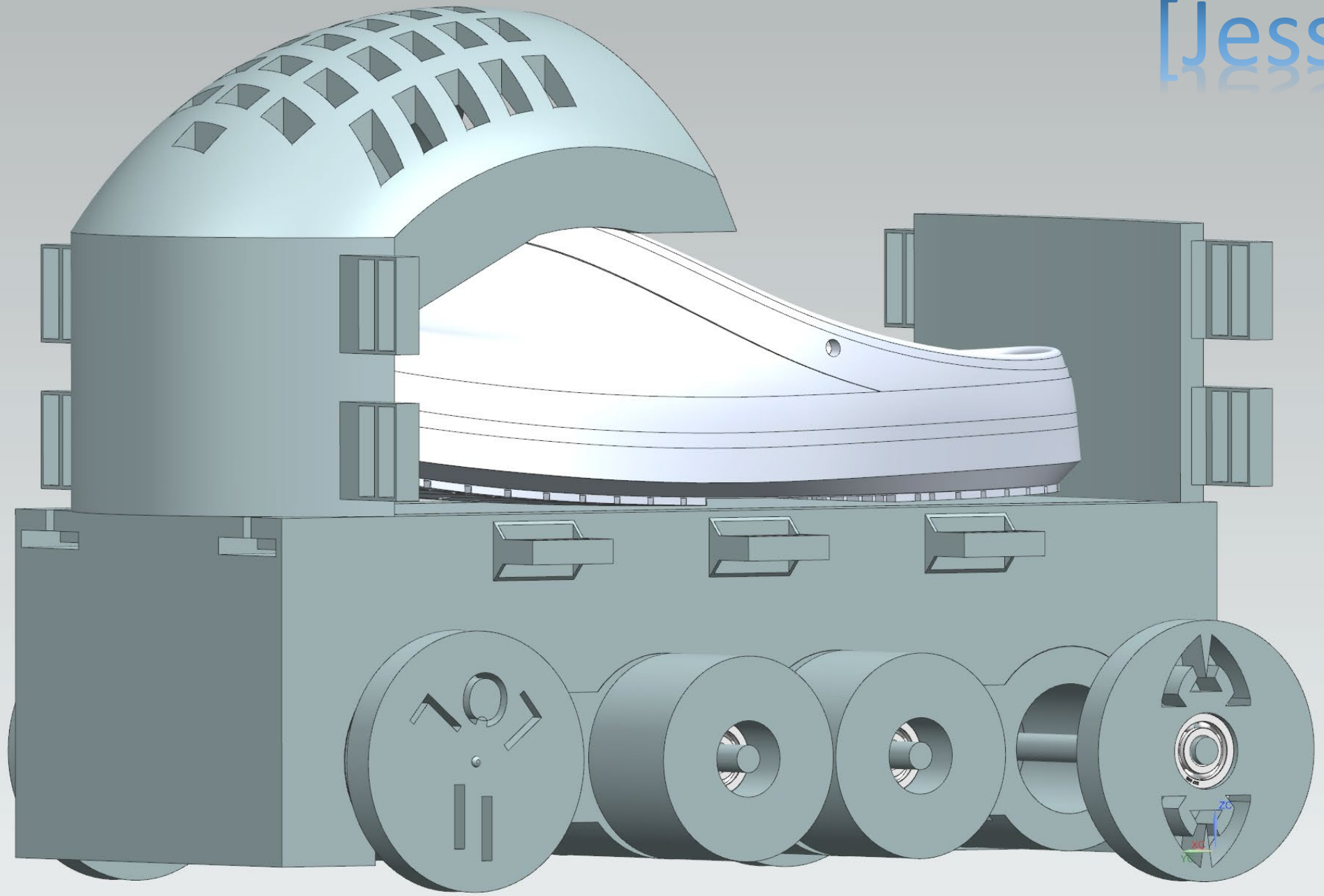
SIZE	DRG NO.	SHEET REV
A2	S8.T3.Naser.shoecar.AssemblyWithShoe.v0	A

SCALE 1:1 | SHEET 1 OF 1

A2

[Jesse]

[Jesse]



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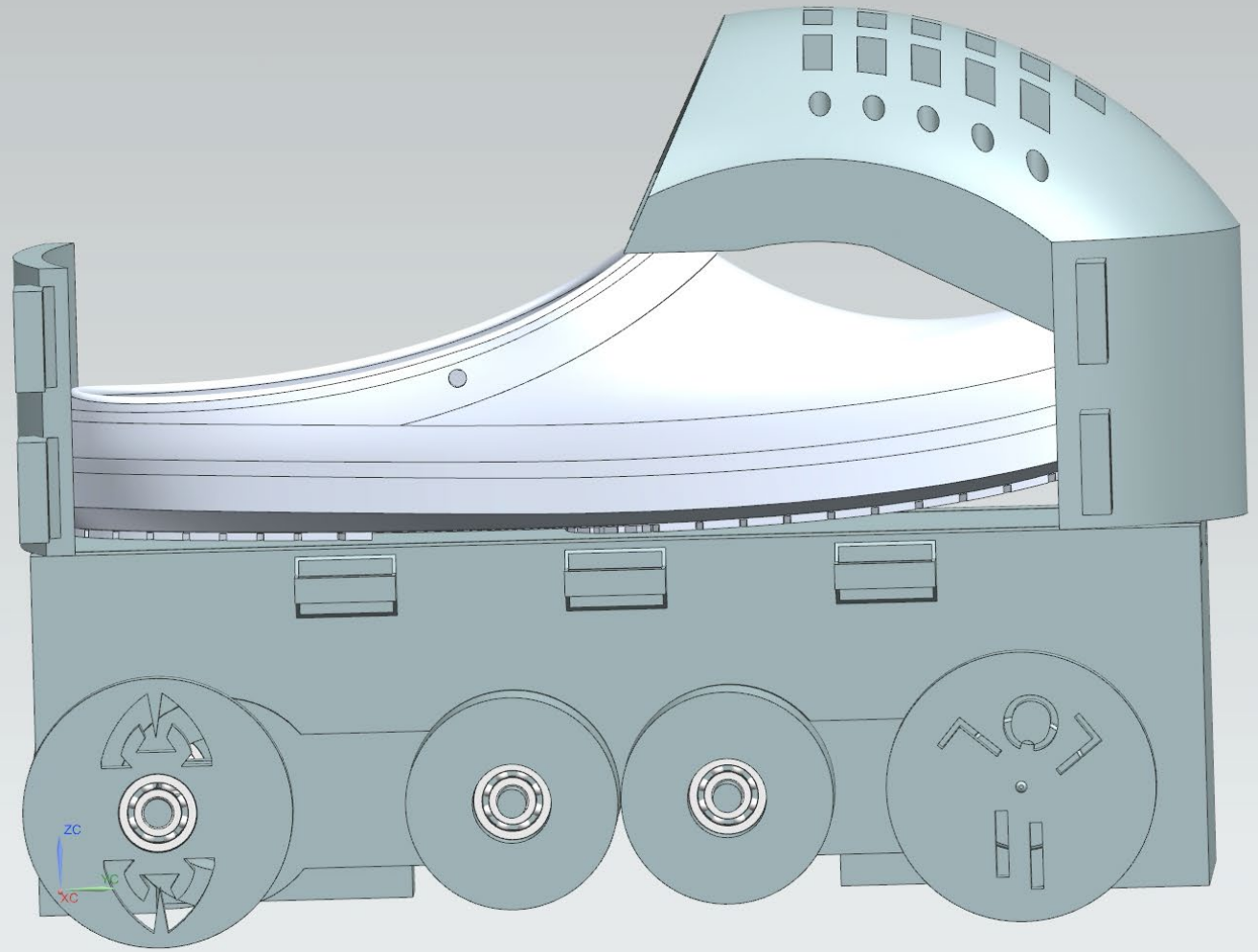

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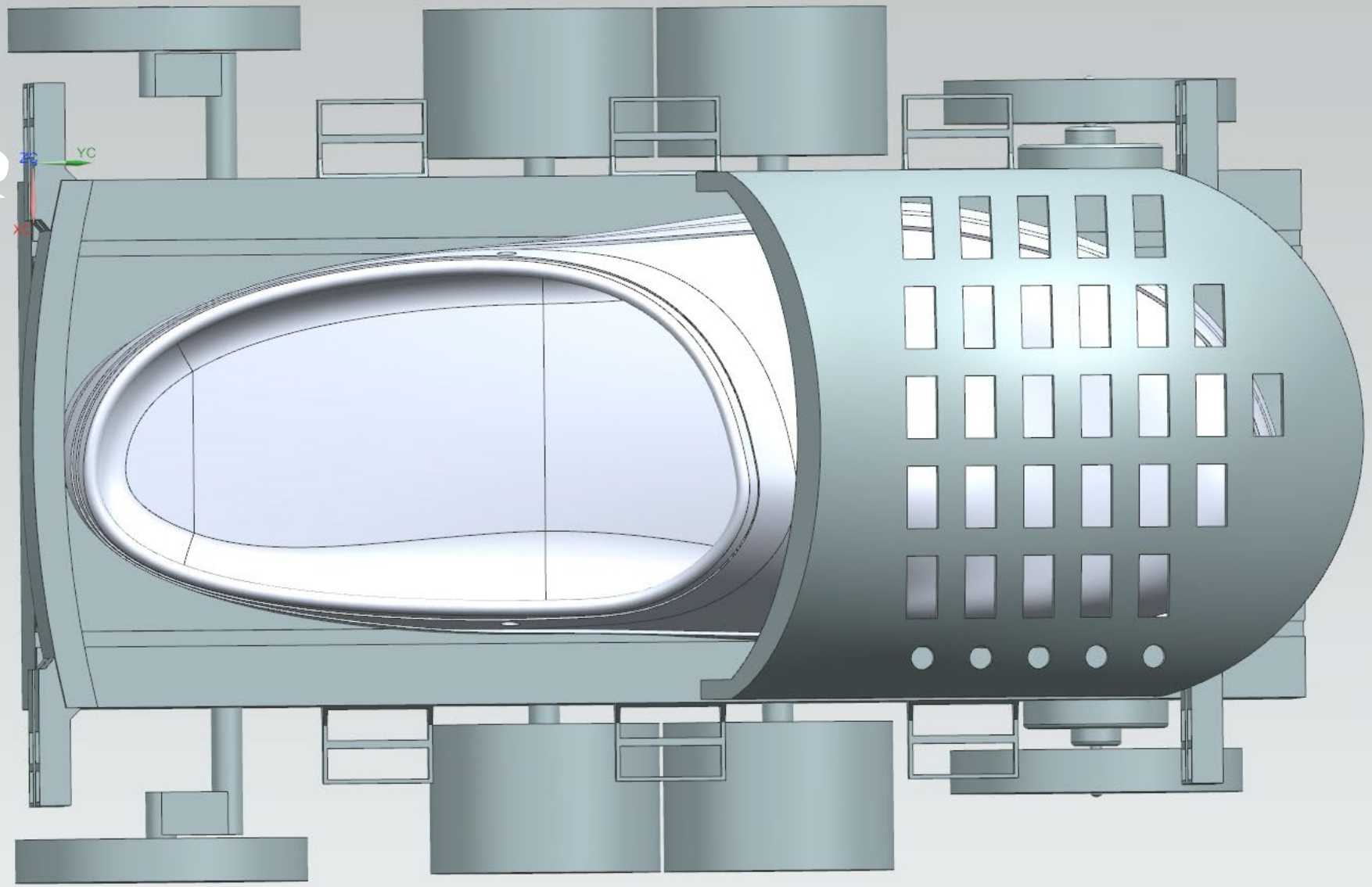

[Jesse]

ASM Skate mode

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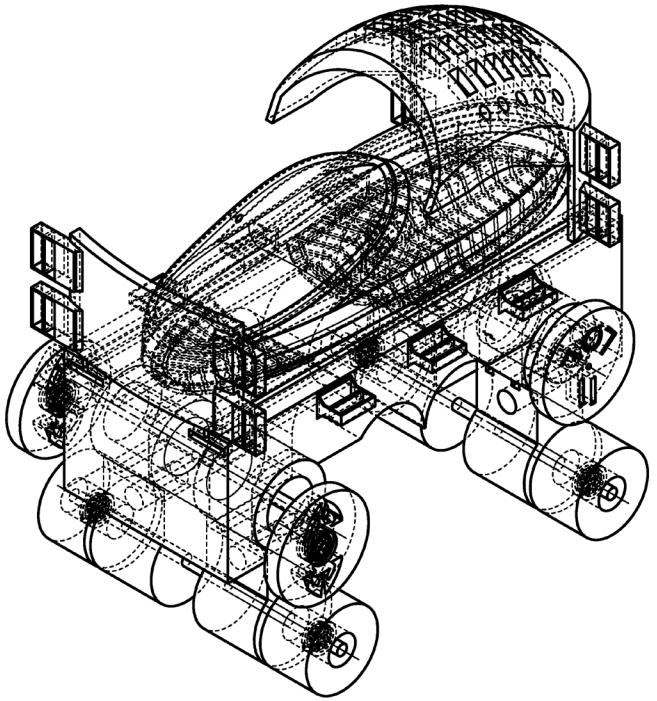
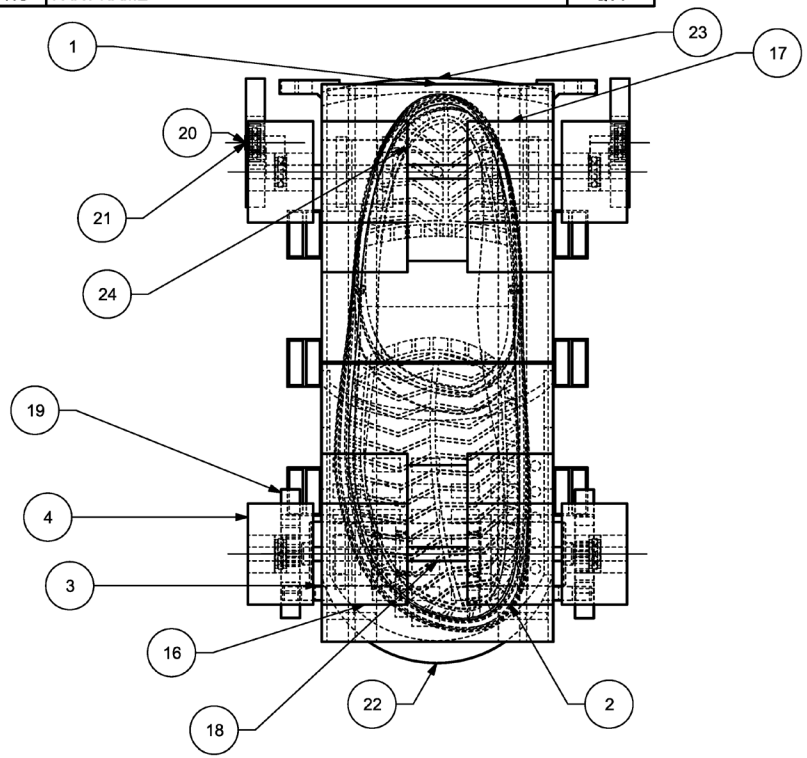
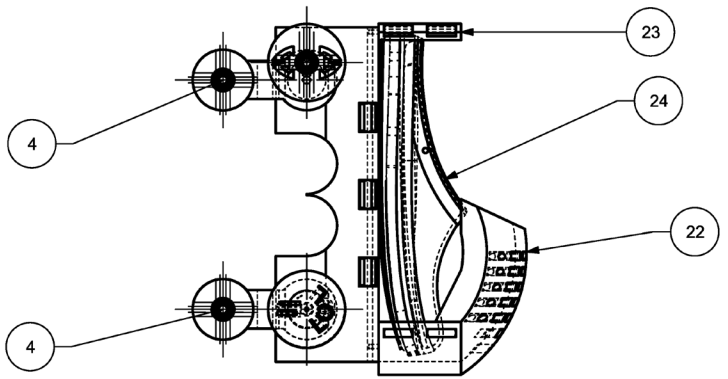
8	S8.T3.TONYGRABCAD.SHOECAR.BEARINGBALL5.V0	6
7	S8.T3.TONYGRABCAD.SHOECAR.BEARINGBALL6.V0	6
6	S8.T3.TONYGRABCAD.SHOECAR.BEARINGBALL7.V0	6
5	S8.T3.TONYGRABCAD.SHOECAR.BEARINGBALL8.V0	6
4	S8.T3.CARROLL.SHOECAR.WHEELROLLERSKATE.V0	4
3	S8.T3.NASER.SHOECAR.MOTOR.V0	2
2	S8.T3.COWELLS.SHOECAR.FOLDMOTIONWIREDRIGHT.V0	1
1	S8.T3.NASER.SHOECAR.PLATFORM.V0	1







ALL DIMENSIONS IN MM

SIEMENS

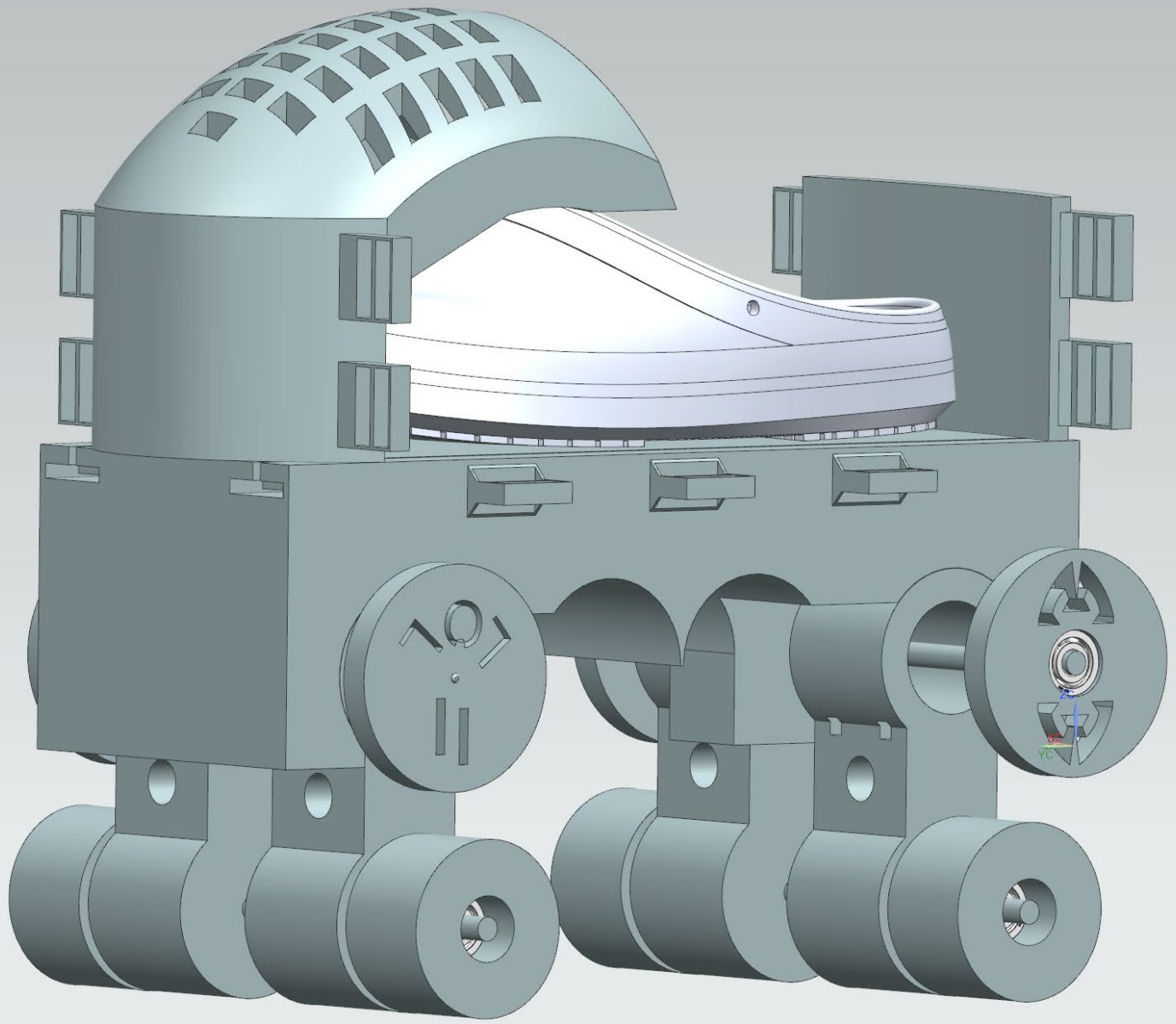
THIS DRAWING HAS BEEN PRODUCED USING AN EXAMPLE TEMPLATE PROVIDED BY SIEMENS PLM SOFTWARE

FIRST ISSUED	Jesse N.	TITLE
DRAWN BY	Oct. 26, 2022	
CHECKED BY		
APPROVED BY		

SIZE	DRG NO.	SHEET REV
A2	S8.T3.Naser.shoecar.AssemblyWithShoeRollerskateMode.v0	A

SCALE 1:1 SHEET 1 OF 1

[Jesse]



[Team]

Problem Solving

[Team]

Difficulties Designing the Shoe Car

A. How to design wheels and axles to create a multifunctional roller skate and RC car? "RC mode" and "skate mode"?

B. How to Create a turning mechanism for "RC car" mode?

C. Where to store motors, batteries and other electronic components?

D. Folding mechanism that engages motor and free skating while maintaining solid integrity?

E. Wires break when motors and wheels rotate between modes?

F. Hold human in place without falling or slipping.

[Team]

Solutions

A. 8 wheels total, only 4 active at any given time. Wheels are attached for easy folding

B. Use bearings to keep rear axle at zero angular velocity. Using motor cavity for axial movement.

C. Large shoe "sole" to store electronic components and wheels when in "RC mode"

D. Folding splits wheels to only 4 at a time. One direction turn has thick stability and metal bars with nut fastener to lock.

E. Cutouts in the body allow the wires to move freely when vehicle is folding

F. Straps, Front + Back locking pieces with straps. Instead of 3D printed shoe.

Fantastic Parts (and who made them)

Parts List

Italics parts are placeholders for real life equivalents.

[Team]

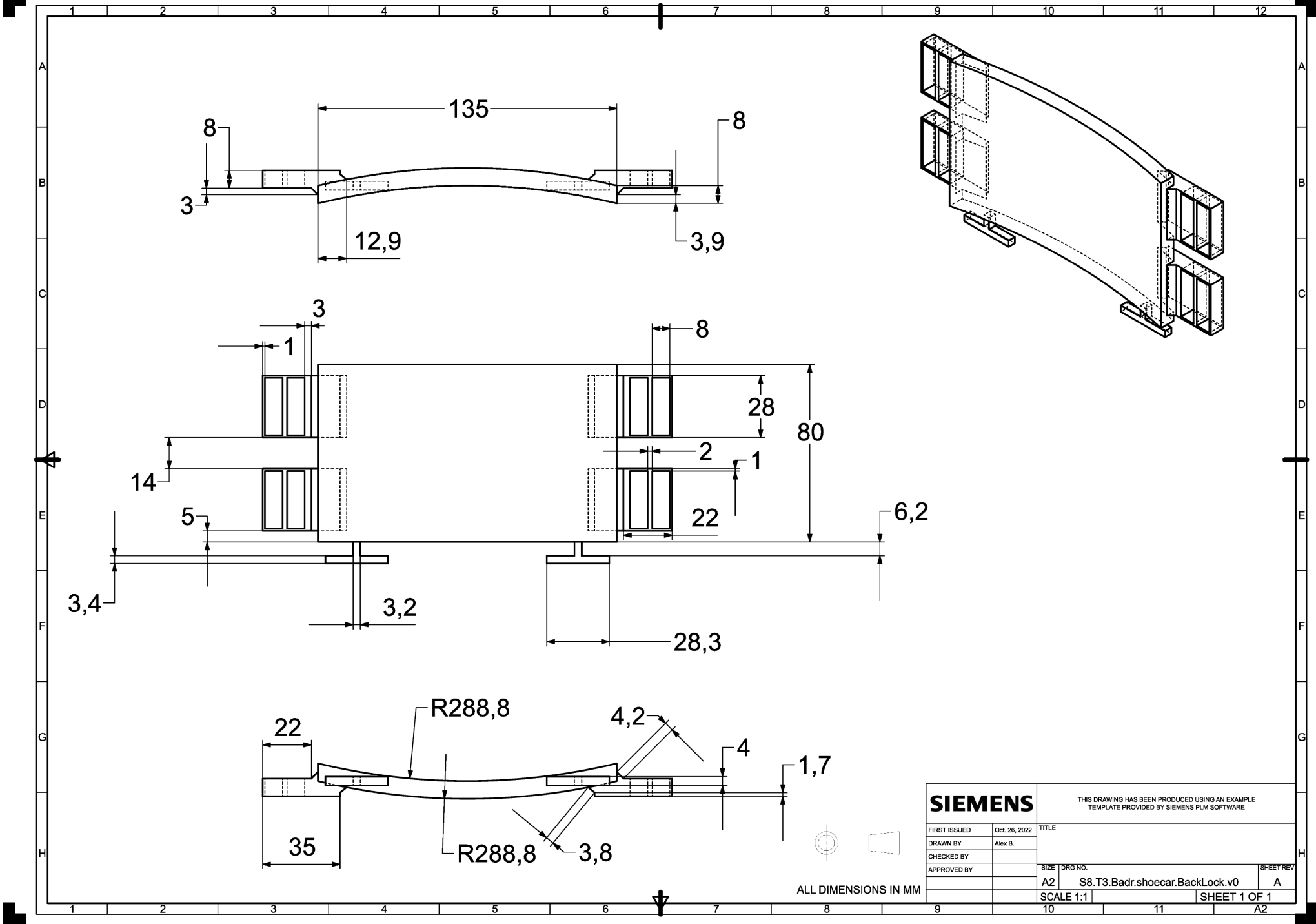
Part Name	Qty	Time to print ($2/hr) (each)	Cura Mass (Infill 20%) (ea. part)	Cura Mass (PLA: $0.03/g) (Qty x mass of ea. part)	Cost ($hr+$g) (ea. part)	Cost (Qty x cost of ea. part)
Badr.BackLock	1	213 min	57g	57g	$8.81	$8.81
Badr.FrontLock	1	695 min	177g	177g	$28.48	$28.48
Carroll.WheelFreeMotion	2	84 min	21g	42g	$3.43	$6.86
Standard Skate Bearing *TonyGrabCAD.Bearing*	6	N/A	12g (real)	72g (real)	$1.56	$9.36
Cowells.AxelFreeMotion	1	93 min	9g	9g	$3.37	$3.37
Standard Skate Wheel *Carroll.WheelRollerSkate*	4	N/A	100g (real)	400g (real)	$12.50	$50.00
Carroll.WheelMotor	2	92 min	24g	48g	$3.79	$7.58
Cowells.AxelRollerskate	2	150 min	13g @ 100%	26g	$5.39	$10.78
Cowells.FoldMotion	2	318 min	102g	102g	$13.66	$27.32
Motor | *Naser.Motor*	2	N/A	250g (real)	500g (real)	$6.50	$13.00
Cowells.FoldMotionWiredLeft	1	314 min	101g	101g	$13.50	$13.50
Cowells.FoldMotionWiredRight	1	312 min	101g	101g	$13.43	$13.43
Naser.Platform (BIG PRINT)	1	2097 min	846g	846g	$95.28	$95.28
Totals:		5012 min (ALL)		2481g (1509g 3D)		$287.77

[Alex]

- Holds back of foot
- Loops into front lock with straps to keep foot in place

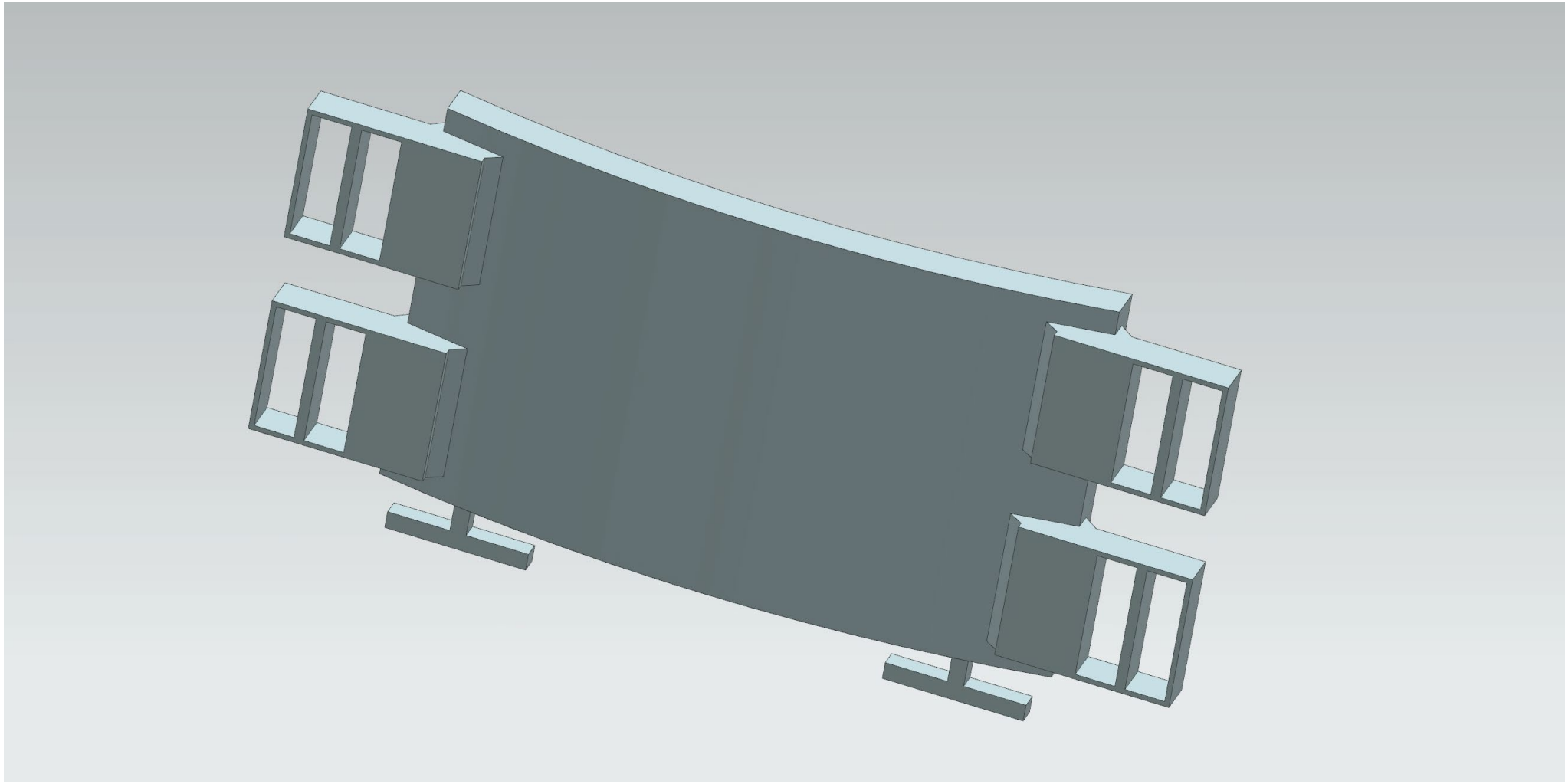
- Forward + Backward forces cancel out foot movement when hitting other lock

- Pattern Feature
- Mirror Feature
- Chamfer
- Datum Plane

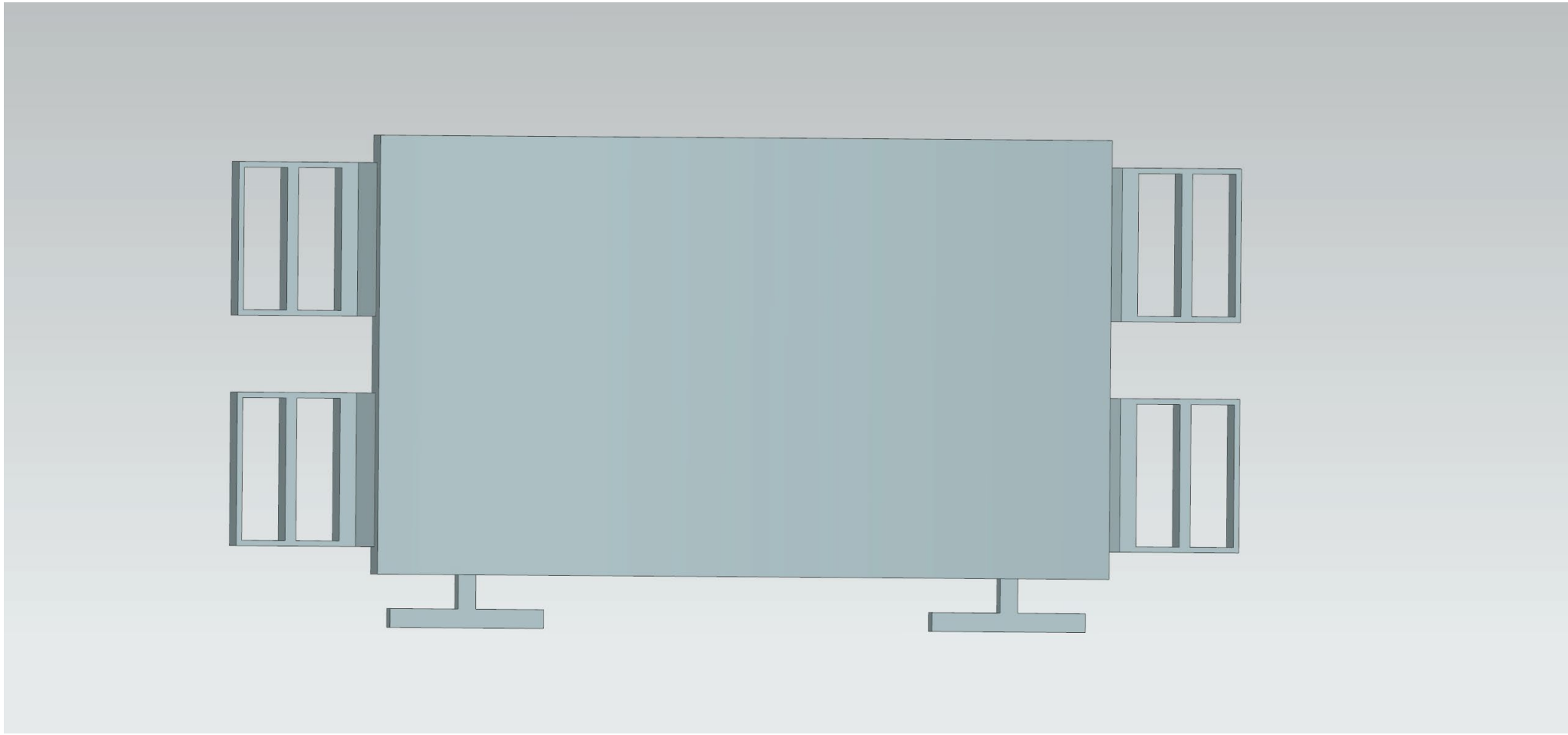


[Alex]

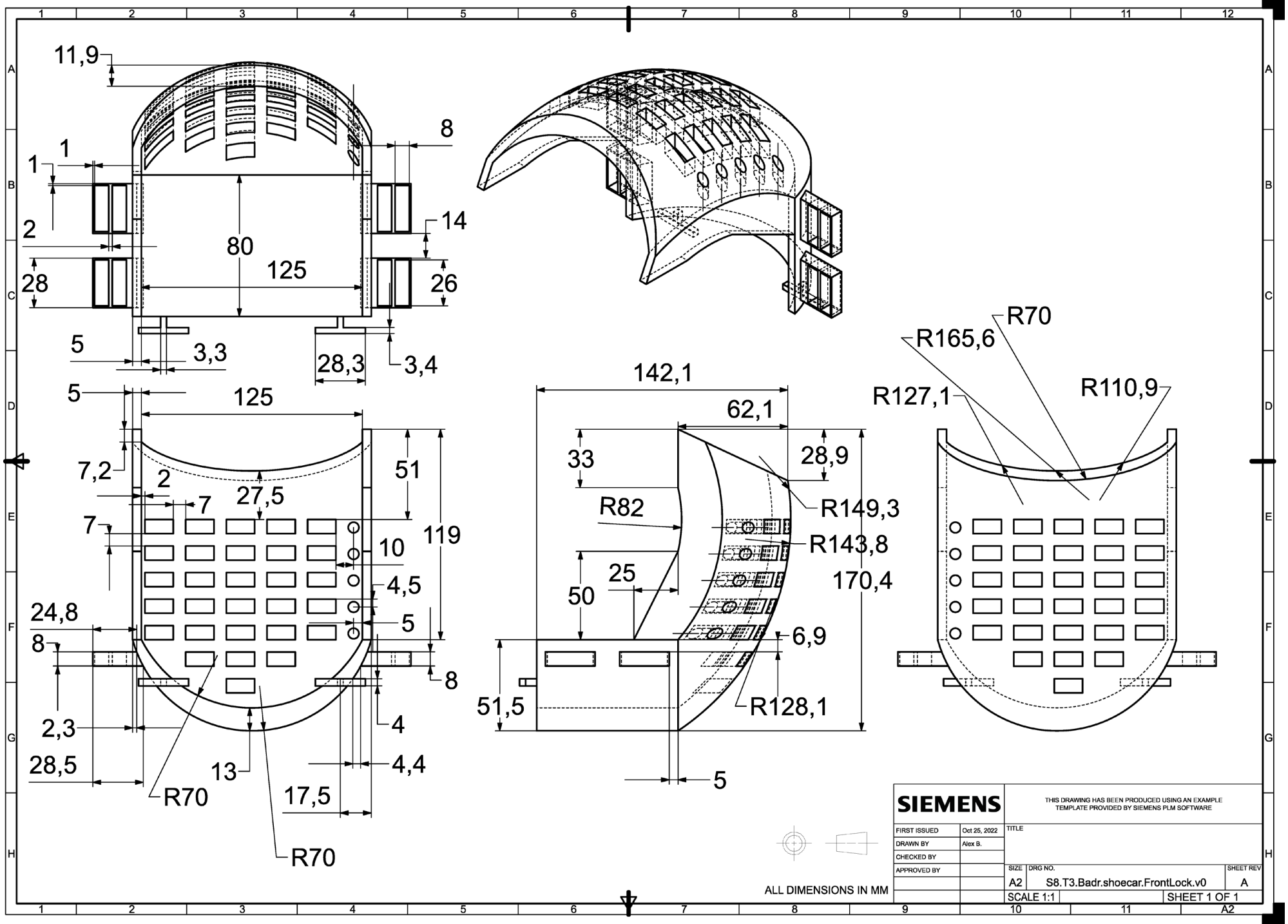
BackLock: $8.81



[Alex]



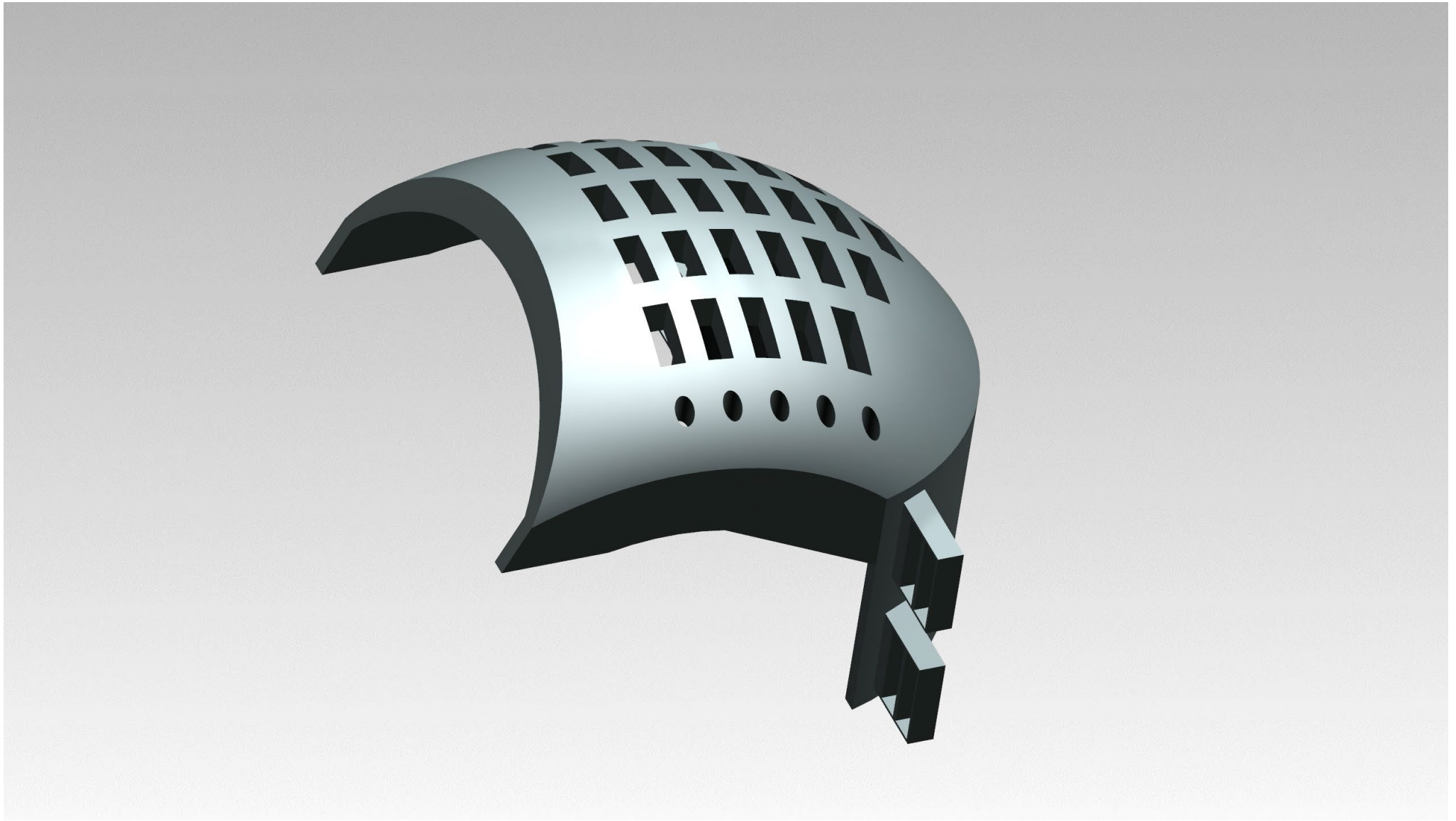
[Alex]



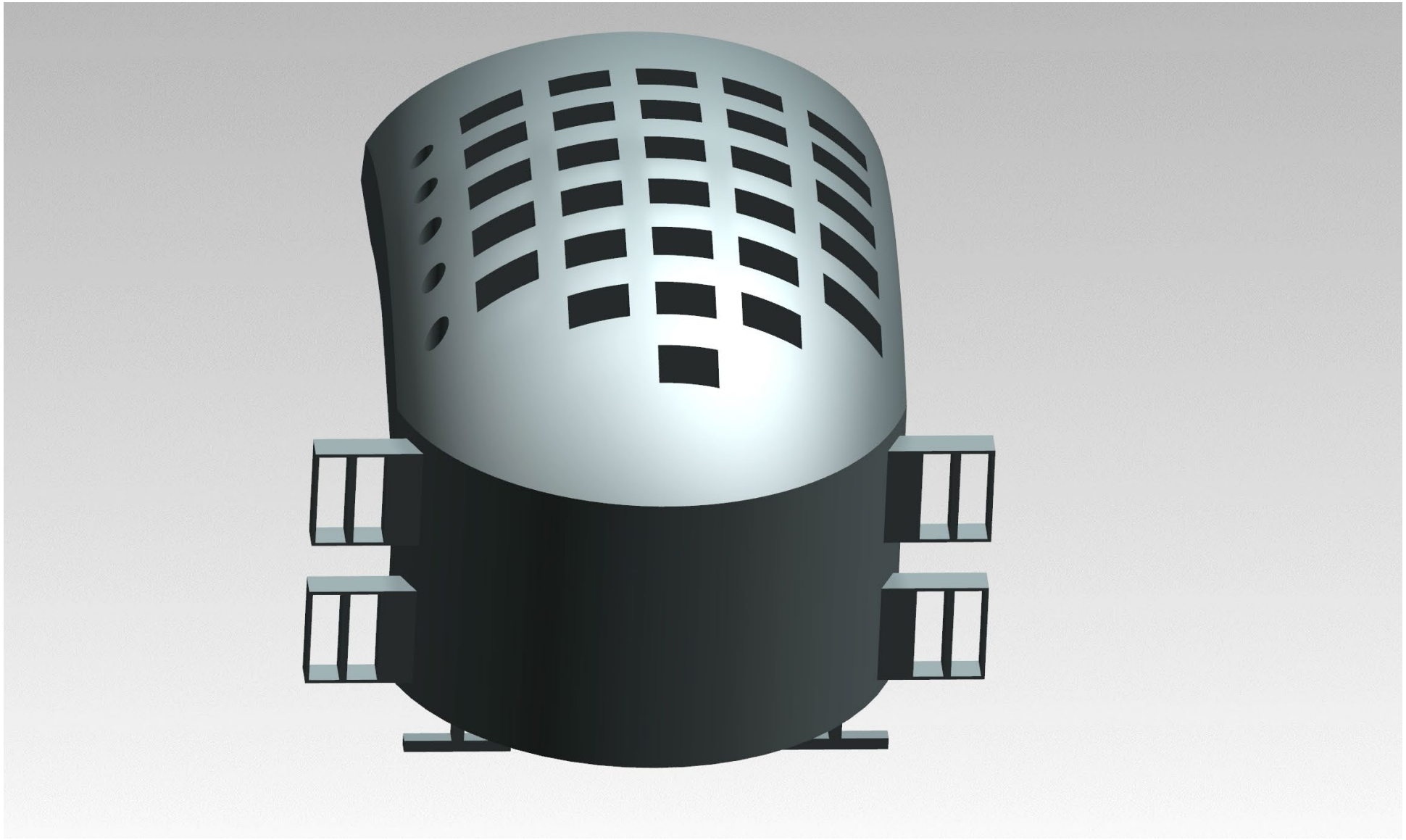
- Use of revolve tool to make curve
- Circle connectors for future ramp/stairs for mini-riders to leave ride.
- Straps loop here and to the back lock.

[Alex]

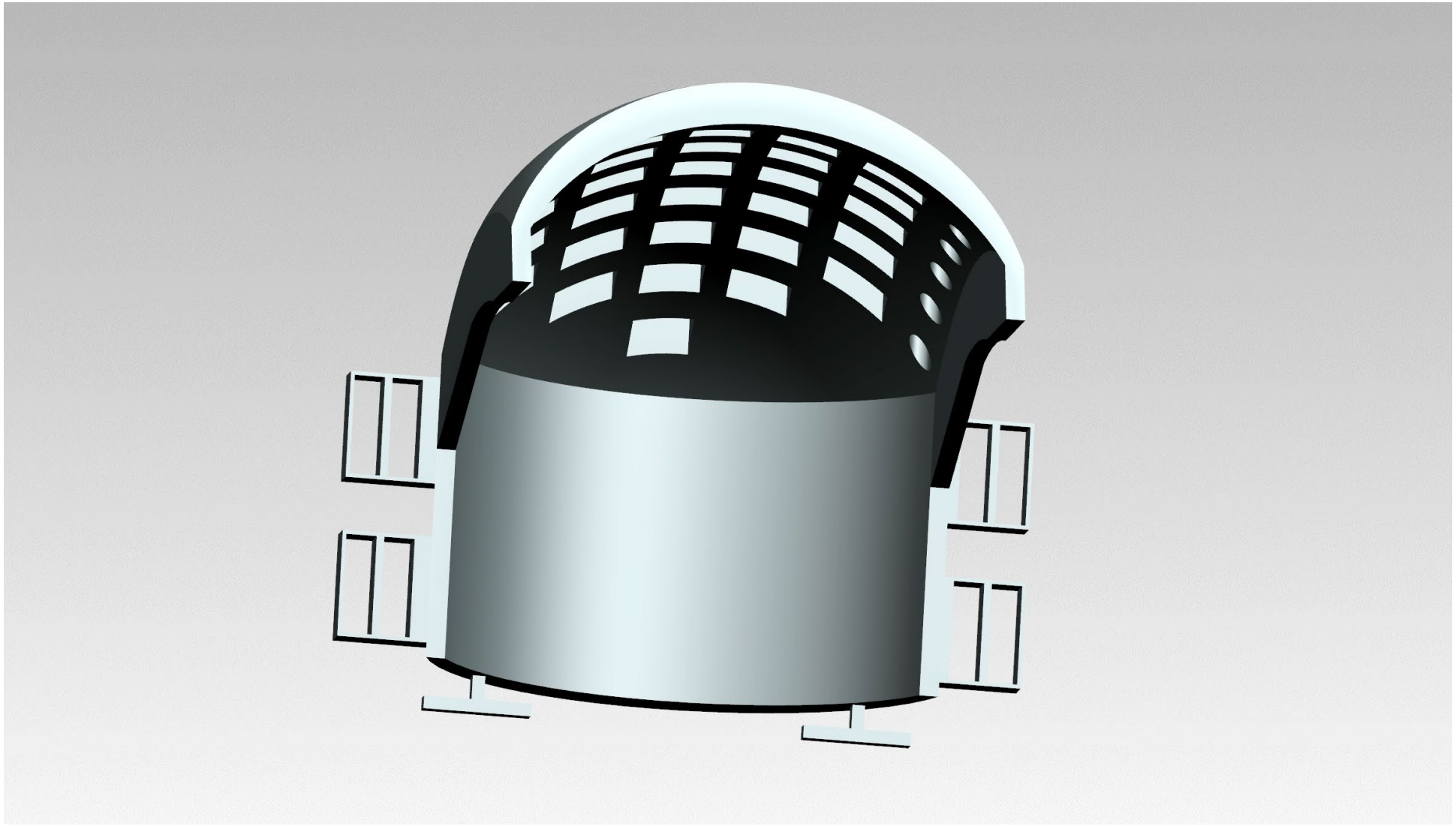
FrontLock: $28.48



[Alex]

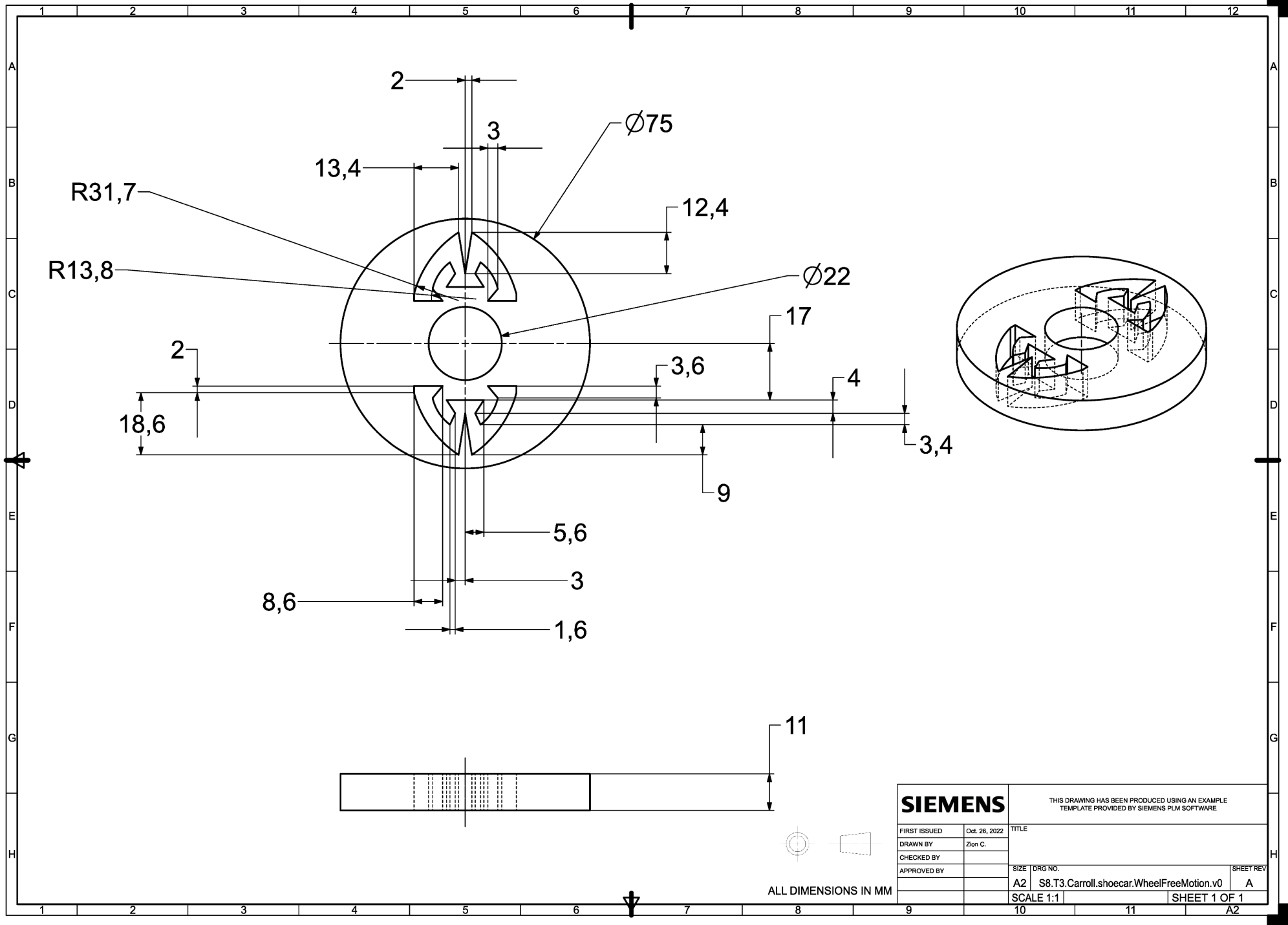


[Alex]



[Zion]

- Mirror curve and scaling curves
- Needed way to display WSU logo
- Wheel needed bigger diameter to touch the floor beyond the platform
- Skate bearing in center

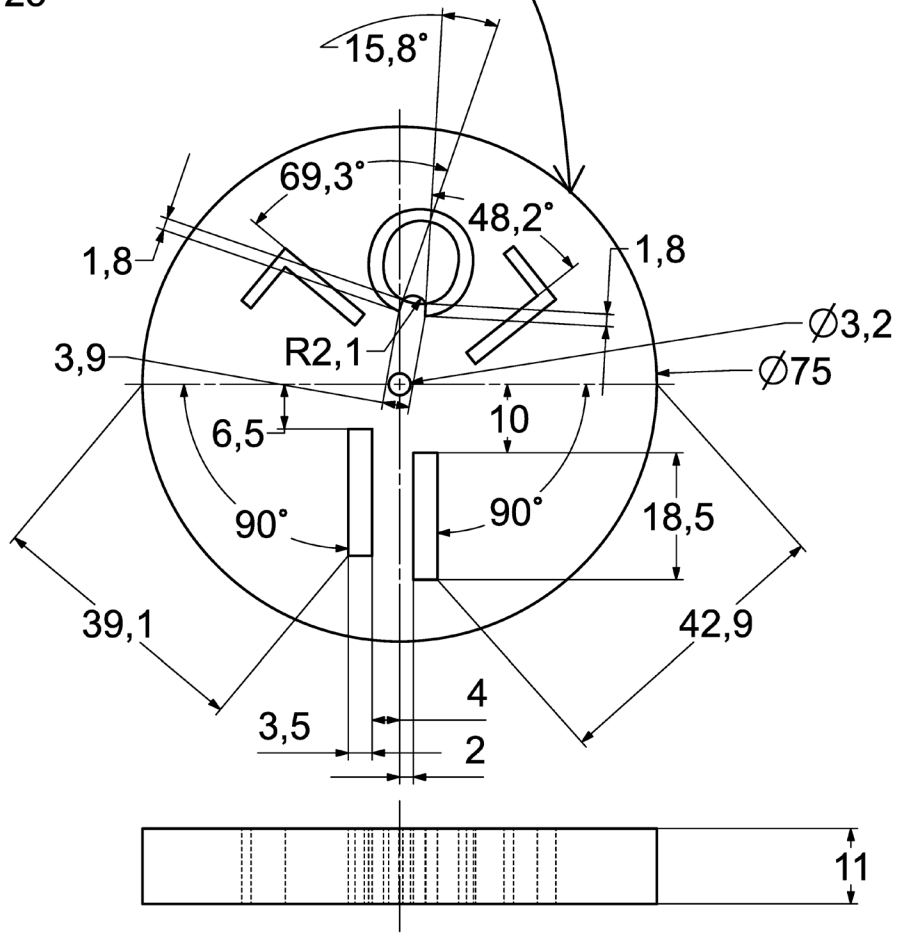


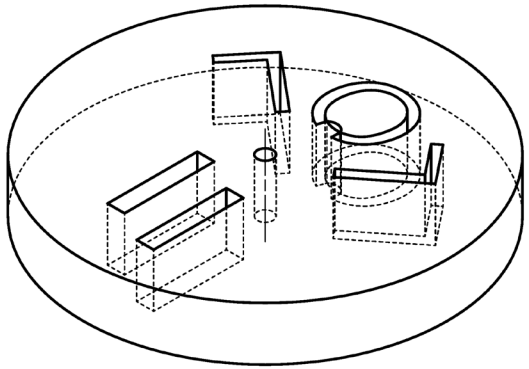
[Zion]

WheelFreeMotion (x2): $6.86

[Zion]

{Text Feature}
Text: "L..O....L" (. = space)
Placement Method: Curves on Faces
Curve:
Font: Arial [Western, Regular]
Anchor: Center
% Parameter: 25





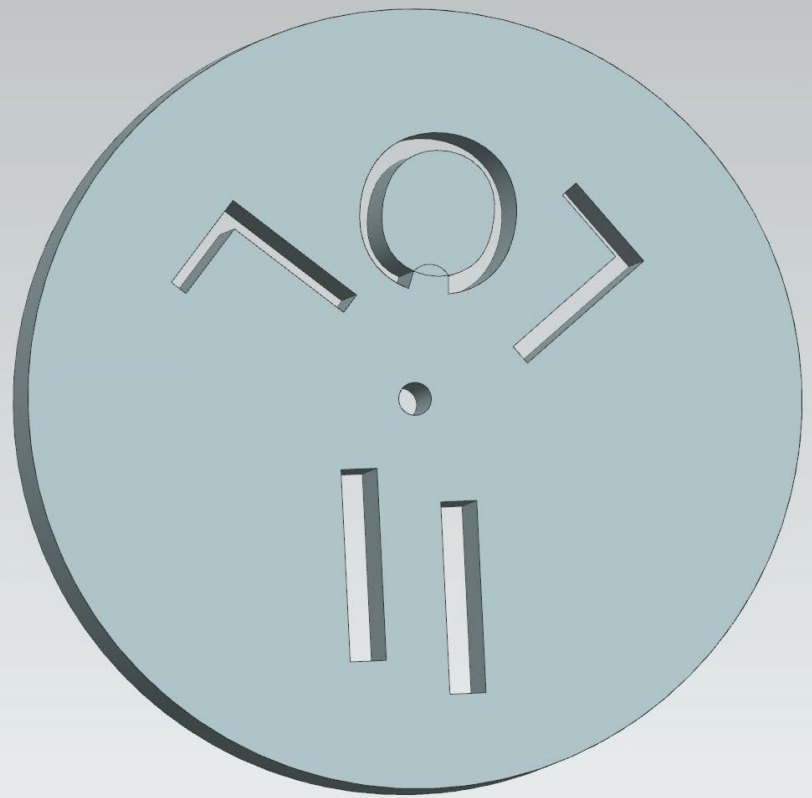
ALL DIMENSIONS IN MM

SIEMENS		THIS DRAWING HAS BEEN PRODUCED USING AN EXAMPLE TEMPLATE PROVIDED BY SIEMENS PLM SOFTWARE	
FIRST ISSUED	Oct. 26, 2022	TITLE	
DRAWN BY	Zion C.		
CHECKED BY			
APPROVED BY		SIZE / DRG NO.	SHEET REV
		A2 S8.T3.Carroll.shoecar.WheelMotor.v0	A
		SCALE 1:1	SHEET 1 OF 1

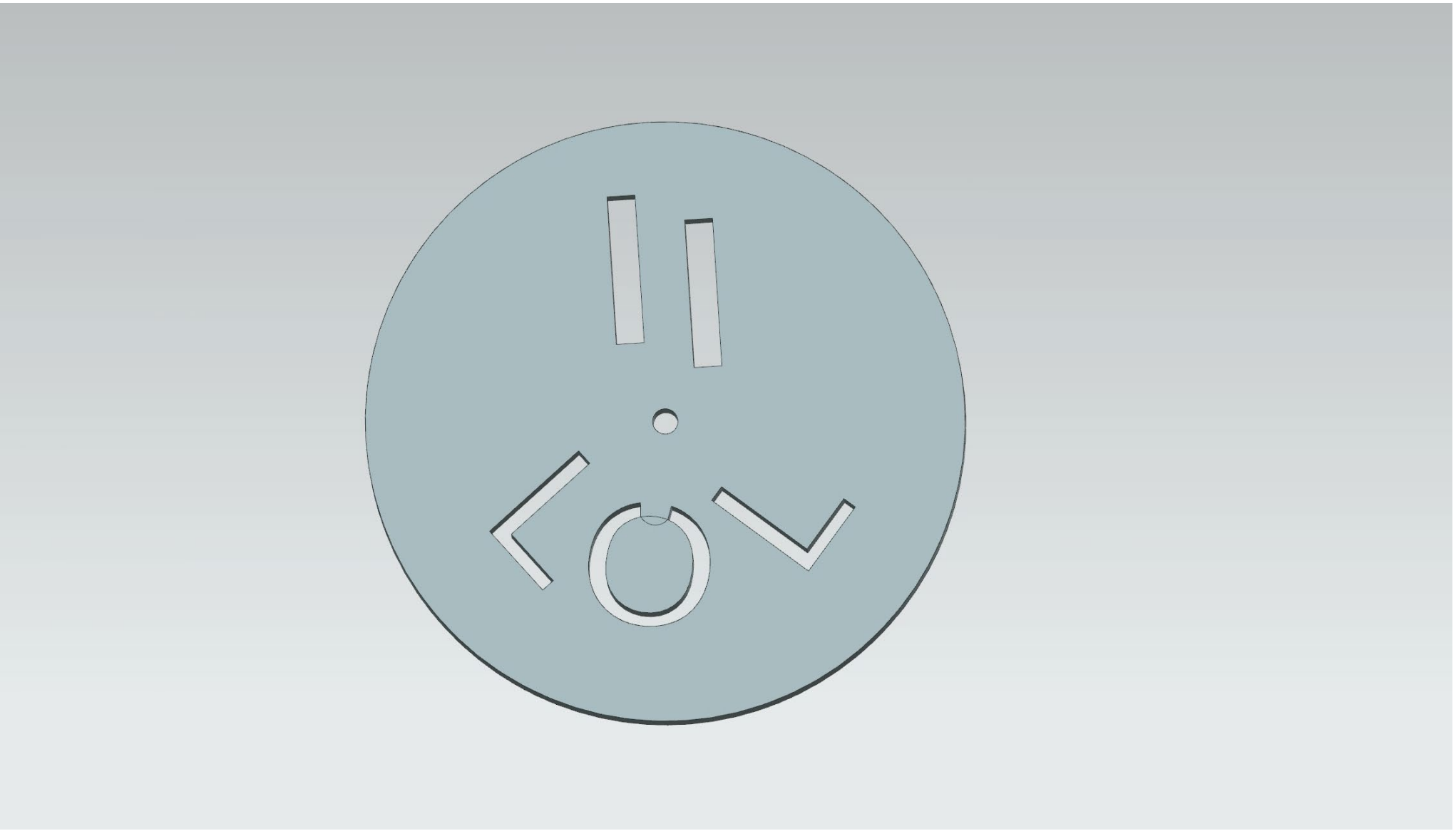
- Use of text tool to make LOL
- LOL looks like human
- Wheel needed bigger diameter to touch floor
- Small center hole is only for the motor

WheelMotor x2: $7.58

[Zion]

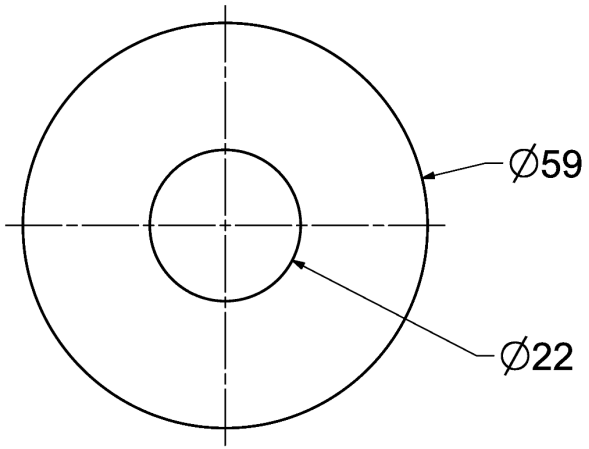


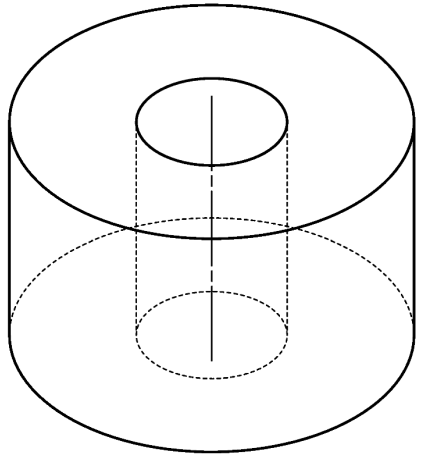
[Zion]

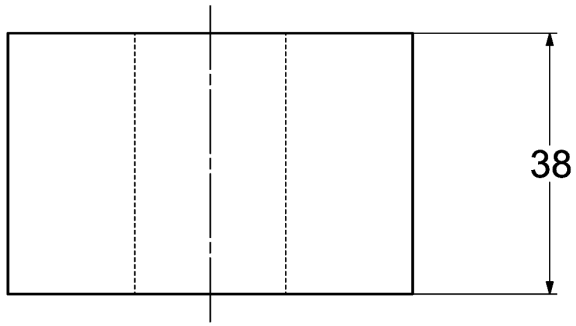


[Zion]

- Placeholder part for real skate wheels
- Bearing fits in center of real skate wheels and locks into place by axel and fastener





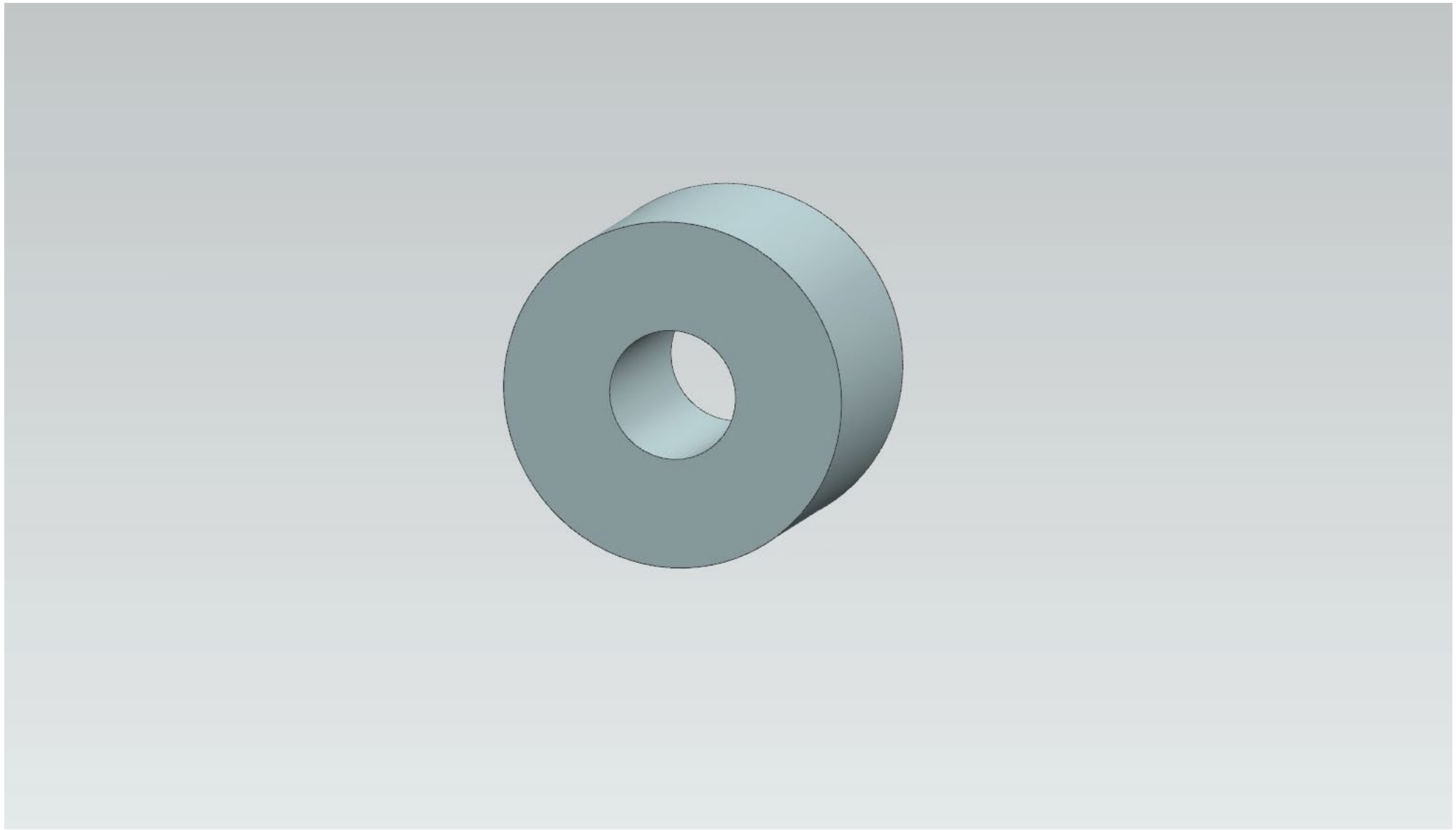


ALL DIMENSIONS IN MM

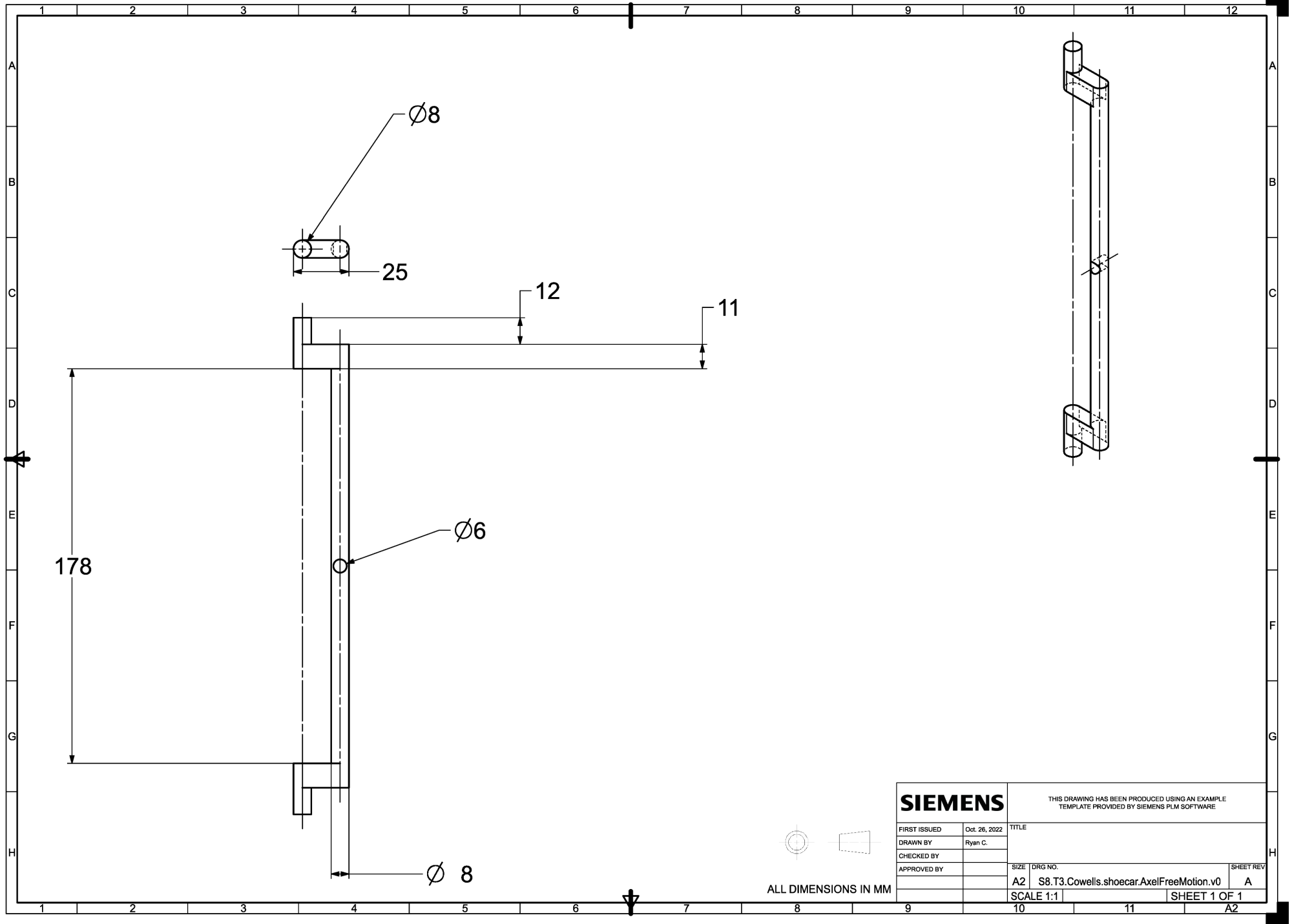
SIEMENS	THIS DRAWING HAS BEEN PRODUCED USING AN EXAMPLE TEMPLATE PROVIDED BY SIEMENS PLM SOFTWARE
FIRST ISSUED	Oct. 26, 2022
DRAWN BY	Zion C.
CHECKED BY	
APPROVED BY	
TITLE	
SIZE	A2
DRG NO.	S8.T3.Carroll.shoecar.WheelRollerskate.v0
SHEET REV	A
SCALE 1:1	
SHEET 1 OF 1	

[Zion]

(Real Skate Wheels) x4: $50



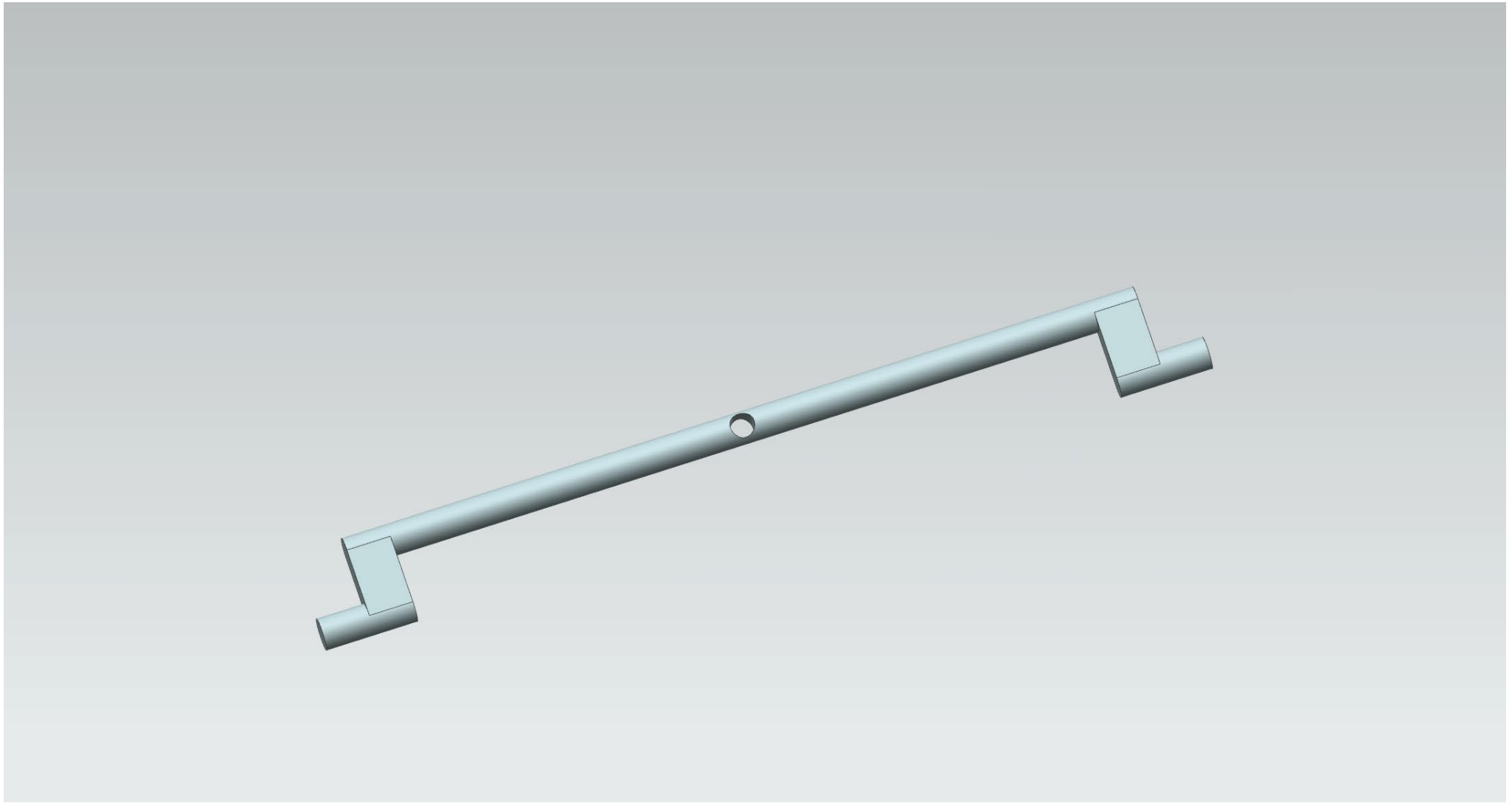
[Ryan]



- Extra side length extension to make wheel not hit the platform / other wheels on turn
- Ends may need to be longer to accommodate fastening into bearing: secure attachment
- Middle hole is for motor to turn

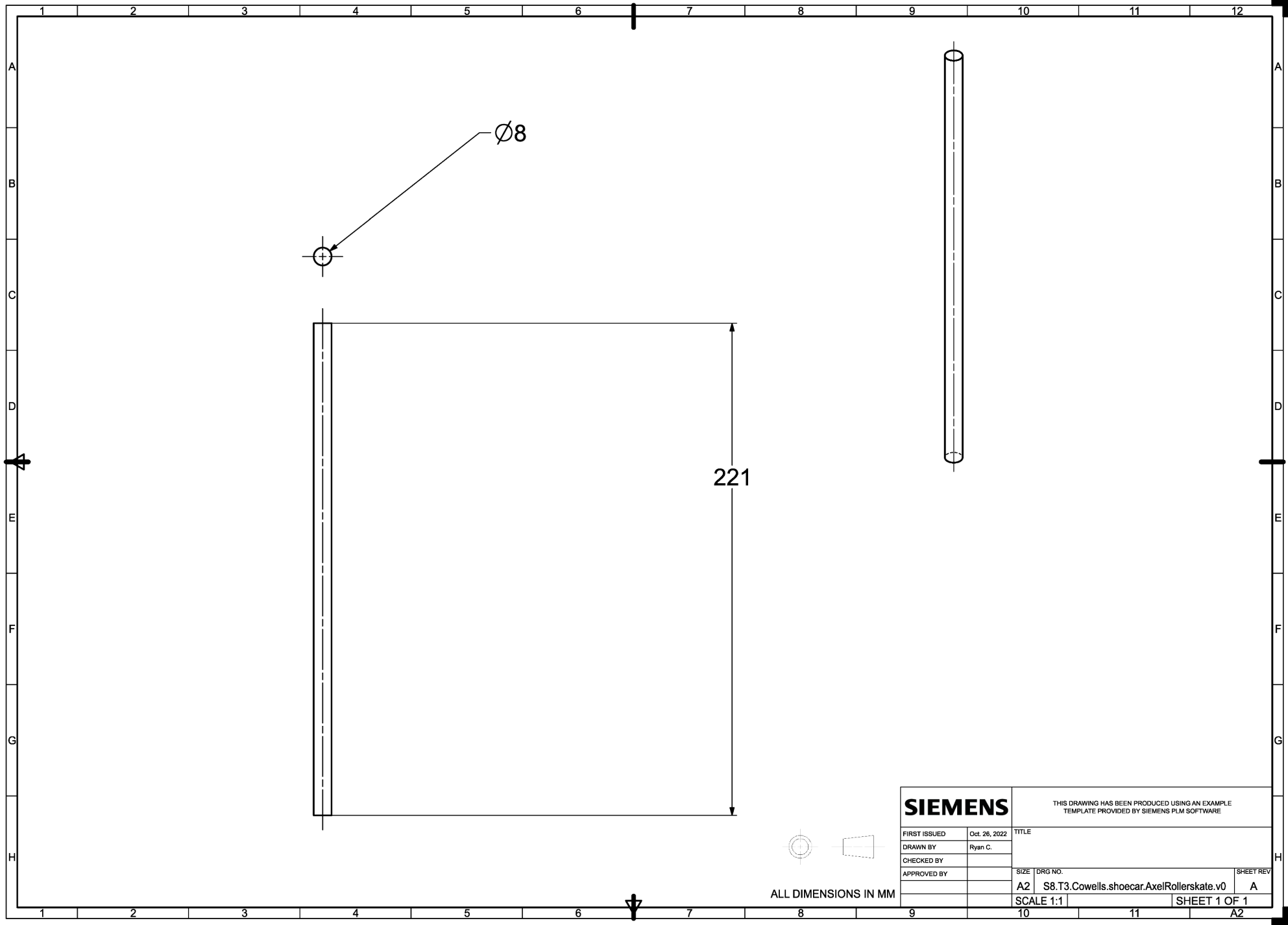
AxelFreeMotion: $3.37

[Ryan]



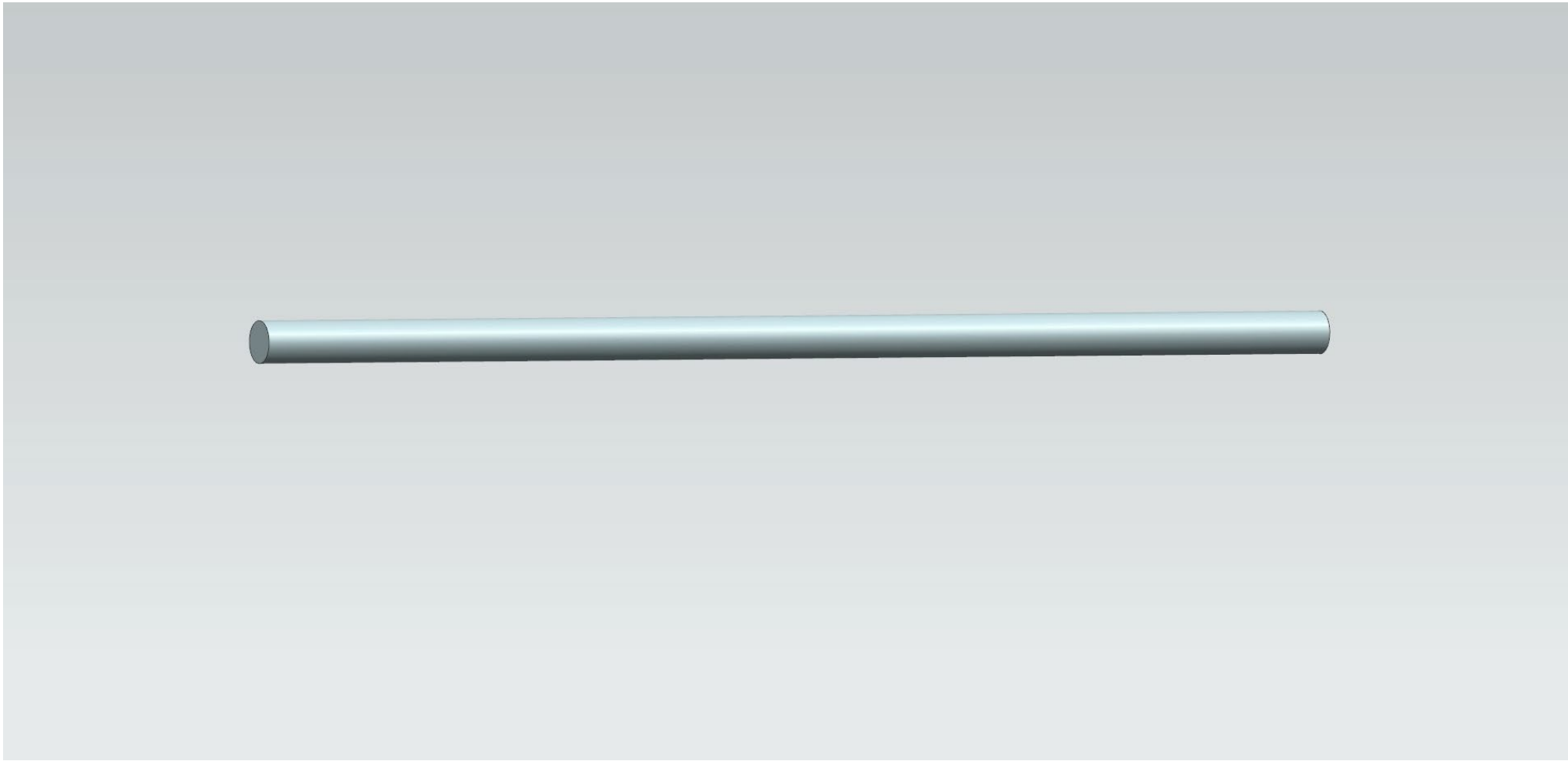
[Ryan]

- 100% infill used for strength for a human to withstand
- May need to be metal if not strong enough

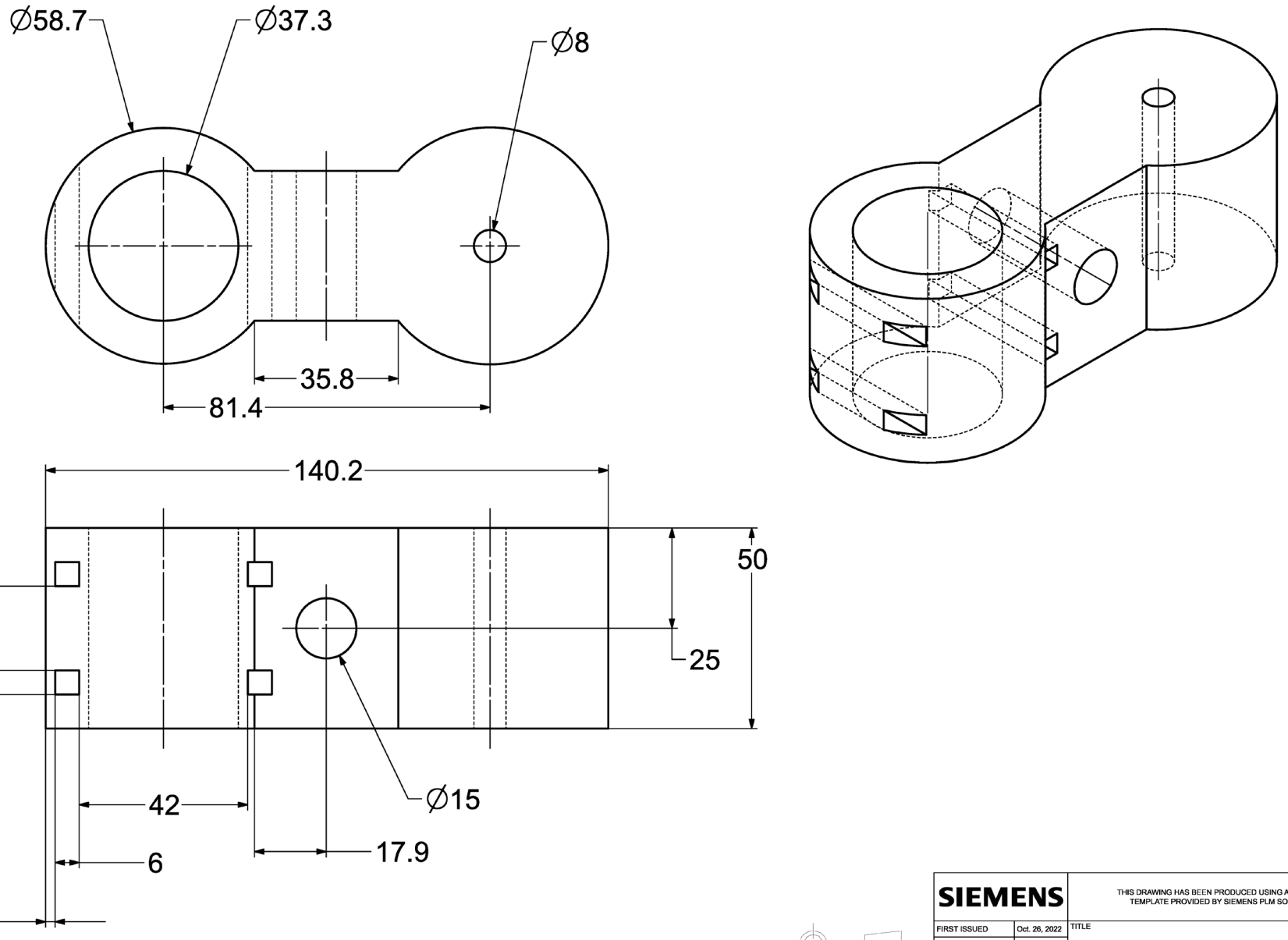


[Ryan]

AxelRollerskate: $10.78



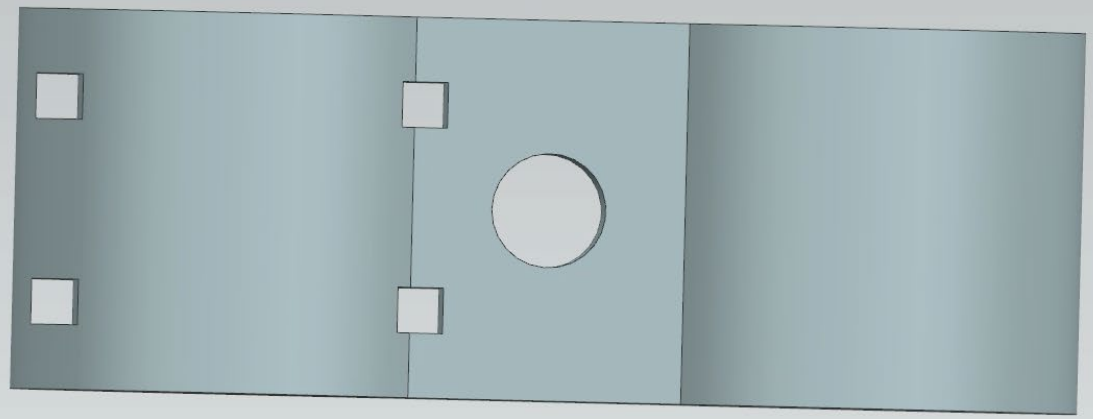
[Ryan]



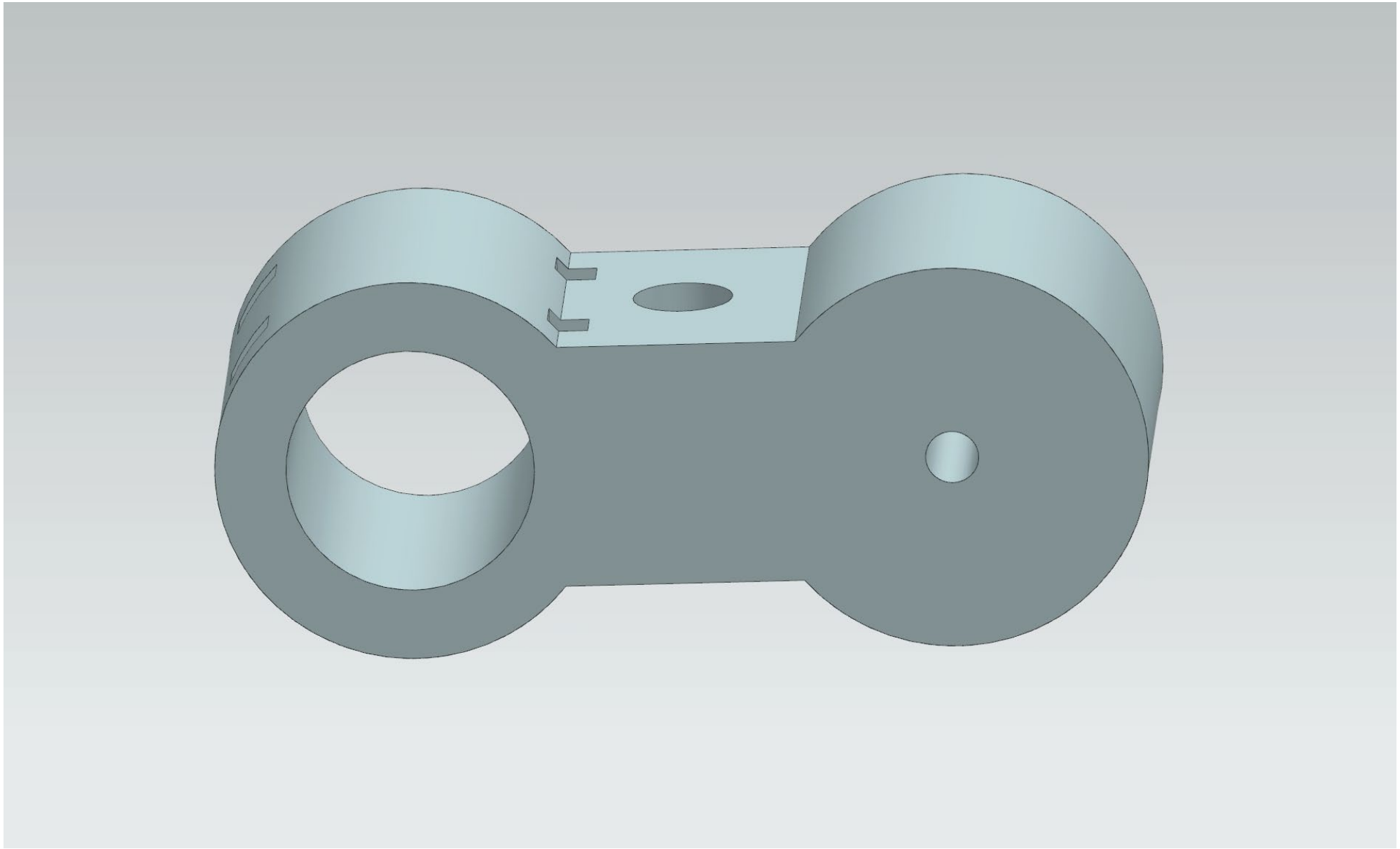
- Turns 90 degrees to change between RC and skating modes
- Hole for space to turn axel in rear
- Other hole for axel to hold skating wheels and distribute force
- Square hole for rods with fasteners to hold set mode into place

FoldMotion: $27.32

[Ryan]

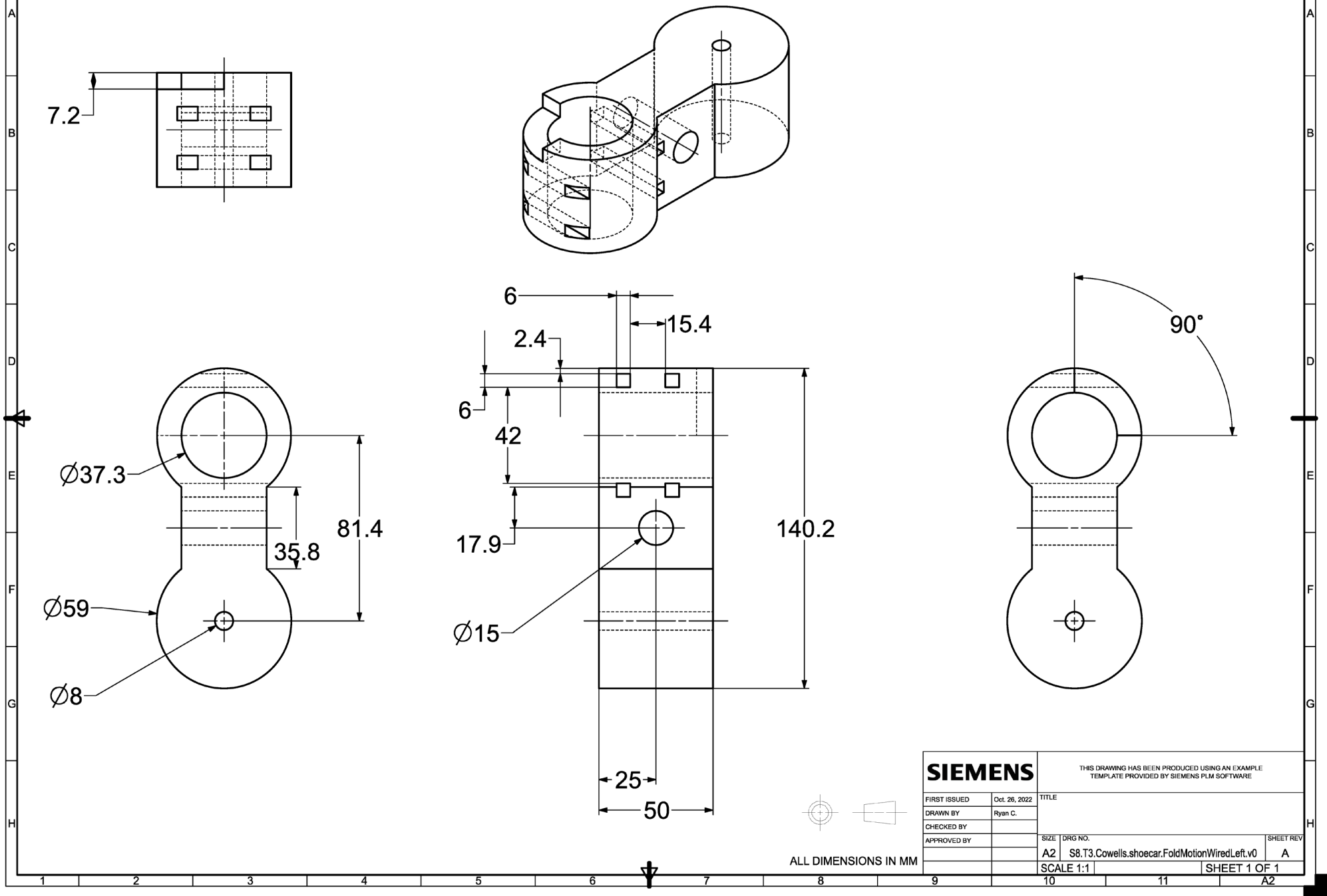


[Ryan]



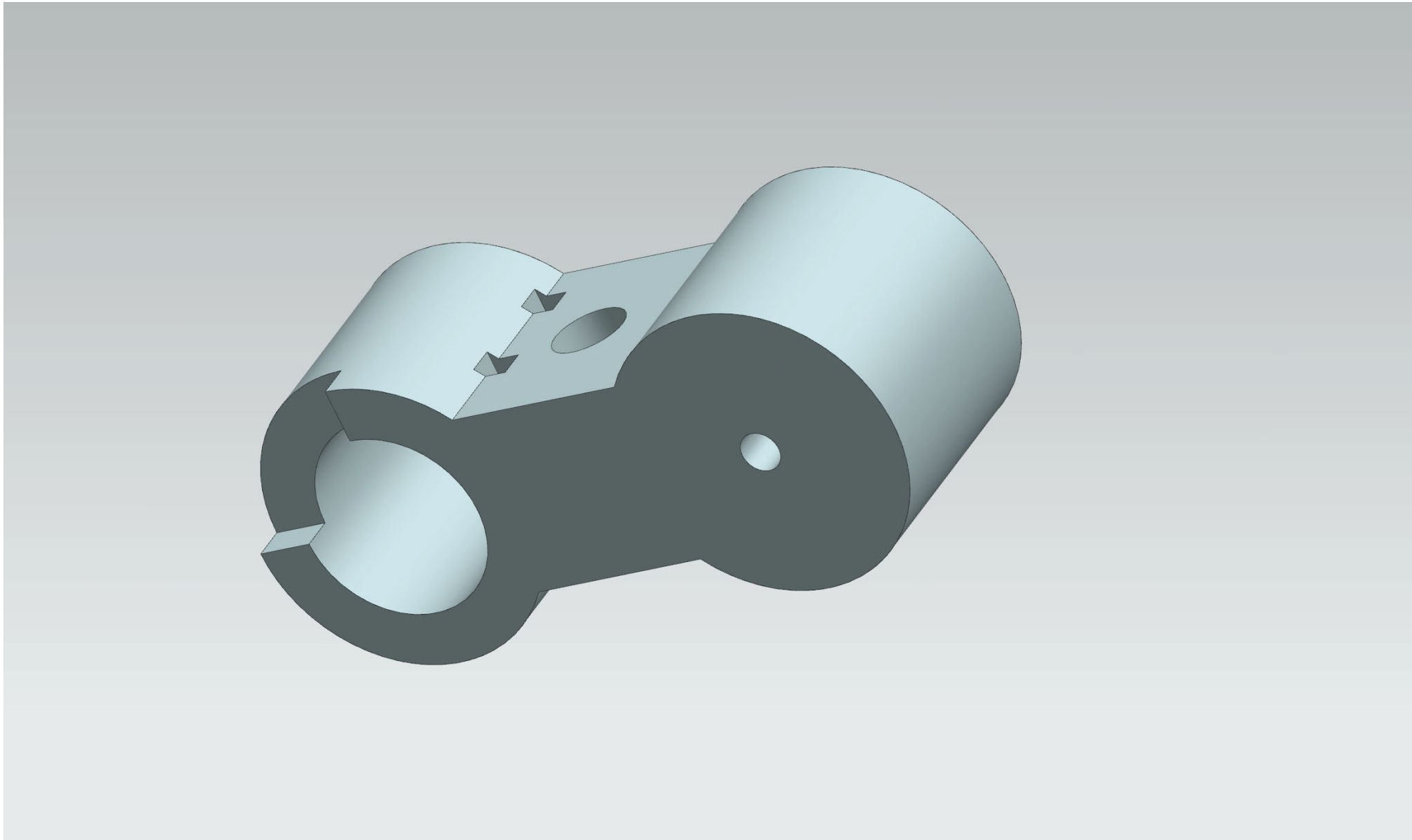
[Ryan]

- 90-degree hole for wires to not be cut when changing modes
- Hole fits motor
- No datums used, only smart placement of sketches to make square holes + extrude

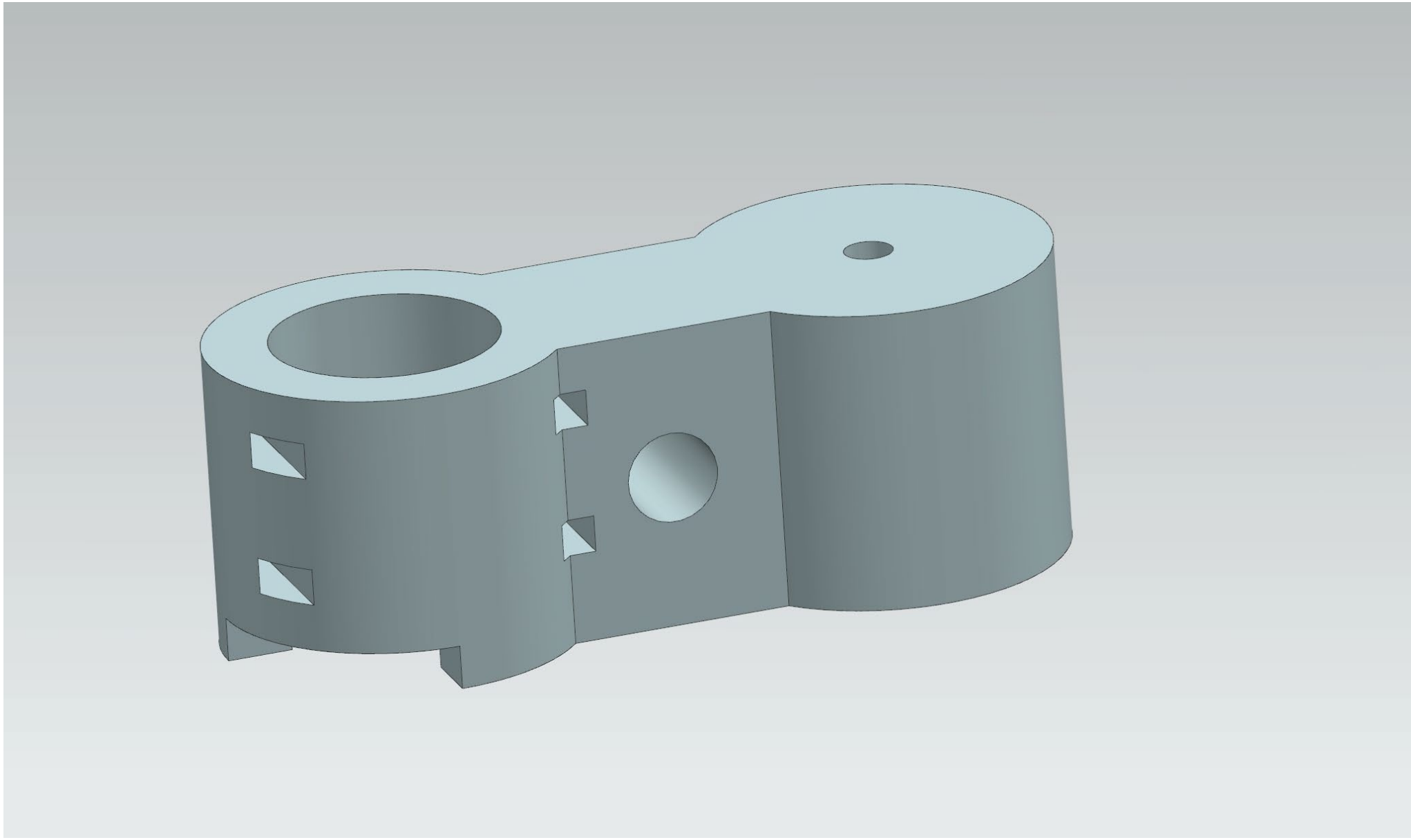


[Ryan]

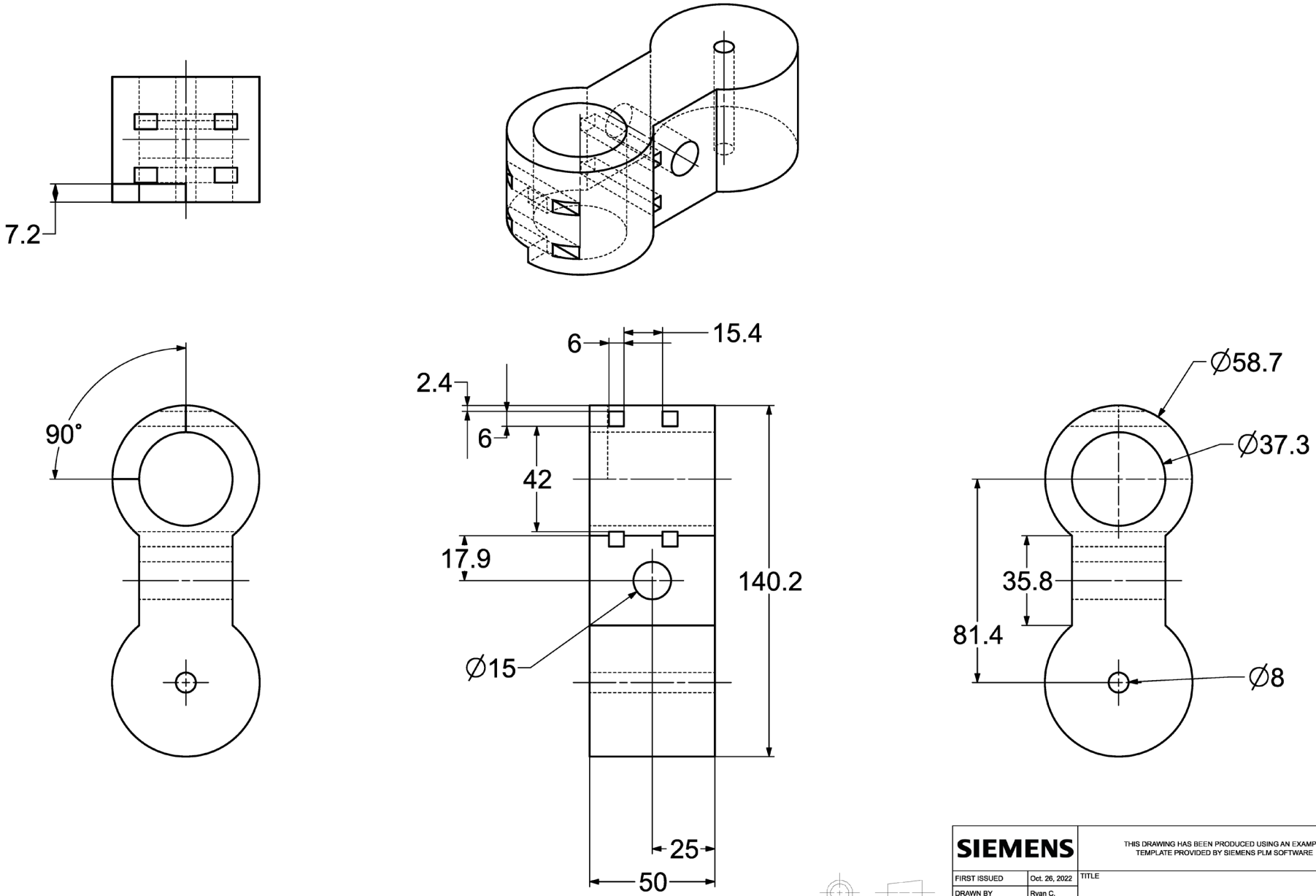
FoldMotionWiredLeft: $13.50



[Ryan]



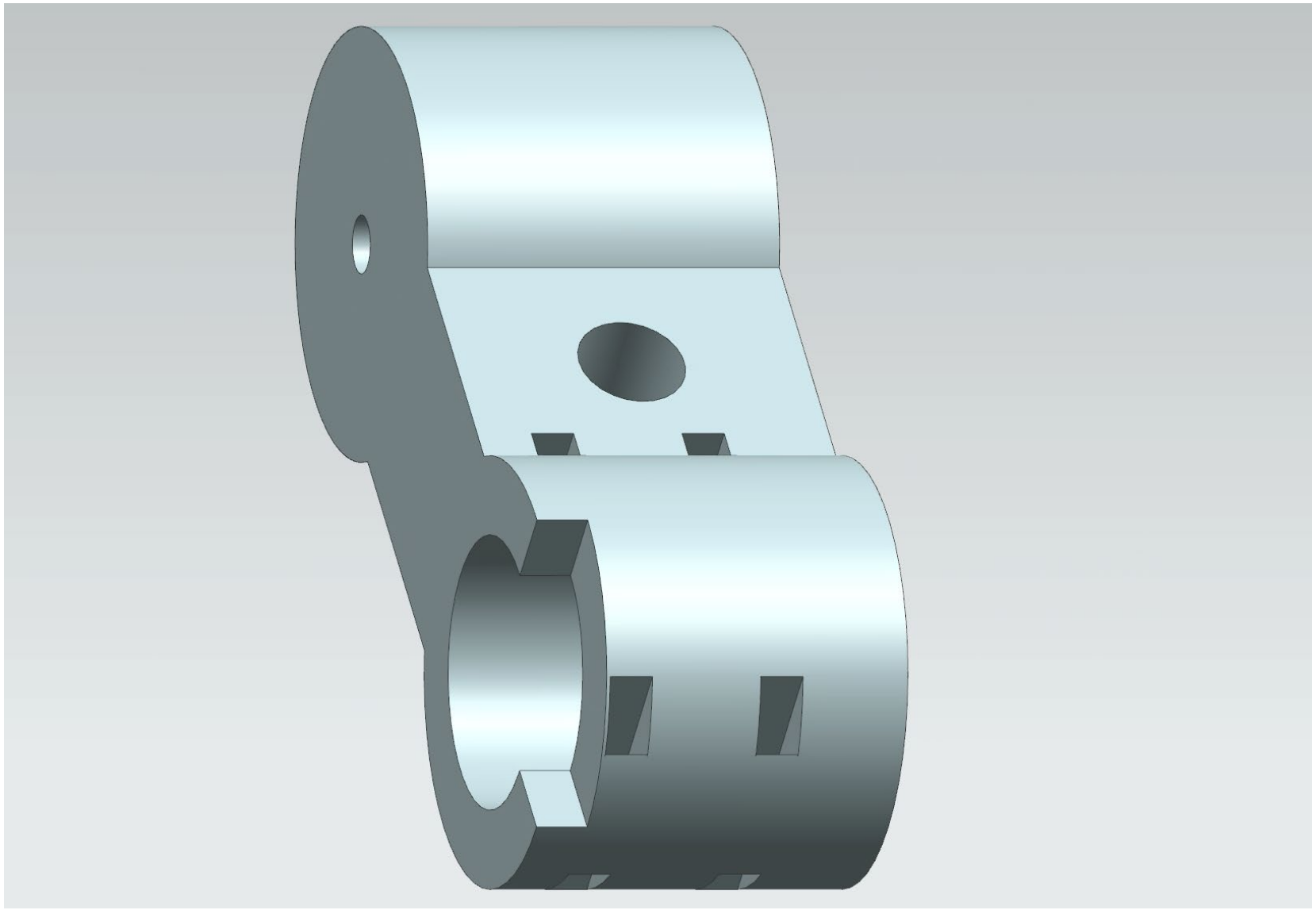
[Ryan]



- Mirrored for other side

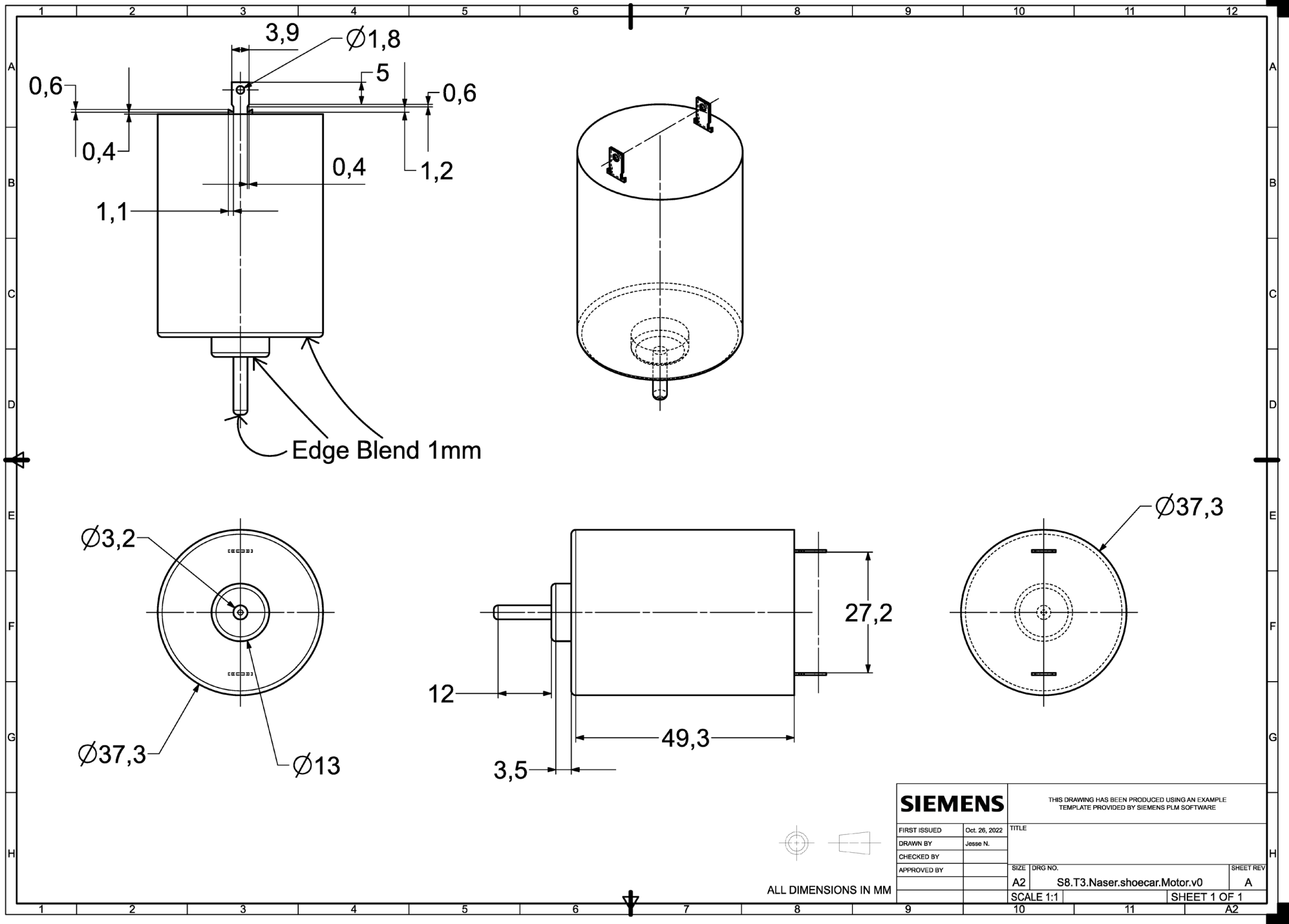
FoldMotionWiredRight: $13.43

[Ryan]



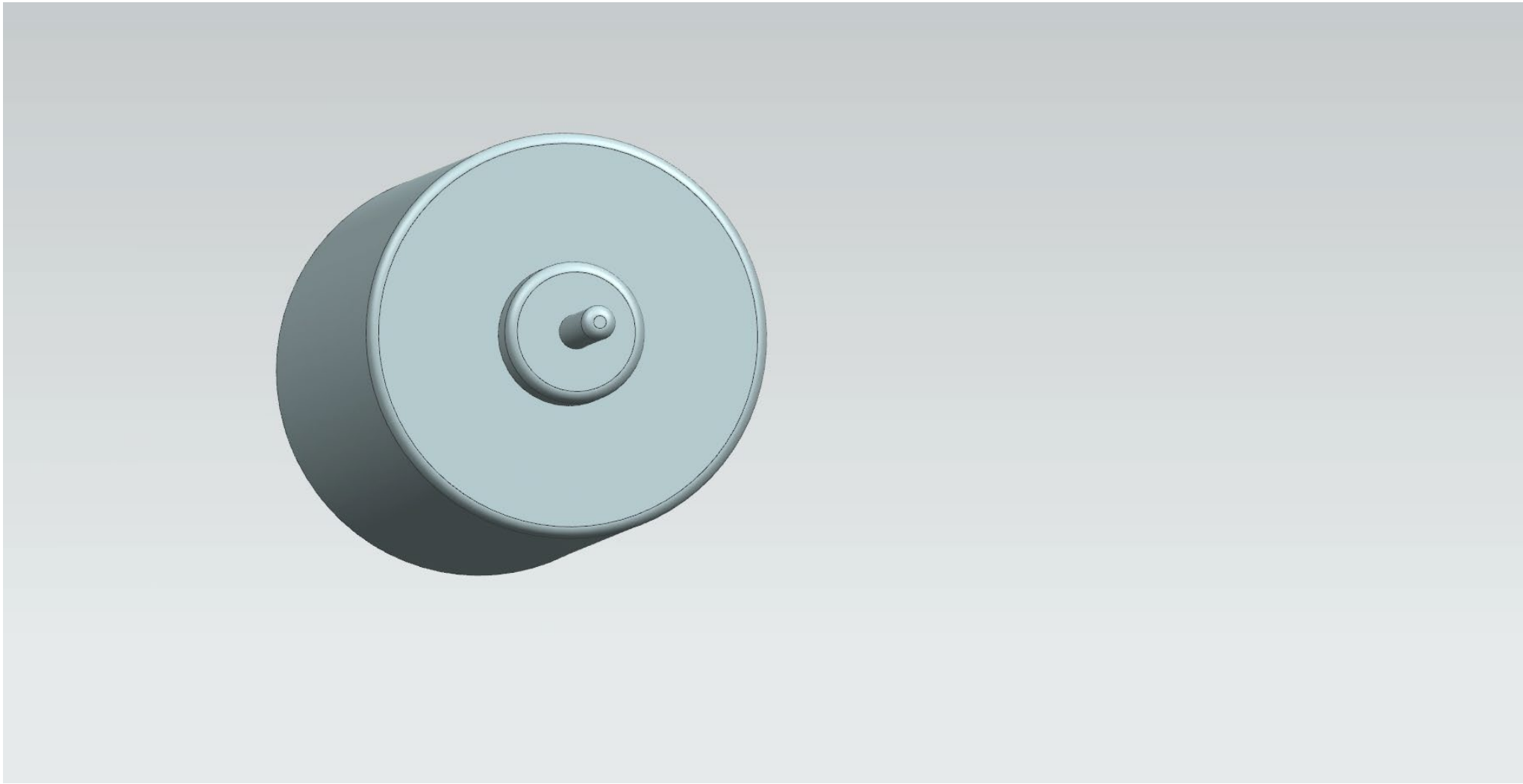
[Jesse]

- Placeholder for motor
- Use of edge blend for right fit
- FreeMotion parts may need extra holes for motor cooling
- Motor sticks out when fitted to accommodate wires + structural integrity in platform

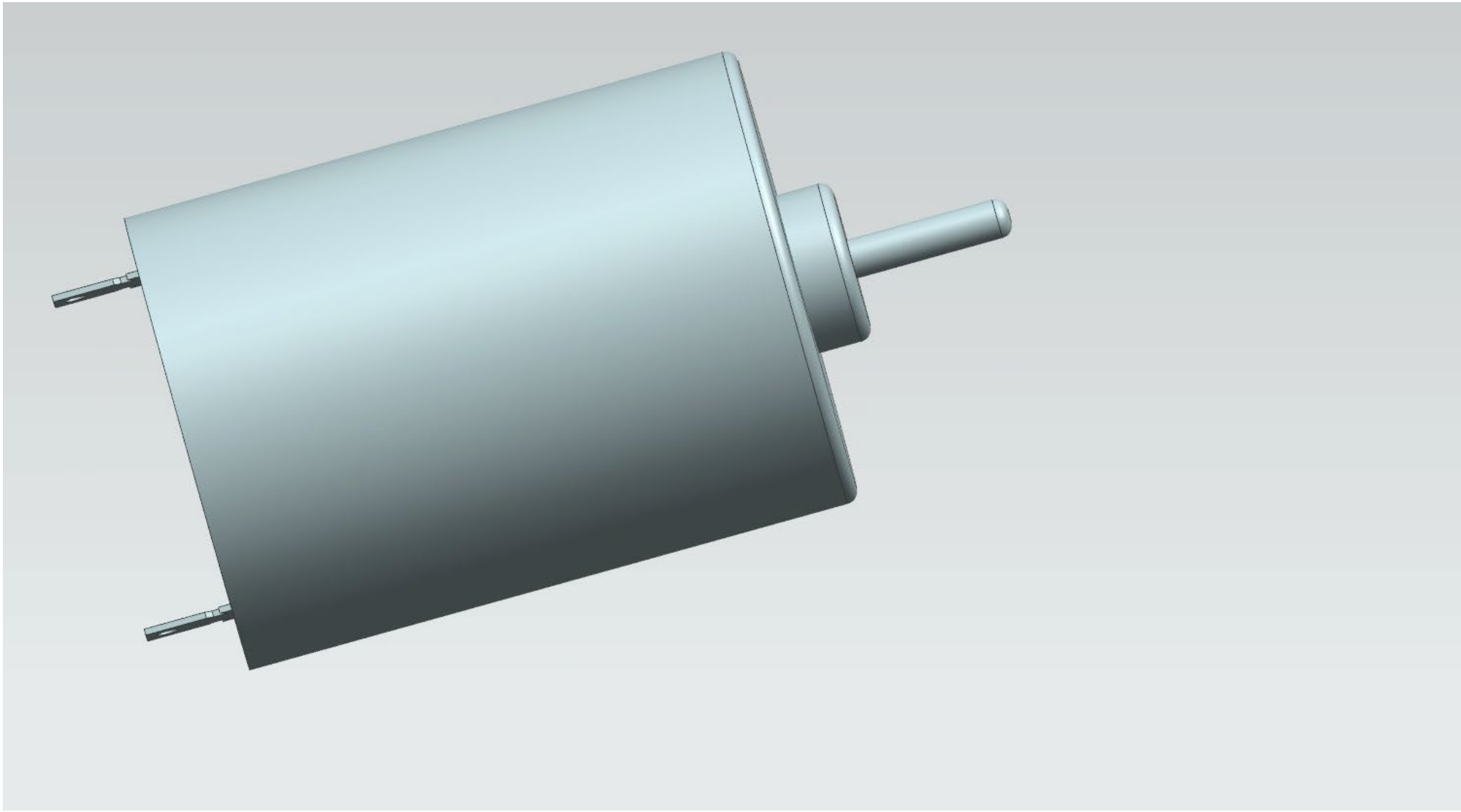


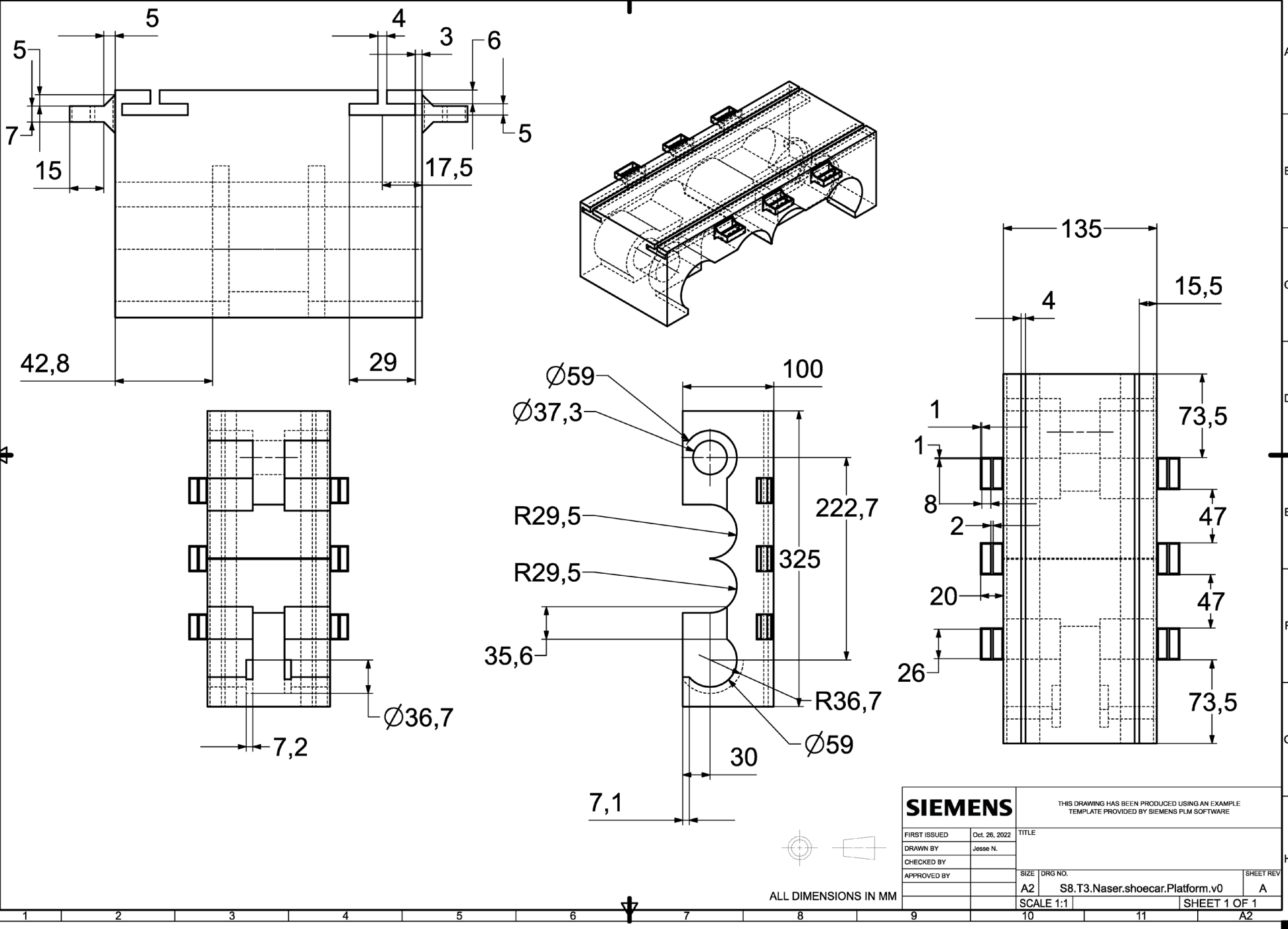
[Jesse]

Motor: $13.00



[Jesse]



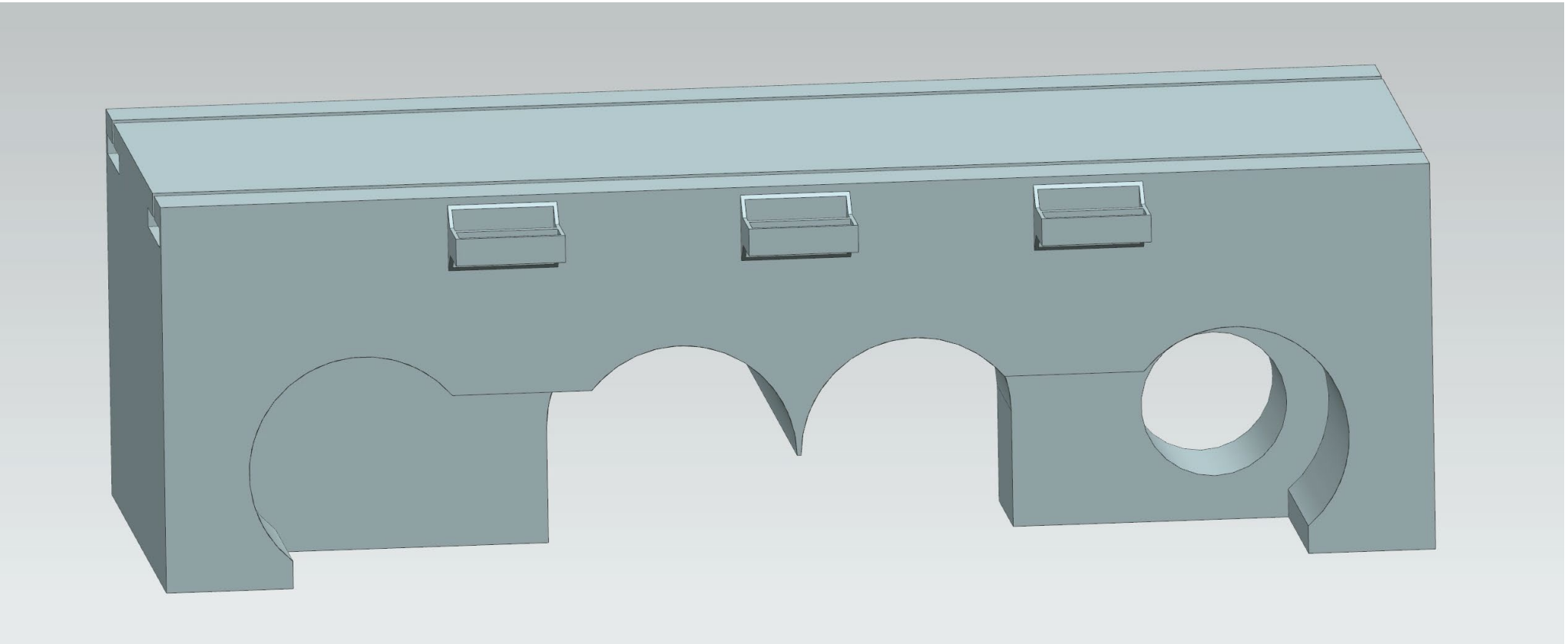


[Jesse]

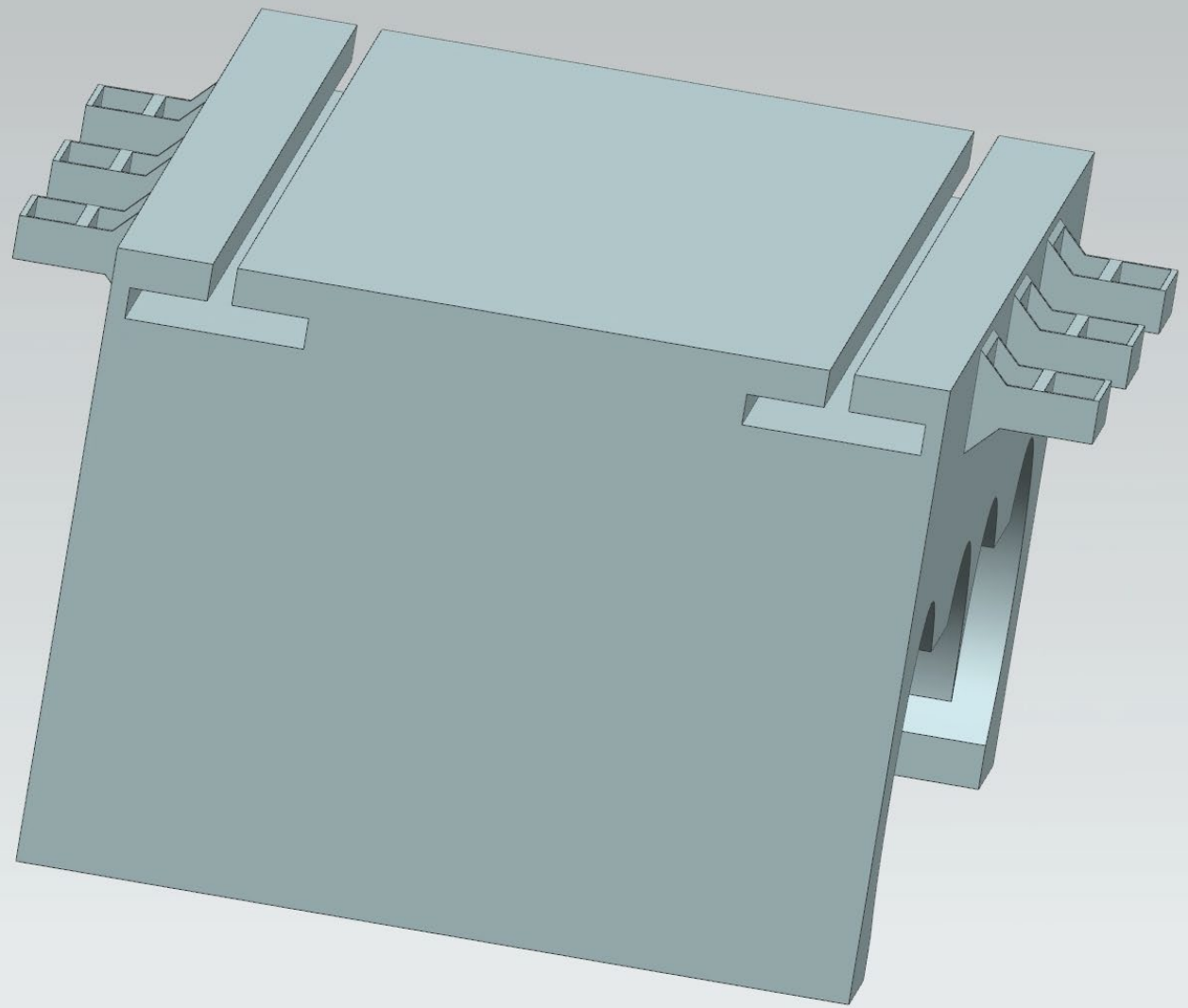
- Use of chamfer and pattern feature
- Track design makes front + back locks move exactly to how big foot is instead of hardcoded numbers
- Arduino, battery, motor will fit under the shoe placement cavity in next revision after prototyping breakout boards

Platform: $95.28

[Jesse]



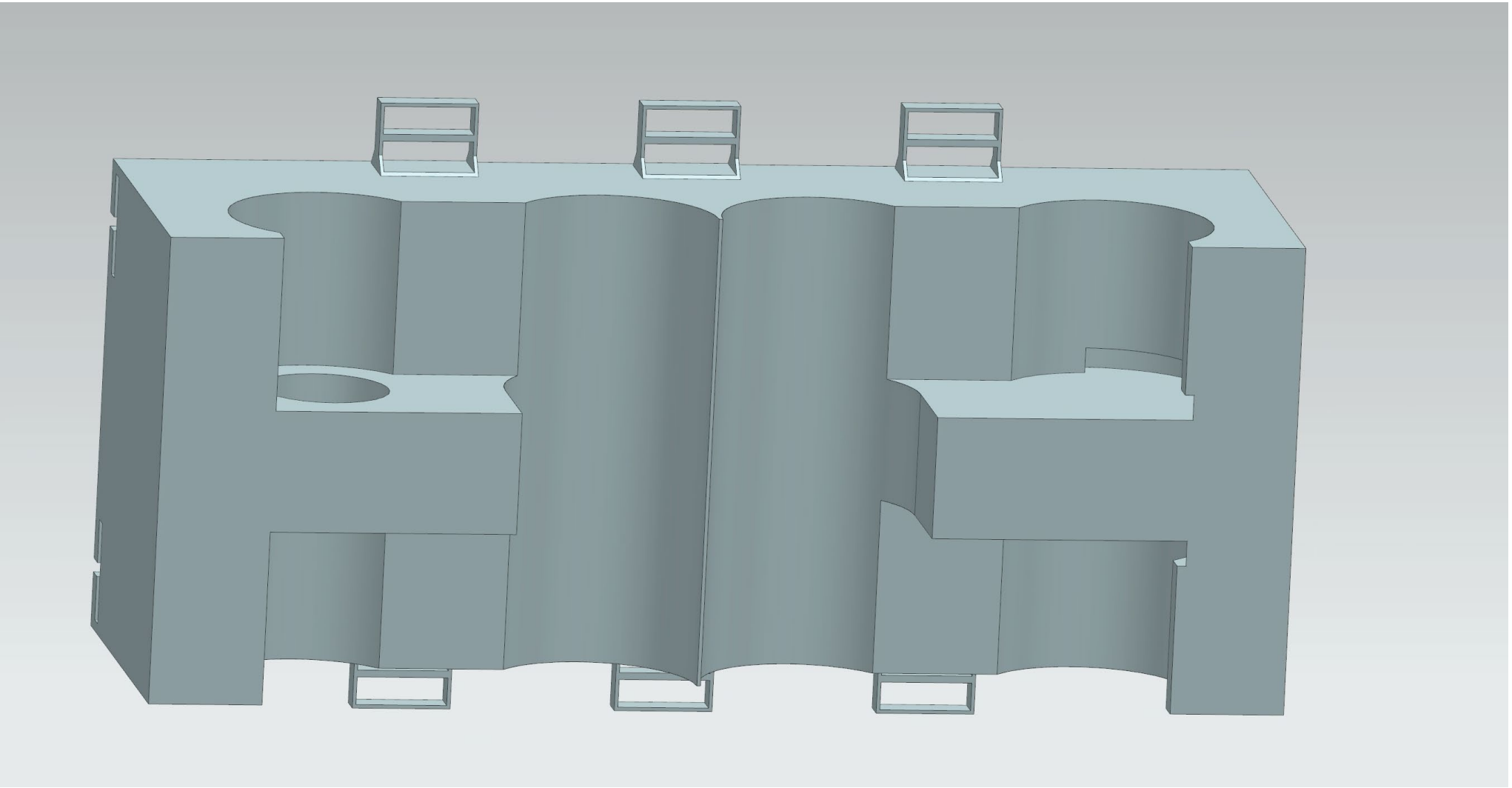
- Variable foot size up to 13 4E
- Fits to your foot by you using your shoe (do not fall off)
- Holes for rods for FreeMotion will exist in next revision after strength testing



[Jesse]

- Straps hold shoe in place for human and fits their foot well
- May be needed to be printed on bigger printer or on angle or use other material

[Jesse]



- Force is distributed on 4 rods for each of 4 wheels when skating
- Axel between two skating wheels distribute force
- Four points of force from FreeMotion fitting