The A-Team

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Executive Summary

Our team, the A-Team, found an optimal solution to the problem given to us in class. The problem was to create an aesthetically appealing car that was able to out-perform other designs in three unique events. These events included the sprint, the pull, and the oval. The sprint and the oval were time based events in which the lowest time to complete the event would win. The sprint consists of a 96" straight line and the oval event requires just one lap of the oval track. The pull event consists of mass "lifting" in which whoever pulls the greatest mass at least 6" won the event.

However some technical challenges were to be faced. The first one being the design of the car body. This involved creating an aesthetic design that could encompass any parts or materials "under the hood." The second challenge was the design of the assembly itself. This would include the design of motor control, steering, and compiling everything together onto the chassis plate. One of the major problems with this was fitting everything onto the chassis plate, while also fitting it under the car body.

To overcome these challenges, we designed a our car body after a McLaren F1, assuming there was no need to worry about space, however we soon found out that we needed all the space we could get after implementing a dual motor, rear-wheel drive control system. These two motors took up most of the room and from there, we just squeezed everything else in. This is an optimal solution because the design is unmatched and with twice as much power coming from the motors, we will be able to perform better in the three events.

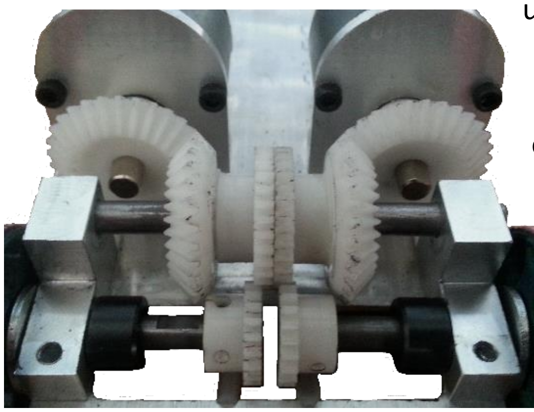
The total cost of creating this design is $183.23, which includes everything needed to make it. The most expensive part was the Arduino board costing $26.95, however because we used two motors, each costing $24.95, the most expensive part could be considered the motors.

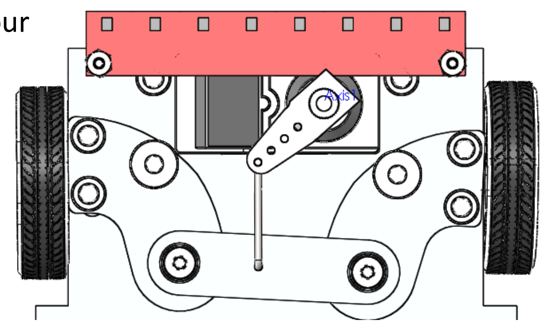
The environment was impacted in the creation of this design through carbon emissions, energy consumption, air acidification, and water eutrophication. In total 3.6 kg of CO_2 were emitted, 48.5 MJ of energy were consumed, 0.022 Kg of SO_2 were emitted and .0011 Kg of PO_4 were emitted. The component that affected the environmental impact the most was the chassis plate with 1.8 kg of CO_2 emitted, 22 MJ of energy consumed, 0.012 Kg of SO_2 emitted and .00041 Kg of PO_4 emitted.

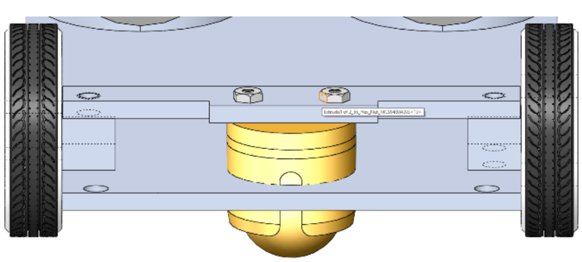
Everyone in the class was able to maneuver around each course, which cannot be said about all the classes. Our design did not outperform anyone else's designs, however we too were able to complete each and every challenge. Thus our design outperformed any design from any class who could not complete all 3 events. However, our design had the slowest sprint time, the slowest oval time and the least amount of weight lifted in our class. Despite this, our design was not far off from other competitor's times and it still won the design competition in the class.

Car Operation

Our design was made with the concept of appeal in mind, however adjustments were made to accommodate for the performance part. The first event, the sprint, we attempted to achieve a faster time with the installation of a dual motor system. The car body, however was made very small, and thus our design reflected the need to squeeze all the components in under the car body. The dual motors affect the sprint by adding more power to the system. They accomplish this by the wheels being each individually connected to a motor, rather than both motors being attached to the same axel. This system allows each wheel to have twice as much power as any other system without this design. In conjunction with this design, you can notice that we used a 2:1 gear ratio from the motor allowing for twice as much speed and half as much torque. We also tried to maximize our speed in the oval event. In combination with the dual motor system and gear system ratio, which not only helps the sprint event, but the oval event as well, we took out the turning system and attempted to control the steering with just the motors. First we attempted to design the front end with the original steering system, however we soon found out that it wouldn't steer sharp enough for the oval turns. Then we attempted a design similar to a shopping cart's front wheels or a zero-turn motor's front wheels, in which the wheels pivot from a fixed point, however the fixed point needed to be slightly off center and this idea soon came to a halt. The design we settled with was a castor ball underneath the front end that drags as the car moves. This allowed for the least amount of friction for a turning system that doesn't require the front wheels to turn. The pull event was maximized simply from the two motors pulling instead of one, giving our design twice as much power as any other design. Another configuration would have been added to switch the gear ratio from a 2:1 ratio



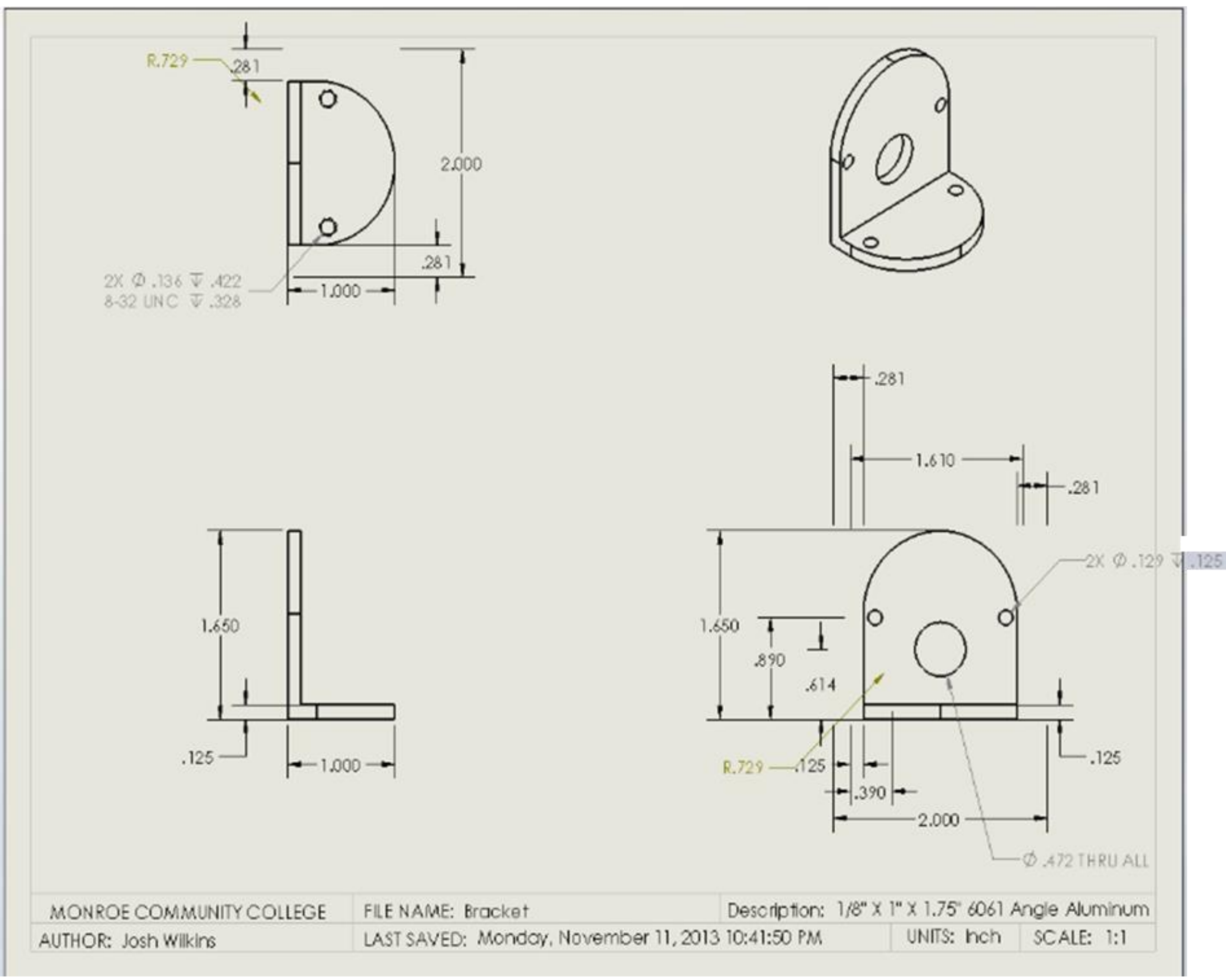




to 1:2 ratio to allow for an even better pulling system, however there wasn't enough room and not enough time to reconfigure the car between events. The aesthetic appeal of the car was maximized firstly with the design originating from a sports car. We then put the wheel mounts on top of the chassis plate to lower the car, giving the car more of a sports look. The wheels were also designed specifically to match the car body. Lights on the car were also added through the use of tiny Lego pieces to add to the appeal of the car.

Design and fabrication

Brackets:



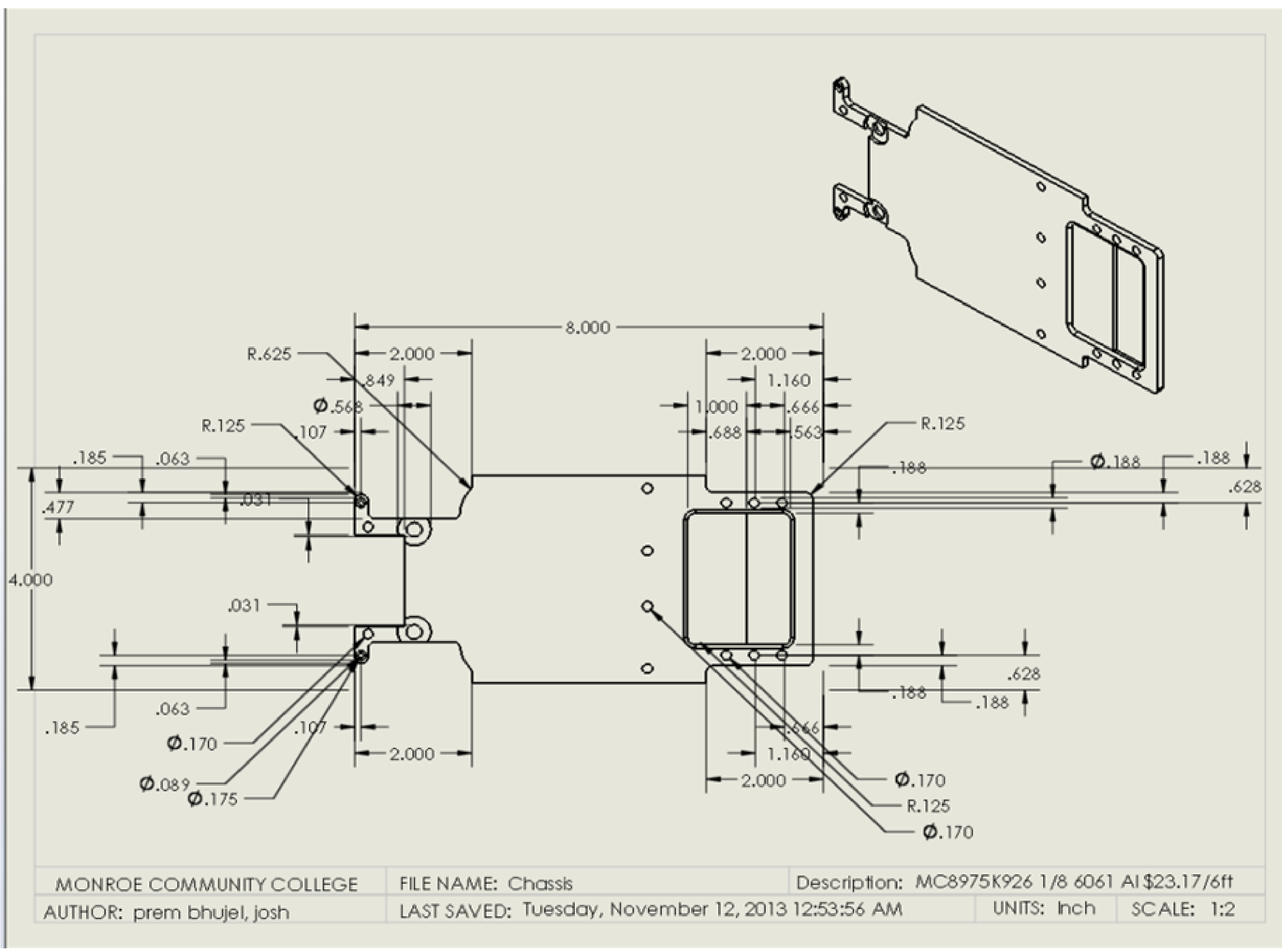
SolidWorks Outline

1. Sketch the profile of the bracket on the front plane and dimension it.
2. Click on feature/Extrude Base-Boss and mid-plane option. In thin feature option select one-direction and apply the thickness of 0.2”.
3. Make sketch on the right plane and make a rectangle on the both sides of the bracket, equal to the height of the bracket and make an extruded cut.
4. Fillet 0.7285” to all four corners.
5. Make tap holes for motor attachment and chassis attachment as shown in the figure

Fabrication Outline

1. Use CamWorks to make part perimeter of the right face with a 3/8” end mill
2. Use 3/8” end mill to cut out the 12mm hole on the right face
3. Use 1/8” end mill to cut out the two holes on the right face
4. Use CamWorks to make part perimeter of the top face with a 3/8” end mill
5. Use correct guidance hole for an 8-32 tapped hole, then tap the hole with an 8-32 tap.

<u>Chassis Plate:</u>



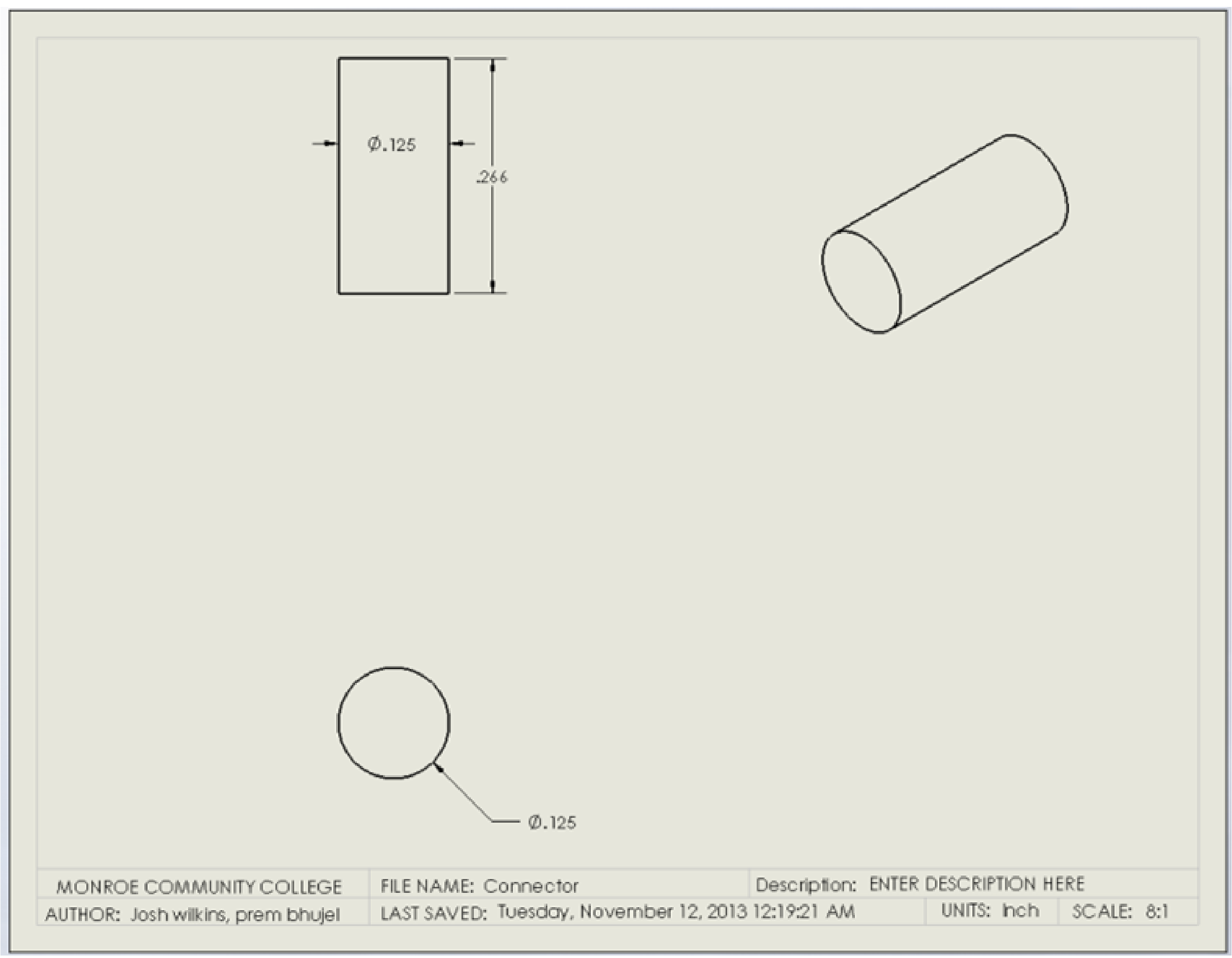
SolidWorks Outline

1. Make chassis plate outline on front plane
2. Adjust chassis plate to fit body by cutting miscellaneous parts from chassis plate
3. Add holes for bracket mounts, wheel mounts, and sensor mounts.
4. Cut out holes for caster ball and make room for gears.

Fabrication Outline

1. Use CamWorks to make part perimeter with a 3/8” end mill
2. Use 3/8” end mill to cut out the back hole of the chassis plate as well as the ball caster hole
3. Use 1/8” end mill to cut out the mount holes as well as the fillets of the well

<u>Connectors:</u>



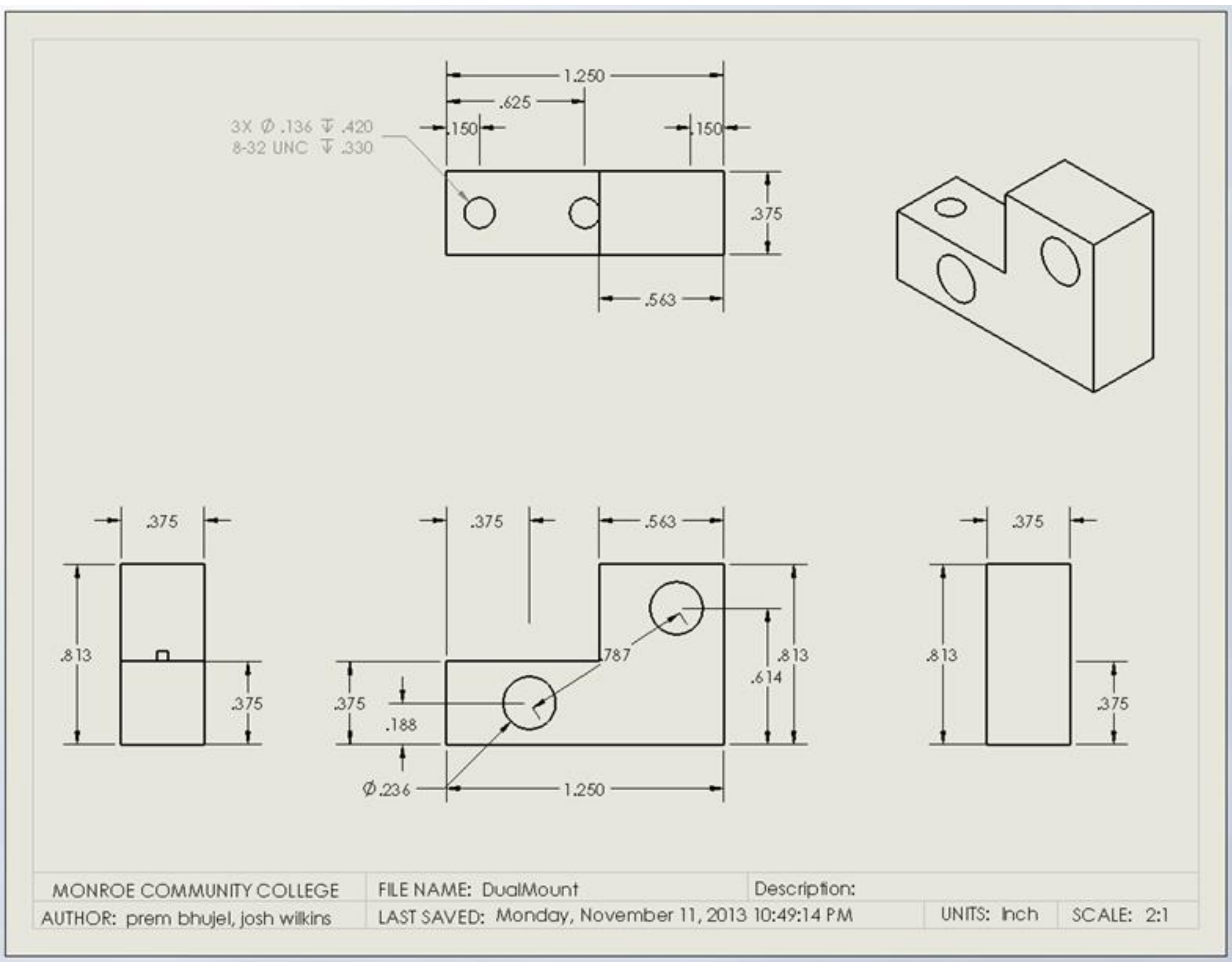
SolidWorks Outline

1. Make 0.125” circle on the front plane.
2. Extrude Base-Boss with a length of .266”.

Fabrication Outline

1. Use miscellaneous cylindrical scrap to make part

Rear Wheel Mounts:



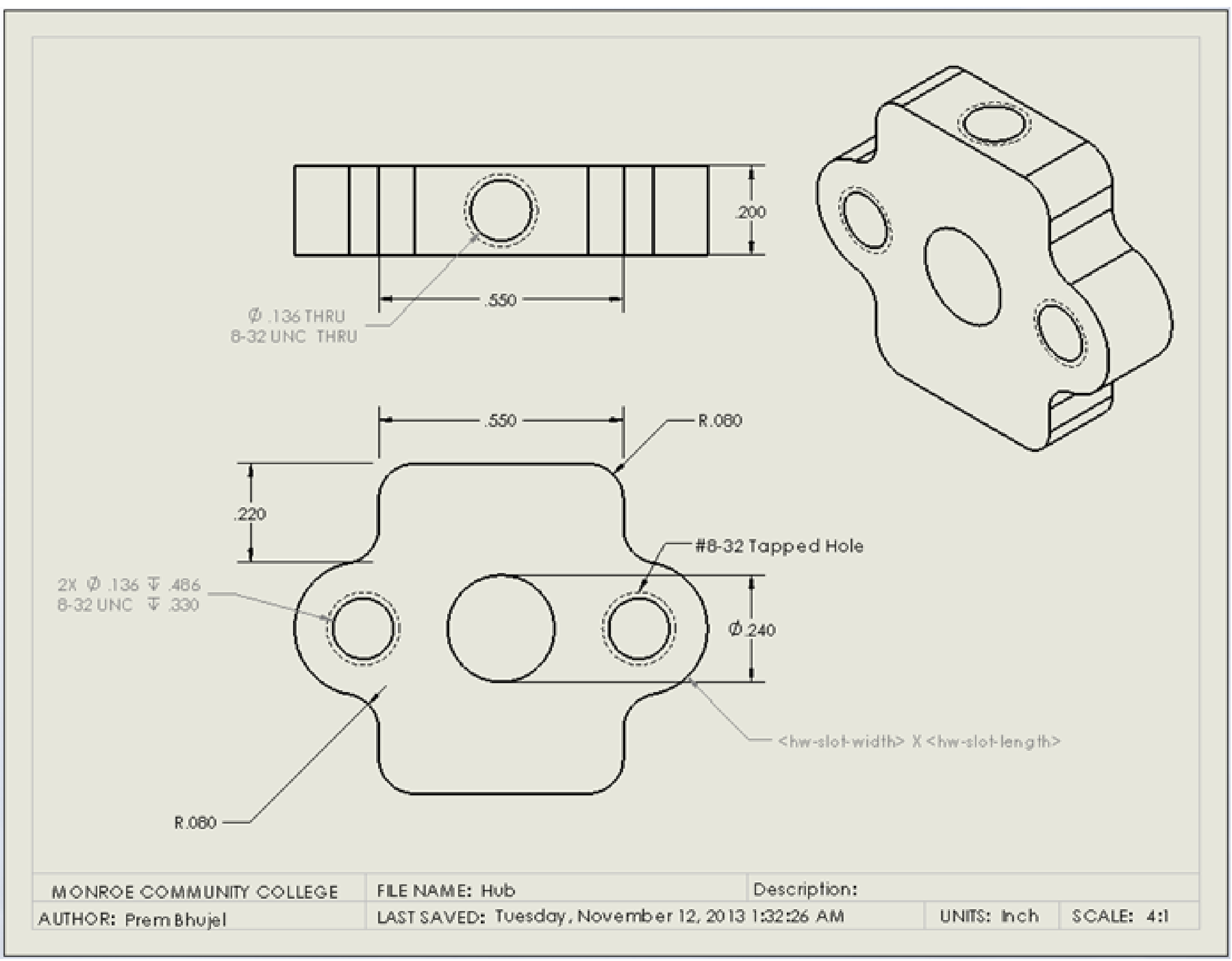
SolidWorks Outline

1. Make L-shaped sketch and Extruded boss to 0.375”.
2. Make three tap holes with the hole-wizard feature on the top plane
3. Create two dimensioned circles on the front plane it and extrude it with the through all end condition.

Fabrication Outline

1. Use 3/8” sheet metal and create a part perimeter with CamWorks using a 3/8” end mill
2. Use a ¼” end mill for the two holes on the front plane
3. Use the correct guidance hole for an 8-32 tapped hole for the holes on the top plane and then tap the holes with an 8-32 tap

Wheel Hubs:



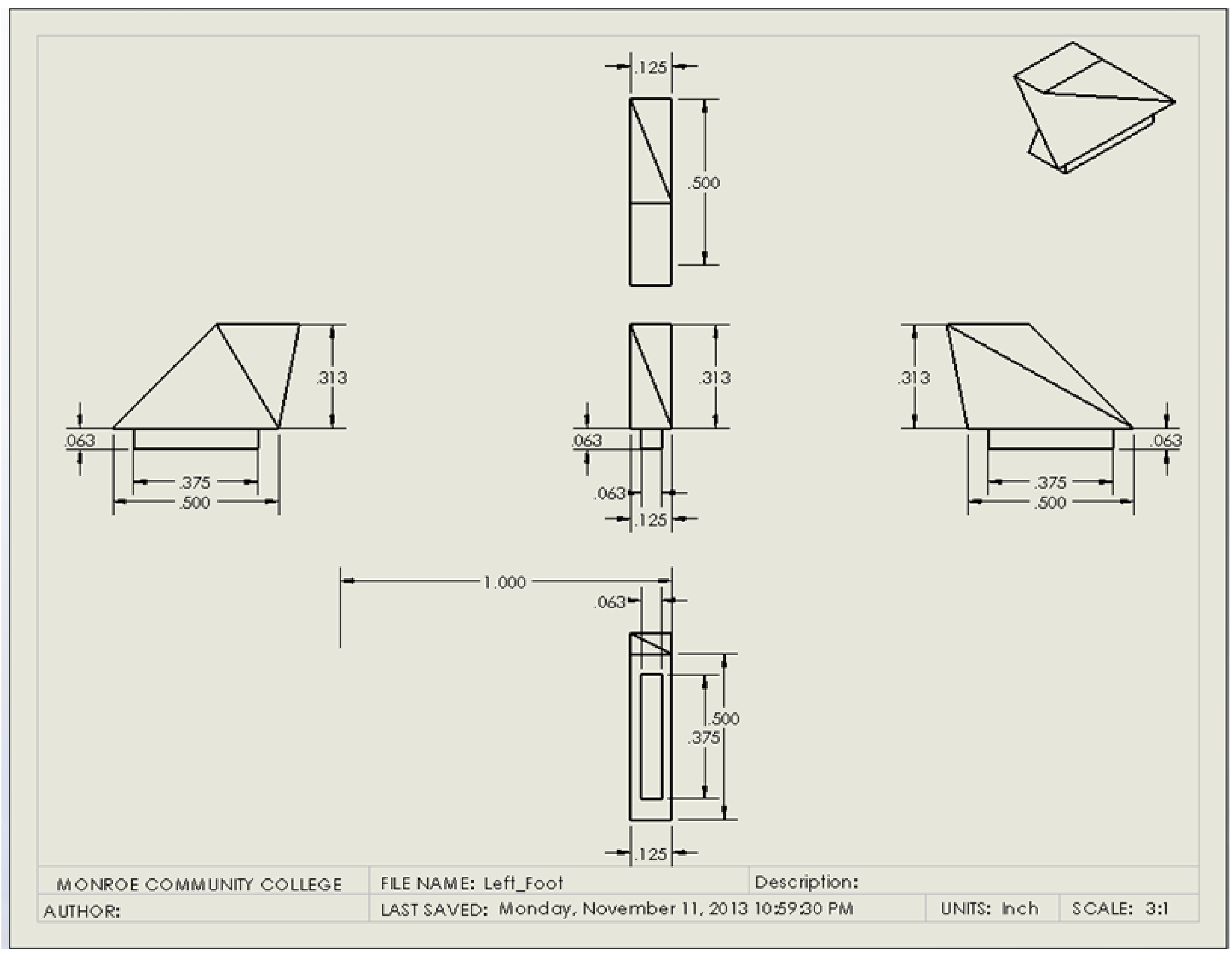
SolidWorks Outline

1. Make the outline of the shape. Fillet it 0.08” on all the corners of the sketch.
2. Extruded boss with a 0.20” width.
3. Make two 8-32 tapped holes on the front plane.
4. Make an extruded cut for the .240 axle hole
5. Use hole-wizard feature to make another 8-32 tapped hole on the top of the part.

Fabrication Outline

1. Use 3/8” sheet metal and create a part perimeter with CamWorks using a 3/8” end mill
2. Use a 3/8” end mill to machine the part down to the correct width
3. Use a ¼” end mill for the axle hole on the front plane
4. Use the correct guidance hole for 8-32 tapped holes for the two holes on the front plane and then tap the holes with an 8-32 tap
5. Repeat step 4 for the hole on the top of the part

<u>Left foot:</u>



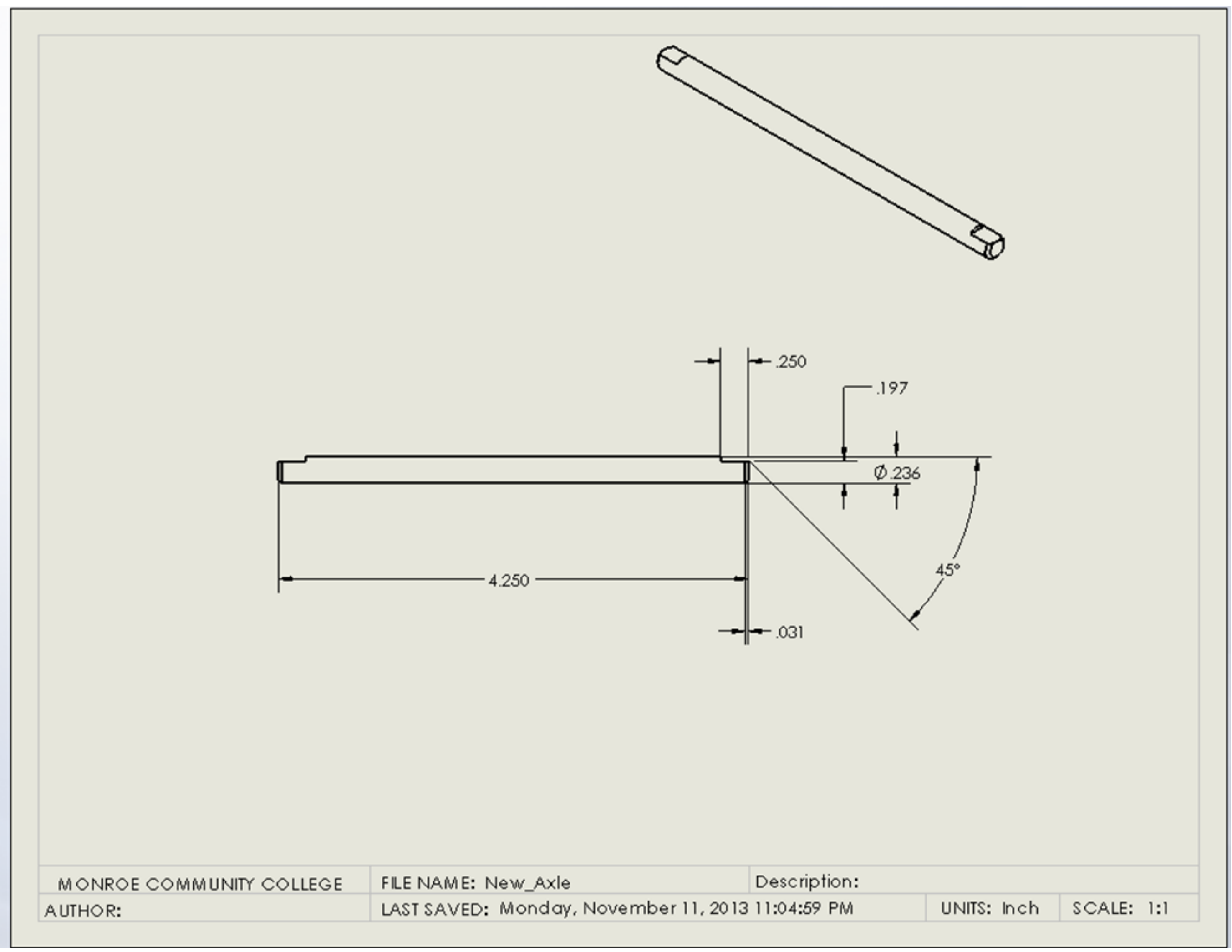
SolidWorks Outline

1. Make sketch on top plane with the rectangle.
2. Create plane and sketch parallel to top plane and create another rectangle on that plane
3. Use loft to connect the rectangles creating this part.
4. Create sketch on top plane. Use offset entities for sketch and extrude boss it 0.063".
5. For right foot, just change the loft points to change the direction of the pattern

Fabrication Outline

1. Convert SolidWorks part into the extension type .stl
2. Use program to orient and print part in ABS plastic with a 3D printer

<u>Axles:</u>



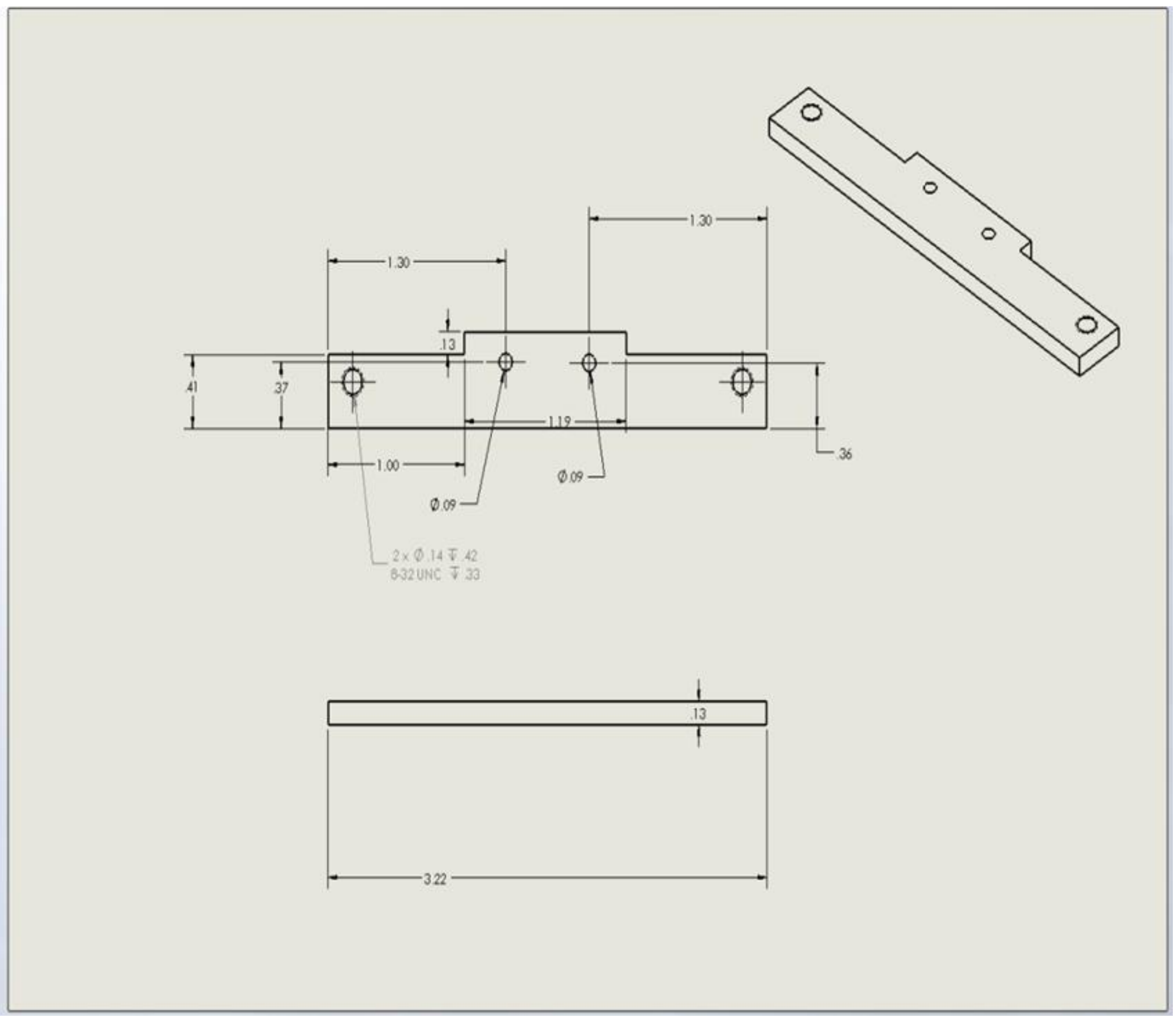
SolidWorks Outline

1. Make dimensioned circle on front plane and extruded boss it. Use mid plane for end condition and make it 4.254” long.
2. Add 45 degree chamfer to both ends to remove sharp edges.
3. Create flat surface on the end for the set screws of the wheel hub and gears.
4. Mirror the flat end across the center line to make another flat end at the other side

Fabrication Outline

1. Find an axle, use a hack saw to cut it to length
2. Use the hack saw to cut the flat parts on the ends as well

Bar (Caster Wheel Holder):



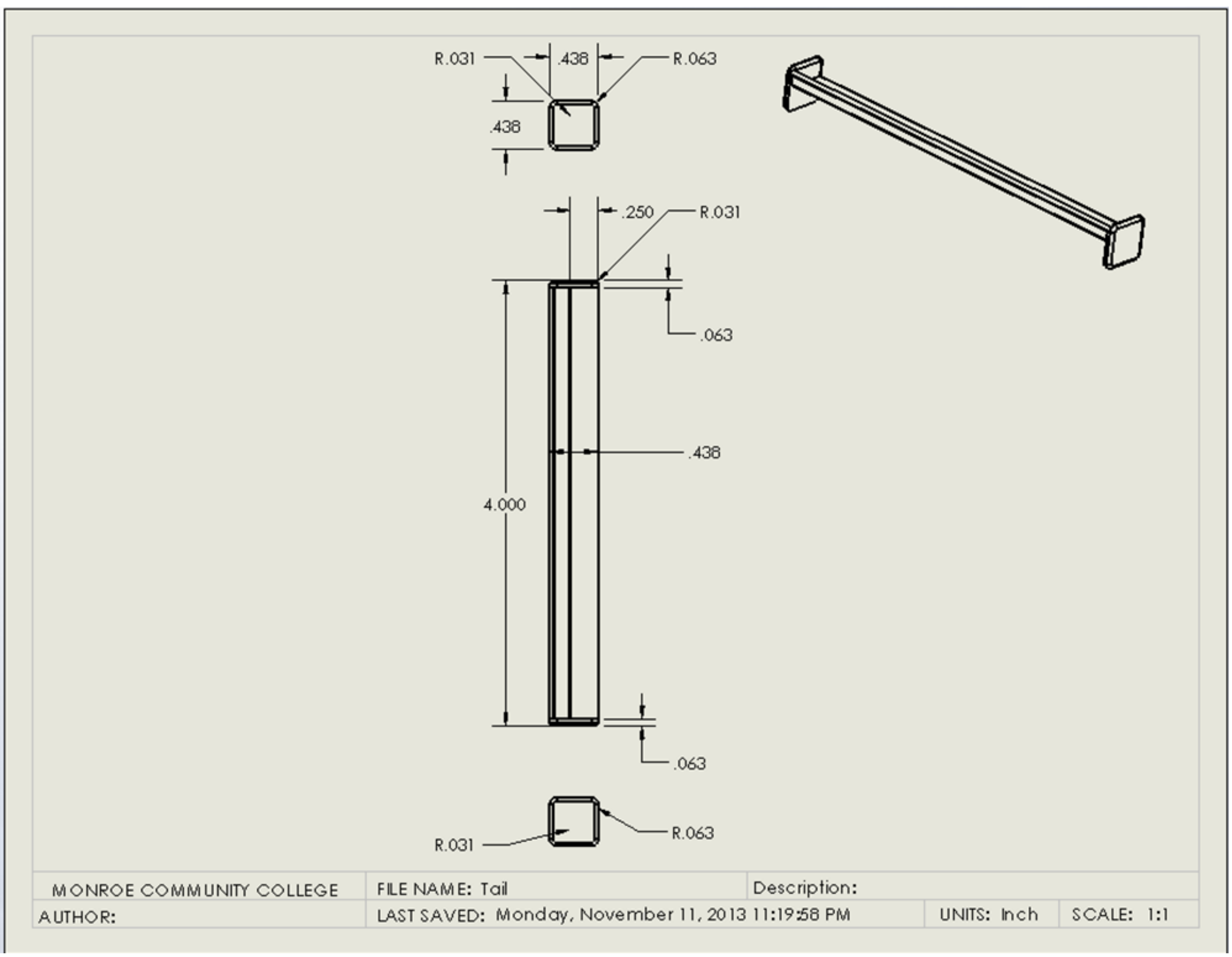
SolidWorks Outline

1. Make rectangle on the top plane and use extruded boss.
2. Use hole-wizard to make two 8-32 tapped holes on the top plane.
3. Cut out the upper corners of the part with two rectangles.
4. Create two holes with extruded cut for the screws of the caster wheel.

Fabrication Outline

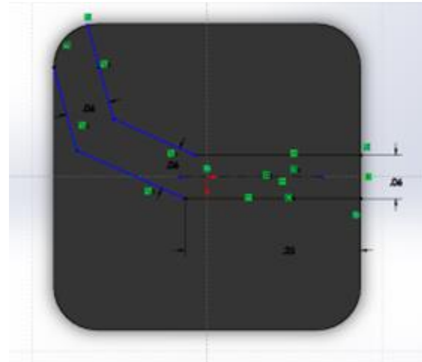
1. Take 1/8" sheet metal and use a part perimeter feature in CamWorks with a 1/8" end mill.
2. Use the correct guidance hole for the 8-32 tapped holes and then tap the holes with an 8-32 tap.
3. Use a 1/16" end mill to cut the last two holes out.

Tail:



SolidWorks Outline

1. Make rectangle on the top plane and extrude it.
2. Create plane above top plane and mirror the first extruded boss.
3. On the top plane create this sketch.
4. Extrude it up to the mirrored rectangle and then add a fillet.

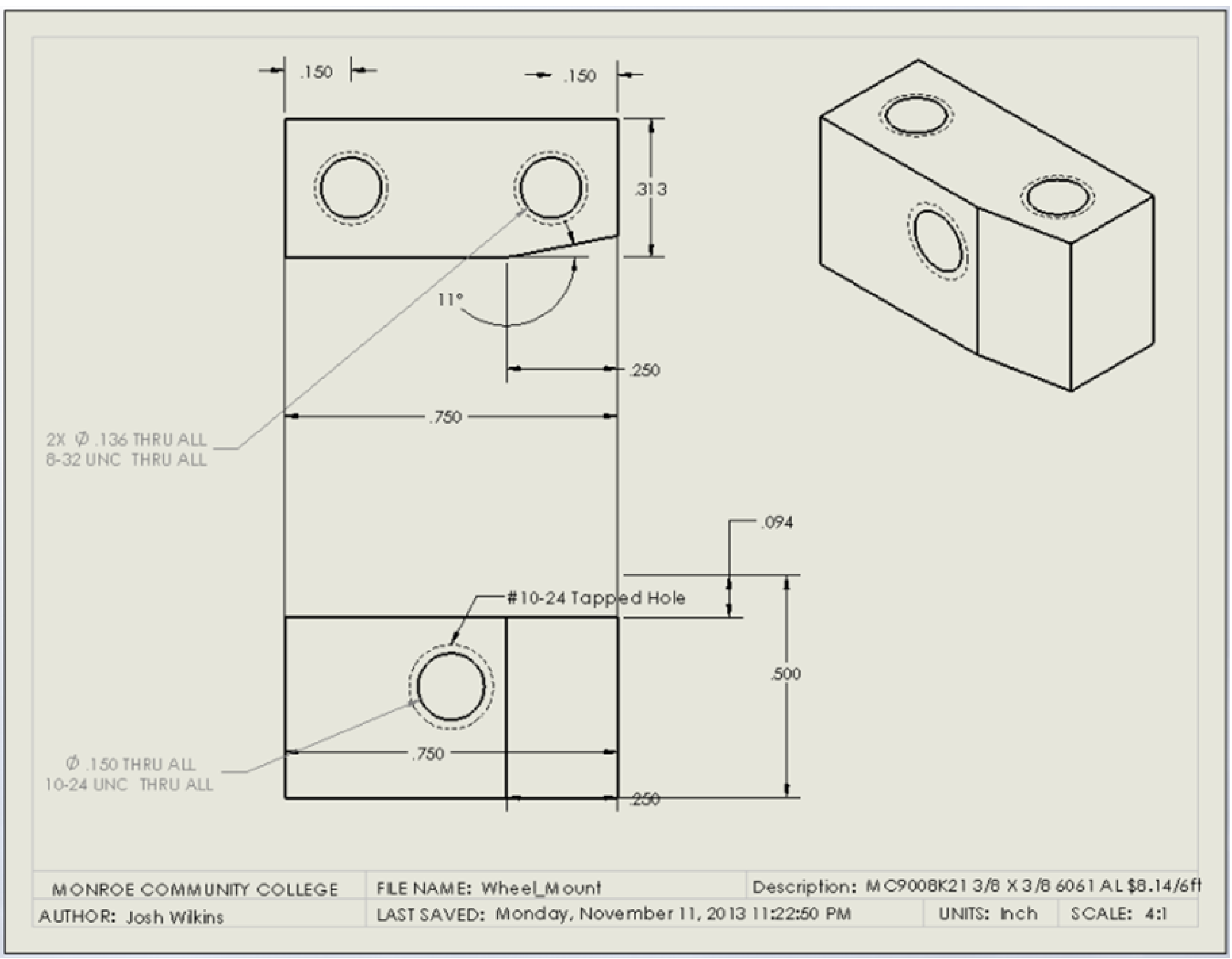


Note: all dimensions are shown in drawing.

Fabrication Outline

1. Convert SolidWorks part into the extension type .stl
2. Use program to orient and print part in ABS plastic with a 3D printer

<u>Wheel Mount:</u>



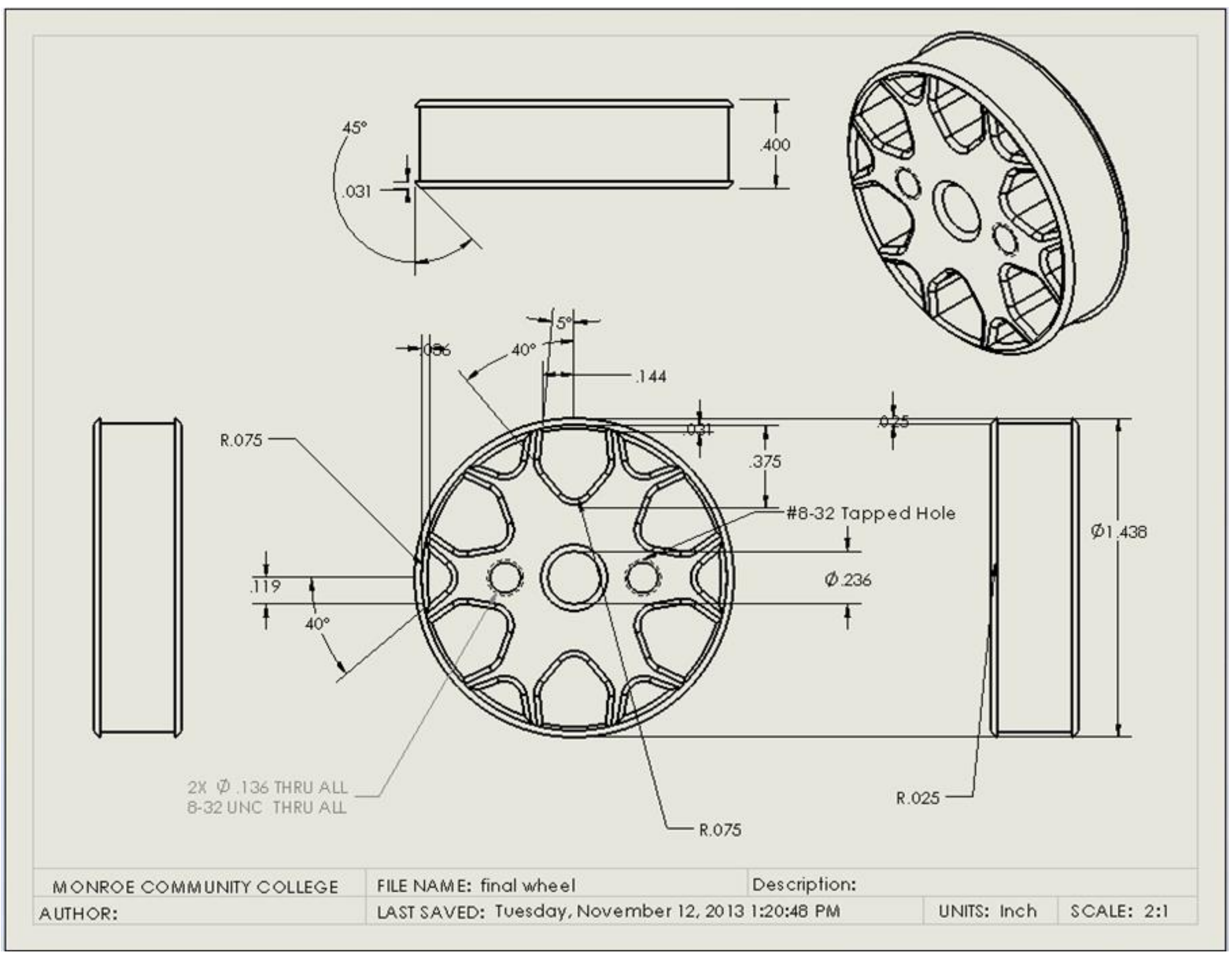
SolidWorks Outline

1. Create a rectangle on the top plane and extruded boss it with mid plane end condition.
2. Insert three 8-32 tapped holes with the hole-wizard (two steps because of the different planes).
3. And chamfer on one corner of mount with angle of 11 deg.

Fabrication Outline

1. Use part perimeter in CamWorks to get the chamfer.
2. Use the correct guidance holes for the 8-32 tapped holes and then tap the holes with an 8-32 tap.
3. Use the correct guidance hole for the 10-24 tapped holes and then tap the holes with an 10-24tap.

Wheels:



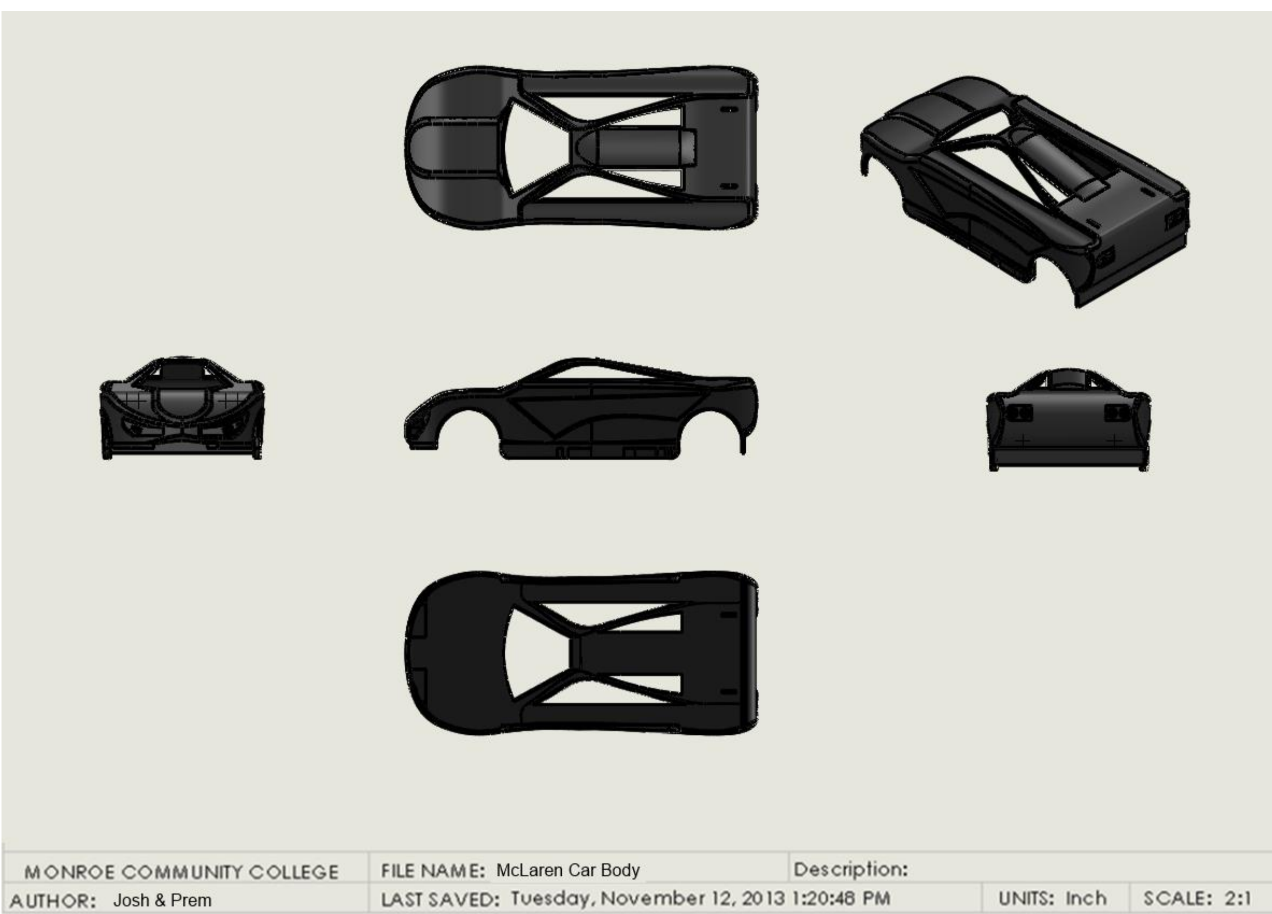
SolidWorks Outline

1. Make a circle on the front plane and extrude it.
2. Use hole-wizard to make 8-32 tapped holes on the front of the wheels.
3. Create two sketches, one for each of the design patterns on the wheel and add a fillet. Use extruded cut with the through all end condition.
4. Use the circular pattern feature on the two sketches with 6 of each going 360 degrees around the wheel.
5. Make another sketch on the front of the wheel and extrude cut the circle for the axle and add a chamfer to it
6. Make a rectangle on the right plane and use the revolve cut feature to make a groove around the wheel for the tread.

Fabrication Outline

1. Convert SolidWorks part into the extension type .stl
2. Use program to orient and print part in ABS plastic with a 3D printer
3. Tap the two tapped holes with an 8-32 tap.

<u>McLaren Car Body:</u>



SolidWorks Outline

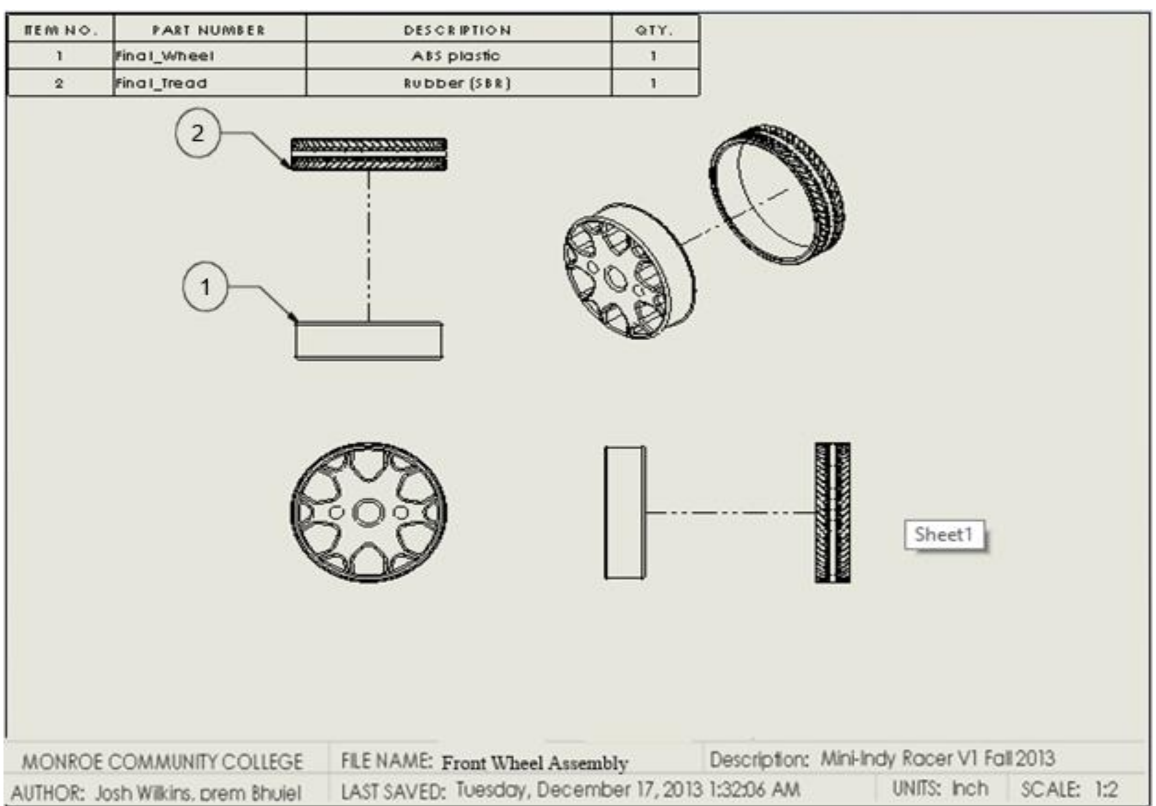
1. Take the front, top and right views of a Mclaren F1 car body and outline them in their perspective views, aligning the center of the wheels
2. Extrude up from the top view outline, up to the top of the right view outline, then cut extrude the front and right view outlines.
3. Shell and Fillet body for streamline and visual appeal
4. Add planes parallel to car body for extruded cuts for the car windows
5. Add more plans and Loft from one to the other to create the top arc
6. Add holes for “feet” to fit in as well as wells in the front and back with pegs for car lights
7. On the right plane, add sketch with offset entities to create front panel
8. Add more planes and loft out a side panel, then mirror it across to the other side
9. Add material to the bottom for a snap on design created by simply making groves into the inside of the car body
10. Add a small grove to the window holes for plastic inserts for the windows

Fabrication Outline

1. Convert SolidWorks part into the extension type .stl
2. Use program to orient and print part in ABS plastic with a 3D printer

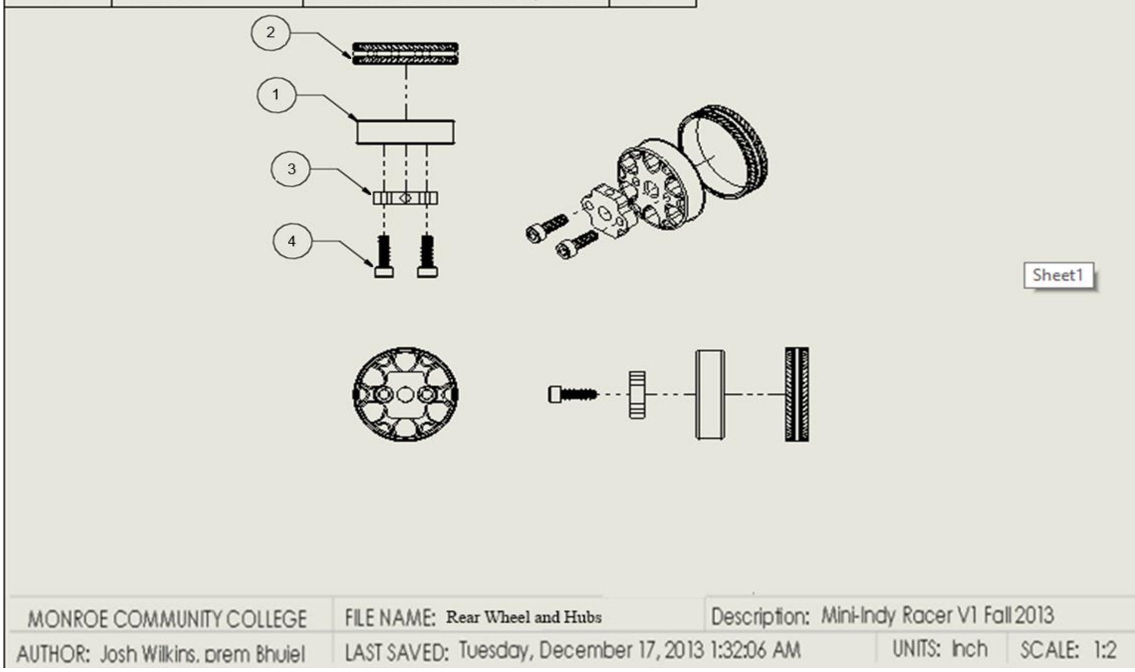
Assembly Drawings

Sub-Assemblies – Front Wheels

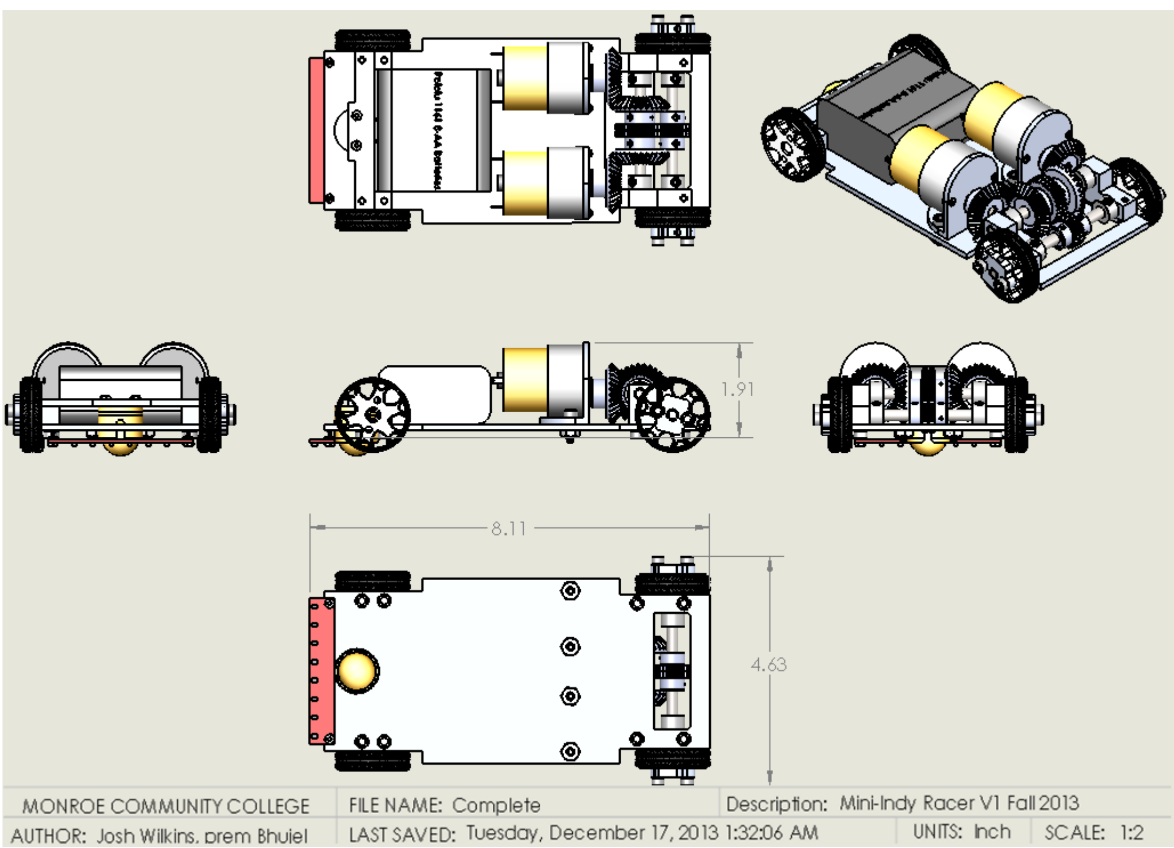


<u>Rear Wheels</u>

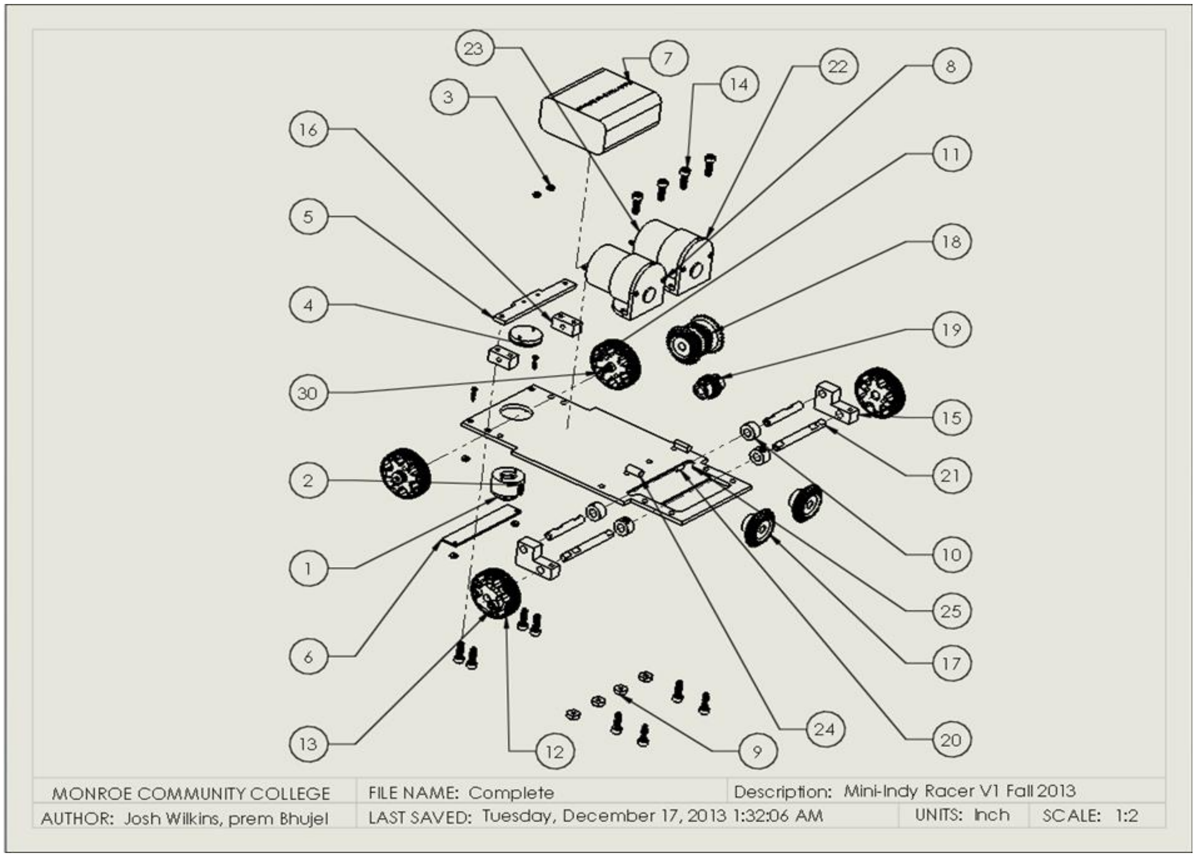
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Final_Wheel	ABS Plastic	1
2	Final_Tread	Rubber (SBR)	1
3	Hub	6061 Aluminum Alloy	1
4	91251A194	8-32 X 1/2 Socket Head Cap Screw	2



<u>Chassis Collapsed View</u>

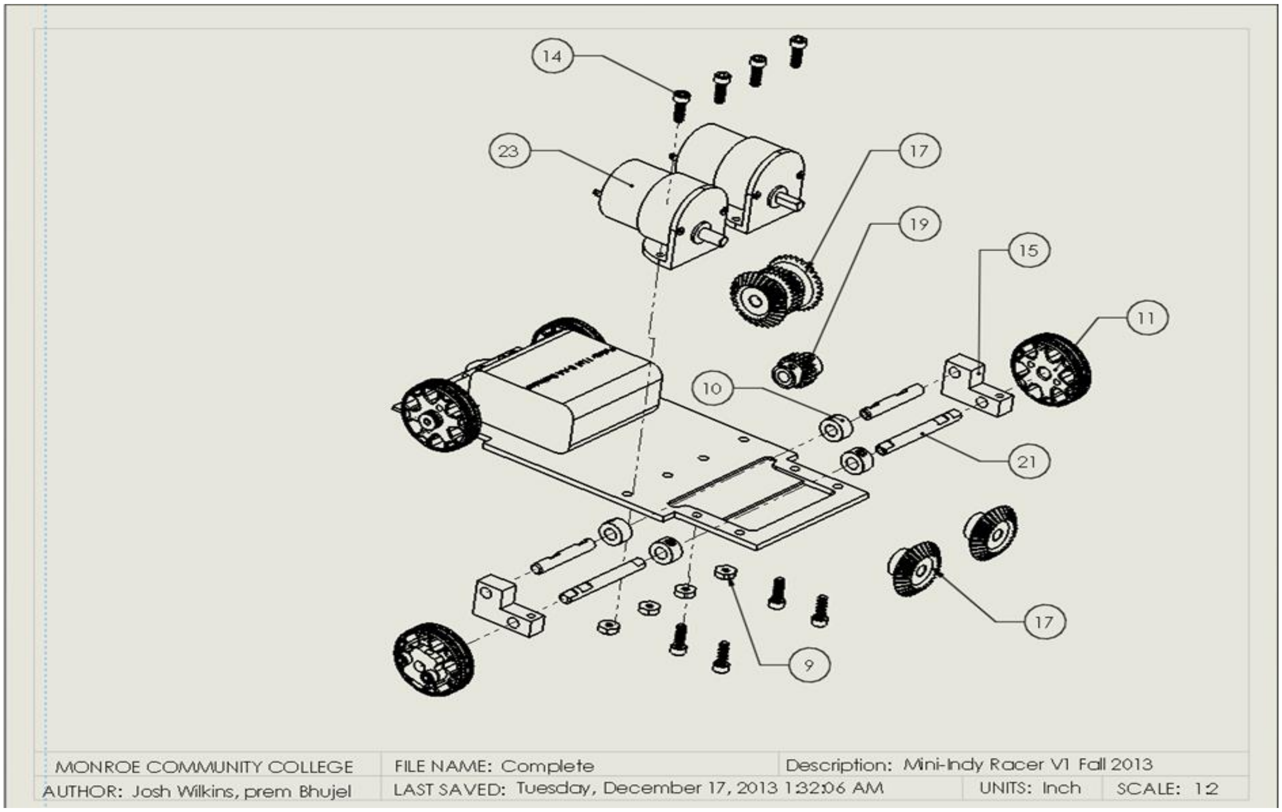


<u>Exploded view</u>



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Ball_Caster_Wheel	Ball_Caster_Wheel	1
2	90480A003	2-56 Machine Screw Hex Nut	6
3	Extenders	1/16" Ball Caster Wheel mount extension	1
4	Extenders	1/8" Ball Caster Wheel mount extension	1
5	Bar	6061 Al ball caster wheel mount	1
6	Pololu_QTR-8A_Sensor	Analog IR Line Sensor Array	1
7	8AA_Battery_Holder	Pololu 1161 8AA	1
8	90272A079	2-56 X 3/8 Pan Head Phillips Machine Screw	8
9	90480A009	8-32 Machine Screw Hex Nut	4
10	Shaft Collar	9414T6	4
11	Rear_Wheel_and_Hub	ABS Wheel, Rubber Tread, and 6061 Al Hub	2
12	DualMount	DualMount	2
13	91251A194	8-32 X 1/2 Socket Head Cap Screw	12
14	Front_Wheel	ABS Wheel and Rubber Tread	2
15	Wheel Mount	MC9008K21 3/8 X 3/8 6061 AL $8.14/6ft	2
16	30_Teeth_Miter_Gear	30_Teeth_Miter_Gear w/ attatchment	2
17	30_Teeth_Miter_Gear	30_Teeth_Miter_Gear w/o attatchment	2
18	30_Teeth_Spur_Gear	30_Teeth_Spur_Gear	2
19	20_Teeth_Spur_Gear	20_Teeth_Spur_Gear	2
20	Connector	1/8" diameter 6061 Al attachment	2
21	New_Axle - Wheels	Rear Axle for Wheel Support	2
22	New_Axle - Gears	Rear Axle for Gear Support	2
23	Bracket	1/8" X 1" X 1.75" 6061 Angle Aluminum	2
24	Jameco_161382_Motor	Jameco 161382 200RPM Motor	2
25	Motor_Shaft	6mm Shaft for Jameco 161382 Motor	2
26	Chassis	6061 1/8" Aluminum sheet metal	1
27	Car_Body	ABS platic printed McLaren F1	1
28	97345A537	Mc97345A537 1/4 Dia. X 1/2 Shoulder Screw	2

Rear Exploded View



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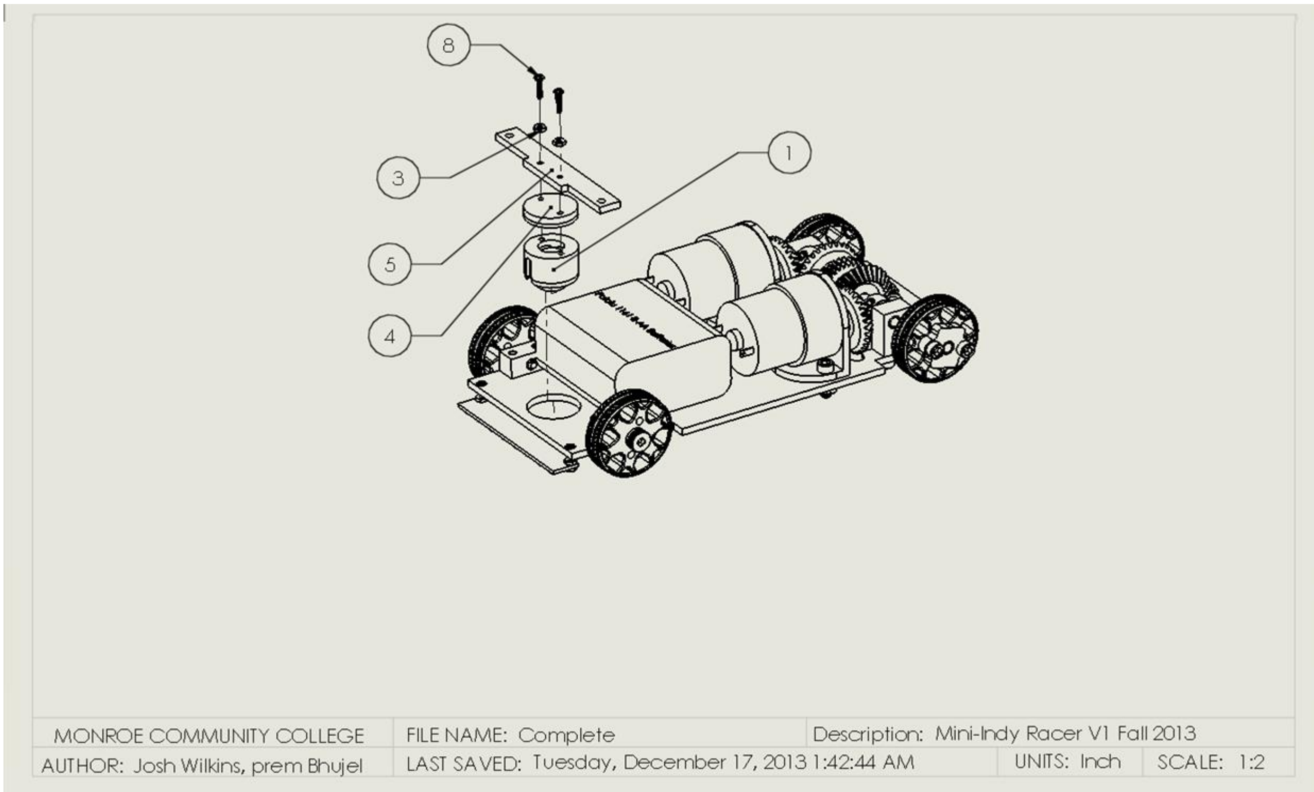
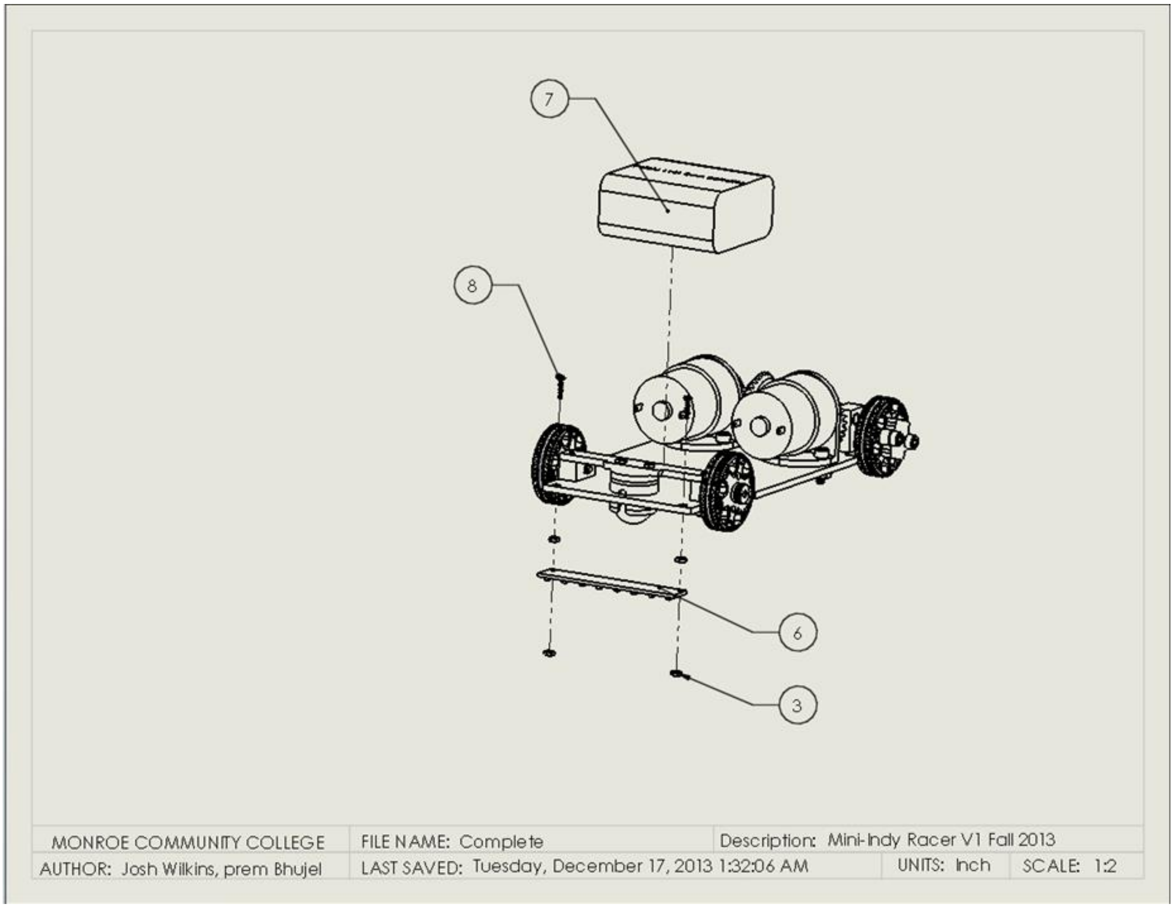
2	90480A003	2-56 Machine Screw Hex Nut	6
8	90272A079	2-56 X 3/8 Pan Head Phillips Machine Screw	8
9	90480A009	8-32 Machine Screw Hex Nut	4
10	Shaft Collar	9414T6	4
11	Rear_Wheel_and_Hub	ABS Wheel, Rubber Tread, and 6061 Al Hub	2
12	DualMount	Rear Axle Attachment Mounts	2
13	91251A194	8-32 X 1/2 Socket Head Cap Screw	12
15	Wheel Mount	MC9008K21 3/8 X 3/8 6061 AL $8.14/6ft	2
16	30_Teeth_Miter_Gear	30_Teeth_Miter_Gear w/ attatchment	2
17	30_Teeth_Miter_Gear	30_Teeth_Miter_Gear w/o attactchment	2
18	30_Teeth_Spur_Gear	30_Teeth_Spur_Gear	2
19	20_Teeth_Spur_Gear	20_Teeth_Spur_Gear	2
20	Connector	1/8" Diameter 6061 Al Attathcment	2
21	New_Axle - Wheels	Rear Axle for Wheel Support	2
22	New_Axle - Gears	Rear Axle for Gear Support	2
24	Jameco_161382_Motor	Jameco 161382 200RPM Motor	2
25	Motor_Shaft	6mm Shaft for Jameco 161382 Motor	2
28	97345A537	Mc97345A537 1/4 Dia. X 1/2 Shoulder Screw	2

Front Exploded View



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
5	Pololu_QTR-8A_Sensor	Analog IR Line Sensor Array	1
6	8AA_Battery_Holder	Pololu 1161 8AA	1
8	90480A009	8-32 Machine Screw Hex Nut	4
25	97345A537	Mc97345A537 1/4 Dia. X 1/2 Shoulder Screw	2

Sensor & Battery Exploded view



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Ball_Caster_Wheel	Ball_Caster_Wheel	1
3	Extenders	1/16" Ball Caster Wheel Mount Extension	2
4	Bar	6061 Al Ball Caster Wheel Mount	1
7	90272A079	2-56 X 3/8 Pan Head Phillips Machine Screw	8
2	90480A003	2-56 Machine Screw Hex Nut	2

Cost Analysis

Part	Description	Supplier	Unit price	Qty Used	Cost/Part
Ball Caster Wheel	Pololu Ball Caster with 3/8" Metal Ball	www.pololu.com	$1.99	1	$1.99
Chassis Plate	MC8975K926 1/8 6061 Al $23.17/6ft	www.amazon.com	$23.17/6ft	1	$23.17
Wheels	MC8572K29 2" Derlin Acetal	www.eplastics.com	$3.14	4	$12.56
Brackets	1/8" X 1" X 1.75" 6061 Angle Aluminum	www.aliexpress.com	$3.00	2	$6.00
Axles	MC 8920K22 6mm 1018 Steel $9.54/6ft	www.homedepot.com	$1.25	4	$5.00
Motors	Jameco 161382 200RPM Motor	www.jameca.com	$24.95	2	$49.90
2-56 Hex Nuts	2-56 screw hex nut	www.homedepot.com	$0.44	6	$2.64
Pololu-QTR_8A Sensor	Analog IR Line Sensor Array	www.pololu.com	$9.95	1	$9.95
2-56 Machine Screws	2-56 X 3/8 pan head machine screw	www.homedepot.com	$0.42	8	$3.36
Shaft Collars	6mm inside dimaeter Shaft Collar	www.amazon.com	$3.02	4	$12.08
Battery Pack	8-1.5V AA Bateries and Pack	www.amazon.com	$13.86	1	$13.86
8-32 Hex Nuts	8-32X1/2 socket head cap screw	www.homedepot.com	$0.52	12	$6.24
Miter Gears	30-Teeth-milter gear	www.ebay.com	$1.45	4	$5.80
Spur gears	20-teeth spur gear	www.ebay.com	$1.35	4	$5.40
Shoulder screws	¼ DaiX1/2 Shoulder screw	www.homedepot.com	$0.16	2	$0.32
Arduino Board	UNO R3 board with DIP ATmega328P	www.amazon.com	$26.95	1	$26.95
			Total Cost		$183.23

Sustainability Analysis of Fabricated Parts

Part Name	Qty	Material	Mass (Kg)	Carbon Emission (Kg CO_2)	Energy Used (MJ)	Air Acidification (Kg SO_2)	Water Eutrophication (Kg PO_4)
Bracket	2	Aluminum 6061 Alloy	1.60 E-02	0.225	2.80	1.5E-03	5.2E-05
Chasis	1	Aluminum 6061 Alloy	1.28 E-01	1.800	22.0	1.2E-02	4.1E-04
Connector	2	Aluminum 6061 Alloy	3.90 E-04	0.002	0.019	6.1E-06	1.1E-06
DualMount	2	Aluminum 6061 Alloy	1.00 E-02	0.134	1.70	9.1E-04	3.1E-05
Final Wheel	4	ABS Plastic	6.00 E-03	0.035	0.657	1.4E-04	1.6E-05
Hub	2	Aluminum 6061 Alloy	3.00 E-03	0.050	0.618	3.4E-04	1.2E-05
Foot - Left	1	ABS Plastic	1.88 E-04	0.0010	0.020	3.2E-06	5.0E-07
Foot - Right	1	ABS Plastic	1.88 E-04	0.0010	0.020	3.2E-06	5.0E-07
Mclaren Body	1	ABS Plastic	7.90 E-02	0.472	8.9	1.9E-03	2.2E-04
Axle - Rear	2	Cast Alloy Steel	1.10 E-02	0.040	0.50	1.6E-04	2.9E-05
Axle - Gears	2	Cast Alloy Steel	8.00 E-03	0.029	0.361	1.2E-04	2.1E-05
Tail	1	ABS Plastic	2.00 E-03	0.015	0.281	5.9E-05	7.0E-06
Turning Bar	1	Aluminum 6061 Alloy	8.00 E-03	0.109	1.300	7.4E-04	2.5E-05
Wheel Mount	2	Aluminum 6061 Alloy	4.00 E-03	0.054	0.667	3.7E-04	1.3E-05
Fabricated Parts	24	Total Mass/Consumption	0.35	3.60	48.5	2.21E-02	1.05E-03

Competition Description

The objectives of this competition were to create the most aesthetically pleasing car body wheels and accessories that could out-perform competitors in a series of events. These events include the sprint, the pull, and the oval. The sprint and the oval are time based events in which the lowest time to complete the event would win. The sprint consists of a 96" straight line and the oval event requires just one lap of the oval track. The pull event consists of mass "lifting" in which whoever pulls the greatest mass at least 6" wins the event.

The creation of the robot had some restrictions; Only one 9V battery and 8AA batteries are allowed, only two Jameco motors are allowed, all parts must be fabricated at MCC, and you must use the original 4" X 8" X 1/8"chasis plate, but it could be modified in any way. Navigation and circuitry is to be provided by instructors and fasteners will be sold by the ELC, however some hardware will be loaned, not sold. The robot may have multiple configurations, but you must be able to switch between them within 5 minutes.

During the final lecture class of the semester, the qualifying competition will be held. The top two cars in the Triathlon and Body building events will be chosen to compete in the World Championship held on Dec 13 at noon and given a free engineering department shirt they must wear at the competition. A given car can qualify for both the Triathlon and body building events.

Body building winners are chosen by faculty members by the aesthetic appeal of the body, wheels and accessories. These winners will have their names engraved on the ENR153 body building cup. The winner of the triathlon will be the team that scores the most points in the three events and the number of trials held will be based on allotted time. These winners will have their names engraved on the ENR153 design competition cup. The sprint score is 100*(fastest time/your time), the oval score is 100*(fastest time/your time), and the pull score is 100*(mass lifted by your car/greatest mass lifted). In the oval event, the black line must be between the fronts wheels at all times and if either wheel touches the black line or the car fails to complete the event, a score of 0 is given. For the pull event, the starting mass and subsequent mass increments will be determined by the faculty and the car must lift the mass at least 6" to be considered a successful lift.

Competition Results

2013 ENR153 Class Triathlon Championship

Team Name	Sprint Time (sec)	Sprint Score	Oval Time (sec)	Oval Score	Mass Lifted (g)	Lift Score	Overall Score	Rank
Roache & Lilly	4.68	55.98	13.41	100.00	1900	100.00	255.98	1
Bartels & Casado	2.62	100.00	19.05	70.39	1000	52.63	223.03	2
Dray & D'Amico	5.02	52.19	16.77	79.96	600	31.58	163.73	3
Singh & Trahern	5.73	45.72	18.4	72.88	800	42.11	160.71	4
Delavale & Jepsen	5.84	44.86	22.15	60.54	600	31.58	136.98	5
Vandermallie & Bergado	6.81	38.47	22.12	60.62	500	26.32	125.41	6
Wilkins & Bhujel	6.99	37.48	29.55	45.38	400	21.05	103.92	7

2013 ENR153 World Triathlon Championship

Team Name	Lecture Time	Sprint Time (sec)	Sprint Score	Oval Time (sec)	Oval Score	Mass Lifted (g)	Lift Score	Overall Score	Rank
Roache & Lilly	TR 12:30pm	3.88	55.93	14.72	100.00	2000	100.00	255.93	1
Lane & Nobles	MW 3pm	3.36	64.58	10.97	134.18	600	30.00	228.77	2
Wabnitz & Frank	TR 8am	3.08	70.45	18.48	79.65	1000	50.00	200.11	3
Armes & Barniak	TR 9:30am	3.23	67.18		0.00	1400	70.00	137.18	4
Hayes & Hannah	TR 3:30pm	2.17	100.00		0.00	500	25.00	125.00	5
Jee & Lovette	R 5:30pm	2.26	96.02		0.00	500	25.00	121.02	6
Montana & Reed	TR 8am	3.03	71.62		0.00	800	40.00	111.62	7
Mitrovits, Guarang, & Smith	TR 9:30am		0.00	15.62	94.24		0.00	94.24	8
Salisbury & Dodson	MW 3pm	7.15	30.35		0.00		0.00	30.35	9
Wilkins & Bhujel	TR 12:30pm		0.00		0.00		0.00	0.00	10
Kinsman & Geiger	TR 11am		0.00		0.00		0.00	0.00	10
Ward & Eberhart	TR 11am		0.00		0.00		0.00	0.00	10
Glantz & Sirianni	TR 3:30pm		0.00		0.00		0.00	0.00	10

2013 ENR153 Body Building Class Championship

Team Name	Score	Rank
Wilkins & Bhujel	5	1
Singh & Trahern	4	2
Dray & D'Amico	3	3
Bartels & Casado	0	4
Roache & Lilly	0	4
Delavale & Jepsen	0	4
Vandermallie & Bergado	0	4

2013 ENR153 Body Building World Championship

Team Name	Lecture Time	1st Place	2nd Place	3rd Place	Score	Rank
Roache & Lilly	TR 12:30pm	3		1	10	1
Wilkins & Bhujel	TR 12:30pm	1	2		7	2
Mitrovits, Guarang, & Smith	TR 9:30am		2	1	5	3
Wabnitz & Frank	TR 8am	1		1	4	4
Salisbury & Dodson	MW 3pm		1		2	5
Armes & Barniak	TR 9:30am			1	1	6
Ward & Eberhart	TR 11am			1	1	6
Montana & Reed	TR 8am				0	8
Kinsman & Geiger	TR 11am				0	8
Hayes & Hannah	TR 3:30pm				0	8
Glantz & Sirianni	TR 3:30pm				0	8
Lane & Nobles	MW 3pm				0	8
Jee & Lovette	R 5:30pm				0	8
Keydel & Unrath	R 5:30pm				0	8

<u>Team Dynamics</u>

The total time that we spent on this project together was approximately 40 hours. Prem spent around 19 hours and Josh spent around 21 hours completing the project, therefore it shows that Josh did a little more work than Prem, however, splitting team based projects into parts is difficult to do. We agree that both members of the team participated and were effective in creating our design, however some things could be changed to improve the dynamics of our team. To start, we should have shared ideas and brainstormed before attempting to create a design straight from the start. We could have also communicated and planned better to finish the written and oral sections of the project.

Task	Task Worker	Time Spent (hrs)
Car Body	Josh	6
Car Wheels	Prem	3
Wheel Hubs	Prem	2
Fabricated Parts	Josh	2
Assembly	Josh	4
Drawings	Prem	6
Sub-Assemblies	Prem	2
Title Page	Josh	0.25
Executive Summary	Josh	1
Table of Contents	Prem	0.5
Car Operation	Josh	1
Design and Fabrication	Prem	5
Sustainability Analysis	Josh	1
Competition Description	Josh	1
Results	Josh	0.25
Team Dynamics	Josh	0.5
Project Assessment	Josh	2
Oral Report	Josh	2
Total Time Spent	Josh	21
	Prem	18.5

Project Assessment

Performance:

Everyone in the class was able to maneuver around each course. Our design did not outperform anyone else's designs, however we too were able to complete each and every challenge. Our design however, had the slowest sprint time, the slowest oval time and the least amount of weight lifted in our class. Despite this, our design was not far off from the next worst times and it still won the design competition in the class. Some designs that were interesting and that we would consider using next time are bigger wheels, working lights, and two motors that faced inward from the outside of the car instead of from inside the car body. The bigger wheels seemed to be the biggest advantage other cars had over us, as it gave them better speed for the events. The lights might have helped us win the world design competition and the motors would have produced less friction, giving us more power from the motors and easily configurable gear ratios. Other teams would probably like to use the car body that we designed as well as the ball castor wheel because these features reduce the turning problems and improve their overall design, however if they were to use the castor ball, they would also need to change to a dual motor control system.

Cost:

The materials that cost the most would be the motors at $24.95 each and the Arduino board costing $26.95. There isn't really anything that could replace these components that cost much less than the originals, however to reduce cost, a chassis plate made from birch plywood or from other non-expensive materials could be used in replace of the aluminum one. Two of the shaft collars used were also not necessary and not using those would also reduce the cost. The replaced components would reduce the cost by $7.41 and $6.04 respectively, creating a total cost reduction of $13.45. The plywood chassis plate would be harder to work with and less durable, but would otherwise have no adverse effect on the performance. Removing two of the shaft collars would also have no adverse effect on the performance.

Sustainability:

The component that created the greatest environmental impact was the chassis plate. An alternative material to reduce the environmental impact would be a chassis plate made from maple wood. The resulting change would reduce the carbon emissions by 1.664Kg $C0_2$, the energy used by 21.491 MJ, the air acidification by .01184Kg $S0_2$, and the water eutrophication by .0029Kg $P0_4$. This new material would be harder to work with and less durable, making it harder to fabricate into a finished part, but would otherwise have no adverse effect on the performance. This new material however, would cost approximately $10-$15 more.

Design Features:

The greatest strength of our design was easily the car body design and overall appeal of the design. Our aesthetic design was nearly unmatched with anyone else's designs, however our greatest weakness was performance in general. In specific, the greatest flaw of the design was the dual motor system. It made way too much friction between the axles and gears, slowing the car down and providing less torque to the back wheels. The changes that would improve the car the most would be the two motors that faced inward from the outside of the car instead of from inside the car body. This would have produced less friction, giving us more power from the motors and a more easily configurable gear ratio system. The working LED lights may have also helped us win the body building design competition. To complete these changes, it would take approximately two hours to configure everything in SolidWorks and another couple hours to remake the parts and reassemble everything. The cost of these materials would be miniscule because it would only require the rearrangement of the parts rather than the reconstruction of new materials.