BLENDER RECONSTRUCTION

Amit Blonder

OCTOBER 16, 2016

COMPUTER SCIENCE

We may have all once imagined a scenario in which we find ourselves in an ancient era, with nothing but our wits and 21st century knowledge, and must endeavor to recreate modern technology. How would we begin? What mechanisms and technology must we reinvent in order to find ourselves where we are today? More importantly, would we even know how to accomplish this? Today, many technologies are split into sections and subsections where only extreme specialists know the innermost workings of a very specific product. For example, even though I have studied electronics, I would not know how to build a battery to provide a steady electromotive force, or what chemicals I must combine in order to create a transistor, or even a resistor. Not unless we take with us the innovations of countless of past inventors and a world database of human technology would we be able to recreate any modern machine. And that is precisely what we will venture to do, as we attempt to formulate how to create a simple blender, from scratch.

In order to create this deceptively simple kitchen appliance without buying any parts, we would first need to separate this project into several fundamental parts which would then be assembled together. Those parts include a spindle, or some rod that can be spun and fitted with blades, and a complementary motor for that spindle. That motor would have to contain a hub, rotor, stator, wiring and many other components that would inevitably prove to be the most challenging pieces to acquire. Additionally, we would need to manufacture the blades attachable to an axle, some container for the base and electronics (housing), and a container for the body that houses the end effector of the blender (jar). The jar does not need to be see-through, but it has to be sturdy enough to withstand a vortex, or a mini-tornado of liquefied fruit. Finally, the blender will also need a jar base, a gasket, a lid for the jar, a power cable as a set of copper wires with insulation, and a switch. All of these parts would have to be made, from scratch, assembled from their respective materials.

As illustrated by Thomas Thwaites, there are a multitude of raw materials that go into the production of everyday goods, including hundreds of different alloys, chemicals, crystals and refined ore that was mined, cultivated, processed, synthesized and refined throughout the entire world. Those materials must eventually end up being assembled into many different forms with complex industrial methods and finally fitted together to comprise our one blender that we could buy for the price of a meal. The refining of raw materials is not a process that was suddenly invented at one point, but rather devised and improved upon over millennia. Large civilization employed thousands of workers for this purpose, such as Chinese iron workers in the 16th century forging pig iron and wrought iron using a blast furnace. If we were to try to undergo the same procedures with only basic tools, we'd find our "refined" iron barely qualifying as soot, just as Thomas Thwaites had.

However, before even thinking about refining ore and smelting alloys, we must first find our ore! This inevitably raises the questions: where do we dig? How far do we dig? How do we know what we have? What are searching for? With *what* are we going to dig? Basic paleolithic tools will need to be "invented" first, starting off with attaching stone-heads to sticks using fiber. Scrounging the earth, however, is enough only to award us with a diversity of rocks that may have minerals within them. We must then go through the process of building structures, such as the ancient Chinese blast furnace, in order to refine the ores into usable material. As such, just to make our blender, we find ourselves having to trace back the entire history of metallurgy and paleolithic technology. All the products and materials we take for granted are based on previous work and inventions, going back hundreds of generations.

It is also important to consider how we would go about building the containers. Plastic is out of the question, since it involves complex industrial procedures built on an already thriving industry. Are we going to chop wood and delve into the realm of carpentry? Will we venture out into a forest and find a tree to cut down, or one that is already felled? We would also need the tools to process the lumber and cut it into usable pieces. Furthermore, as in the realm of additive manufacturing, we would need a way of attaching our parts together. Will we find a natural glue to use, like the tree resin Native Americans used, or will we manufacture nails to pound into our containers? Another option is to smelt the containers out of ore, or form them out of clay. Whatever the method, it certainly won't turn out like a modern blender.

The motor that drives the blades is the heart of our to-be-blender, but it will prove to be technological feat in itself, as previously discussed. It would require winding a coiled wire into an electromagnet capable of driving the rotor, which must rest on bearings coated with grease so that it may revolve smoothly. It would also need a pair of permanent magnets on the stator, and a gasket that can fit snugly on the jar base to not let liquids flow down into the motor from the jar. A modern blender spins up to speeds of tens of thousands of rotations per minute (RPM), though we can go as low as 1000 RPM. Still, the 60Hz wall AC current would not be able to drive such high speeds without a well-made gearbox, and we would likely need a transformer as well to convert from 120V. With all of the requisite parts, it is easy to conclude that assembling a stable high-speed motor takes incredible mechanical precision and an understanding of the laws of electromagnetism not found in pre-industrial civilizations, let alone in the paleolithic era.

The mastery of electricity also comes with its own problems, as copper wires would have to be made thick enough, and with enough insulation, so that they do not melt away as did Thomas Thwaites'. Ferromagnetic material and rare earth magnets would also need to be specifically mined, and the magnets themselves have to first be magnetized enough with a current source and a coil of wire. Insulation would be more difficult without access to plastic, but any insulating material should do, like fabric or paper. And in the end, even if we perfectly manufacture everything, all of our parts must be assembled together. How can the blades be attached to a spindle? How can a spindle be mounted onto a rotor? How can a rotor be secured within its hub around bearings? How can the hub incorporate the wiring needed for the motor? How can the hub be mounted onto a base? All these questions refer to engineering problems solved throughout the history of mankind through numerous trial and error.

The construction of a blender with nothing but raw materials would already be an incredible feat to be done in one lifetime. However, if we are to keep with the spirit of starting from scratch, it's important to remember that in order to build a blender, one must be alive! Thus, we should not take anything as a given. We would have to grow our own food by re-inventing agriculture and construct our own shelter to survive the winter. If we had to worry about that, surely we would not have time to even think about a blender! The society around us allows us to venture on specialized endeavors and explore new inventions, and we would not be able to exist as we do today without the contribution of fantastic dedicated industries around the world, and the contributions of humanity that got us here. We are, as it were, standing on the shoulders of giants, and without them, we would have a long way up before we could attain a goal as mighty and lofty as building a blender.

Works Cited

Swaby, Rachel. “One Man's Nearly Impossible Quest to Make a Toaster From Scratch.”*Gizmodo*, Gizmodo.com, 21 Apr. 2011, gizmodo.com/5794368/why-its-harder-than-you-think-to-make-a-simple-toaster.

CALCULATIONS

Amit Blonder

$$\text{Density of steel } d \approx 8 \text{ g/cm}^3$$

$$\text{Volume of blade V} \approx 3\text{mm} \times 2\text{cm} \times 13\text{cm} = 7.8 \text{ cm}^3$$

$$\text{Mass of blade } m = dV = 62.4 \text{ g}$$

$$\text{Moment of inertia } I = mr^2$$

$$\text{Moment of inertia of a rectangular prism } I = \frac{m}{12}(w^2 + l^2) \approx 0.9 \text{ kg·m}^2$$

$$\text{Frequency } f = 1000 \text{ RPM} \div 60 \text{ s/min}$$

$$\text{Angular velocity } \omega = 2\pi f \approx 105 \text{ rad/s}$$

$$\text{Time to speed up } \Delta t = 8 \text{ s}$$

$$\text{Angular acceleration } \alpha = \frac{\omega}{\Delta t} = 13.125 \text{ rad/s}^2$$

$$\text{Torque T} = I\alpha \approx 11.8 \text{ kg·m/s}^2$$

Assumption: the torque to accelerate the blade would be about the torque needed to pulverize the food

$$\text{Rotational Power } P_{rot} = \text{T}\omega \approx 1239 \text{ W}$$

$$\text{Electrical Power } P_{el} = P_{mech} + P_{j\ loss}$$

Assumption: equal loss as mechanical power (50% efficiency)

$$\text{Electrical Power } P_{el} = 2P_{rot} = 2478 \text{ W}$$

$$\text{Current } I = \frac{P_{el}}{V} = \frac{P_{el}}{110 \text{ V}} \approx 22.5 \text{ A}$$

According to wire gauge chart:

22.5A @ 110V requires at least a <u>12-gauge wire</u>

SCHEMATICS

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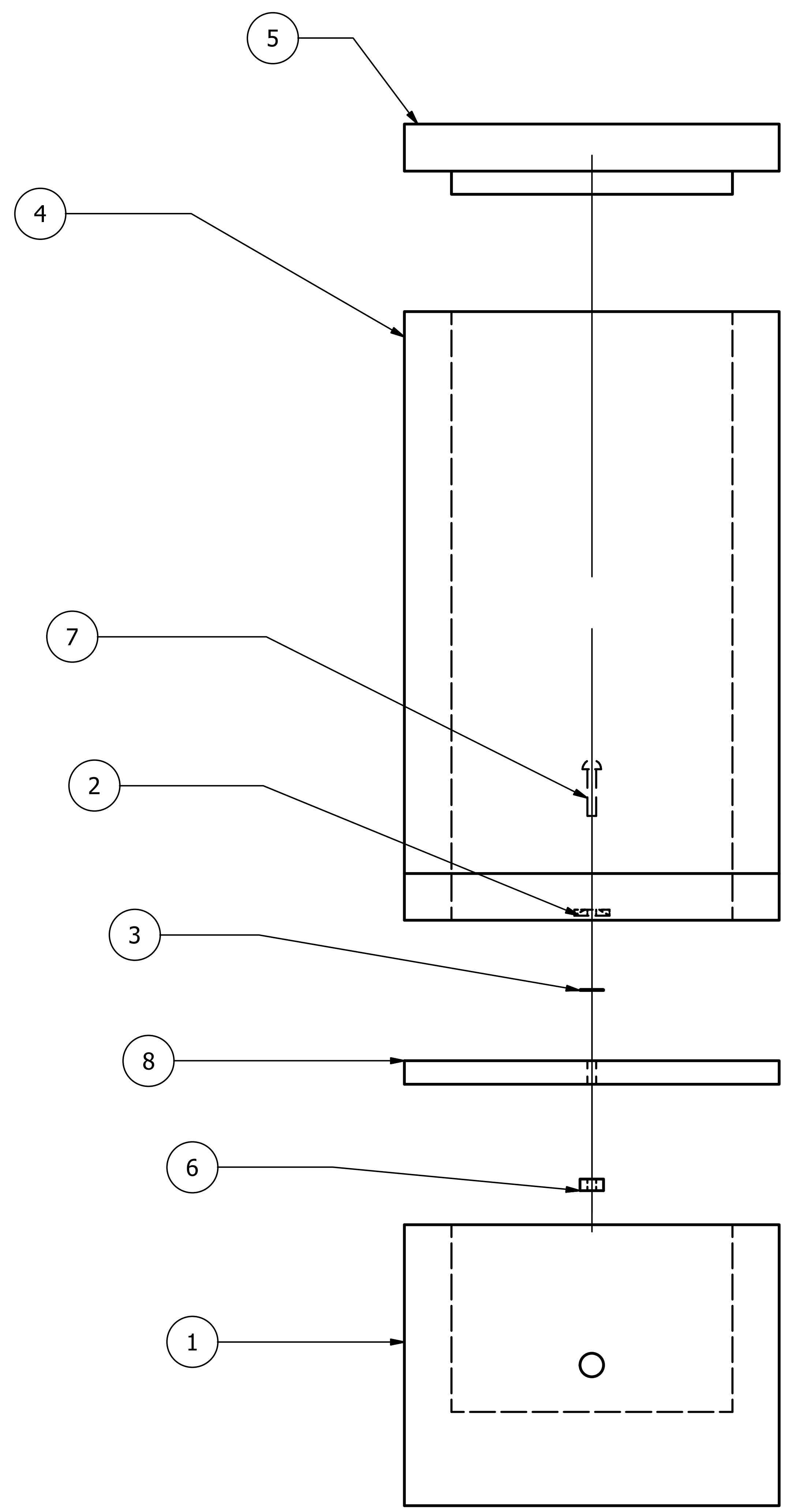
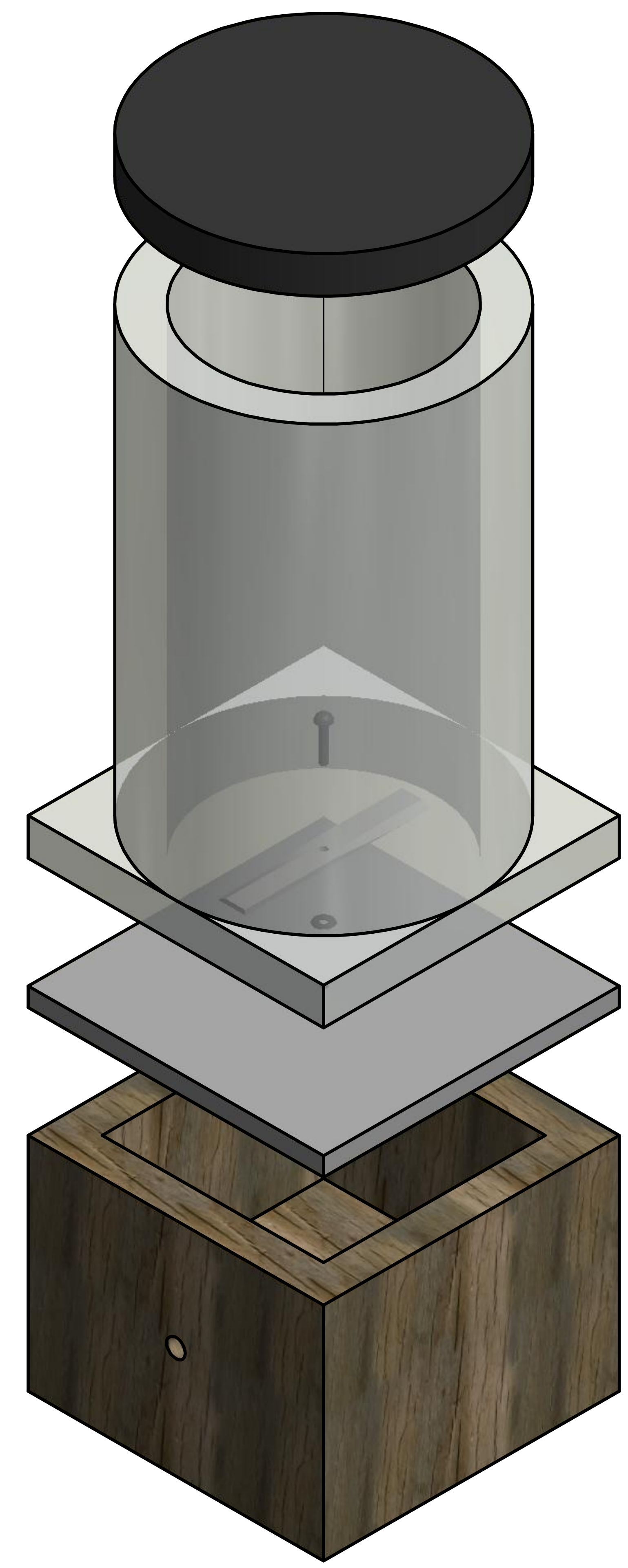
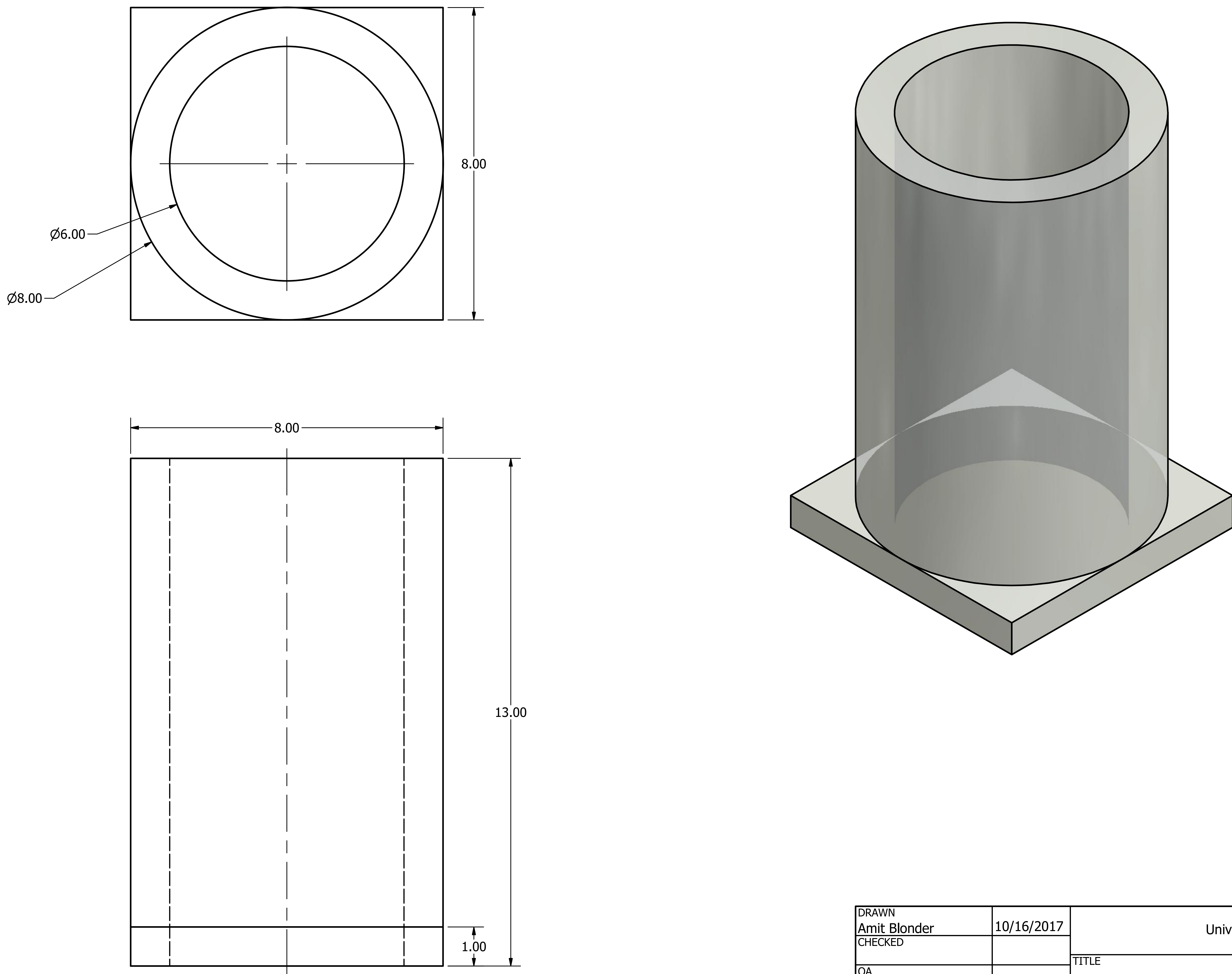


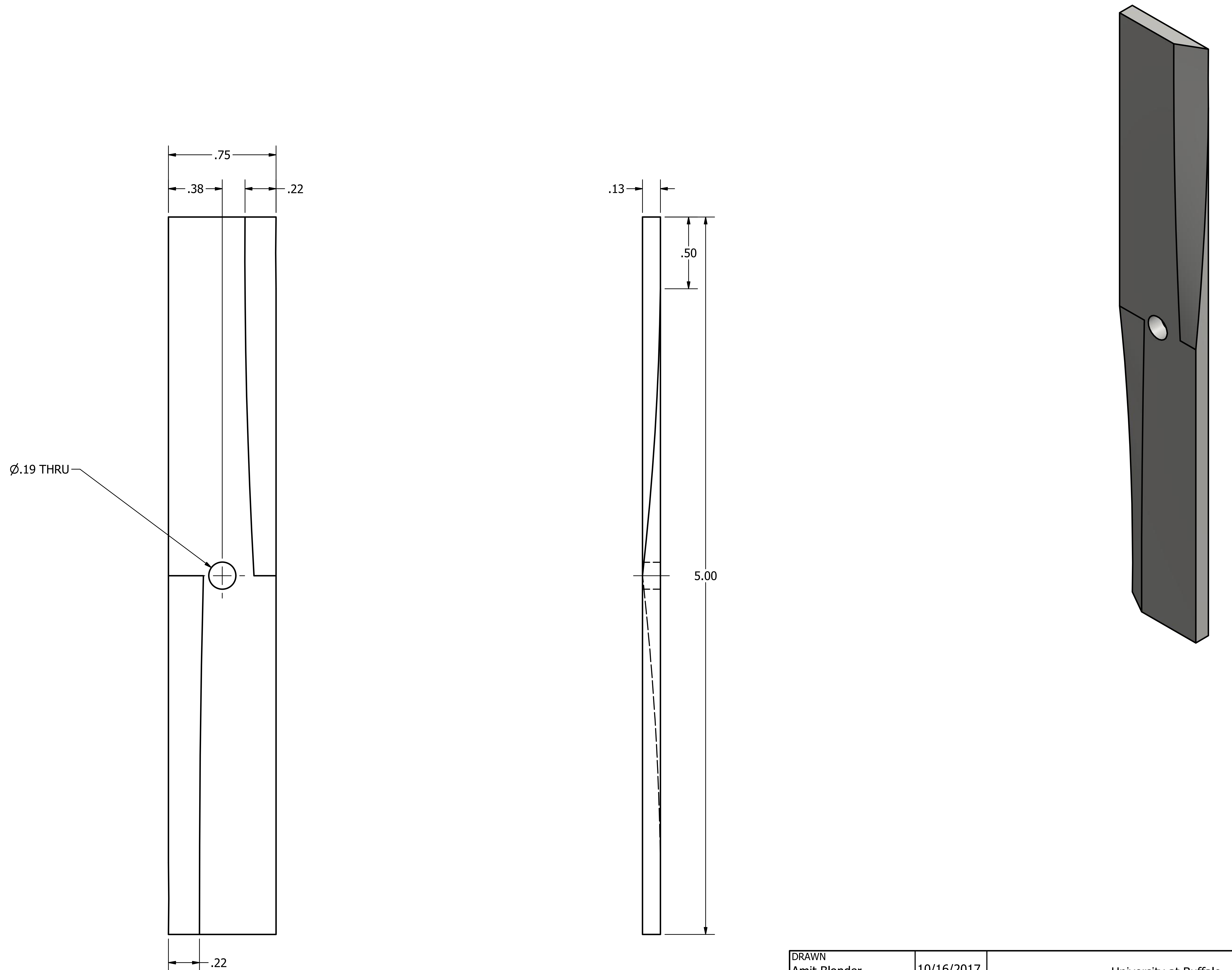


PARTS LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	Housing	Houses electric power.
2	1	Blade	Slices evil fruit.
3	1	Gasket	Guards against liquid invaders.
4	1	Jar	Holds fruity justice!
5	1	Lid	Prevents escape.
6	1	Motor	Spins up the blades.
7	1	Spindle	Transmits terrifying torque.
8	1	Jar Base	Base of operations.

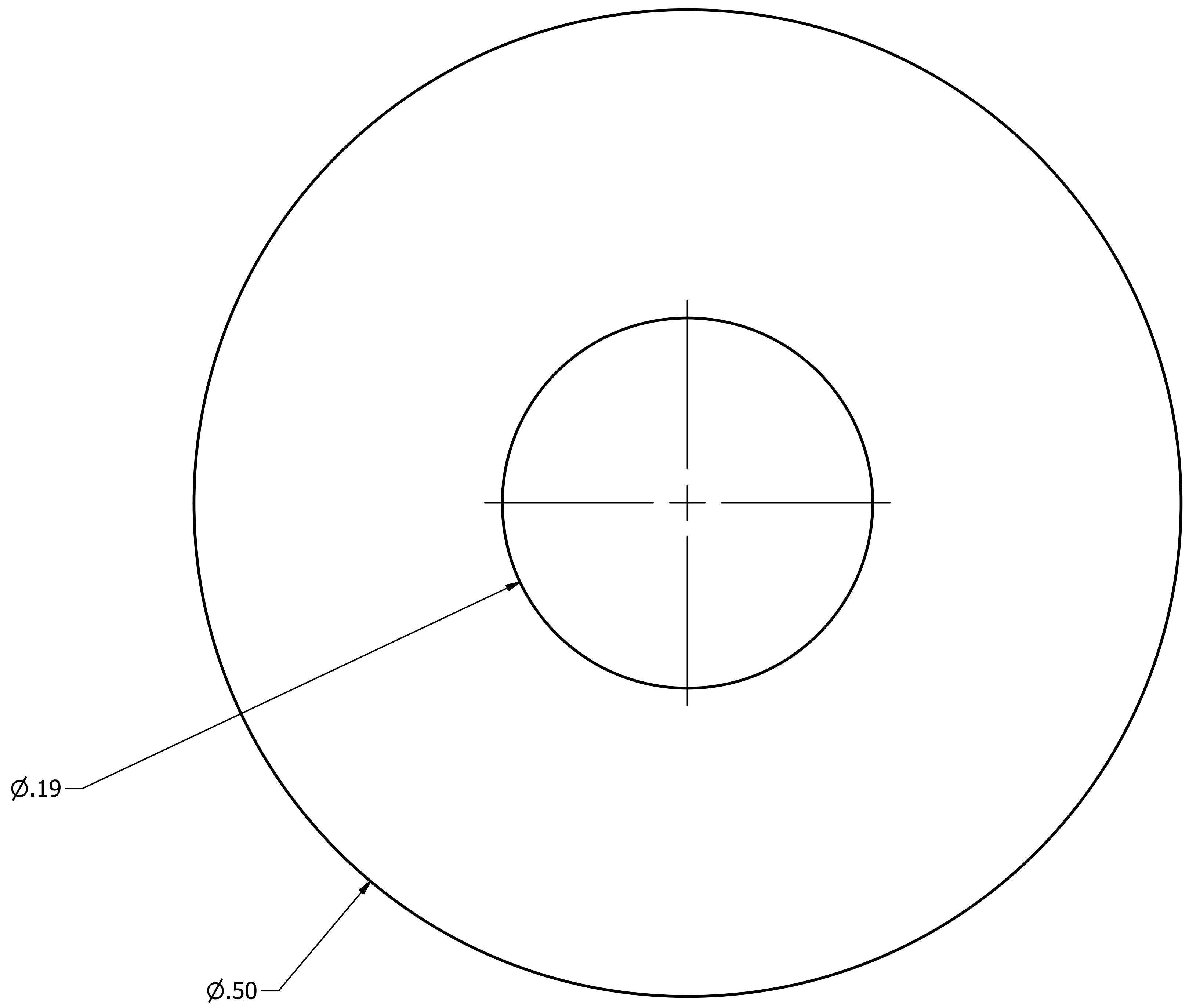
DRAWN Amit Blonder	10/16/2017	University at Buffalo
CHECKED		TITLE
QA		Caveman Blender
MFG		
APPROVED		SIZE C / DWG NO Blender / REV
		SCALE 1:4 / SHEET 1 OF 1

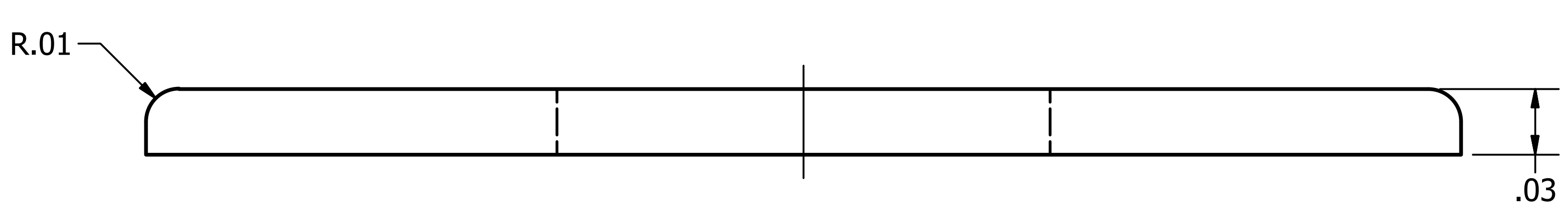


DRAWN Amit Blonder	10/16/2017	University at Buffalo			
CHECKED		TITLE			
QA					
MFG		Jar			
APPROVED					
		SIZE C		DWG NO Jar	REV
		SCALE 1 : 2		SHEET 1 OF 1	

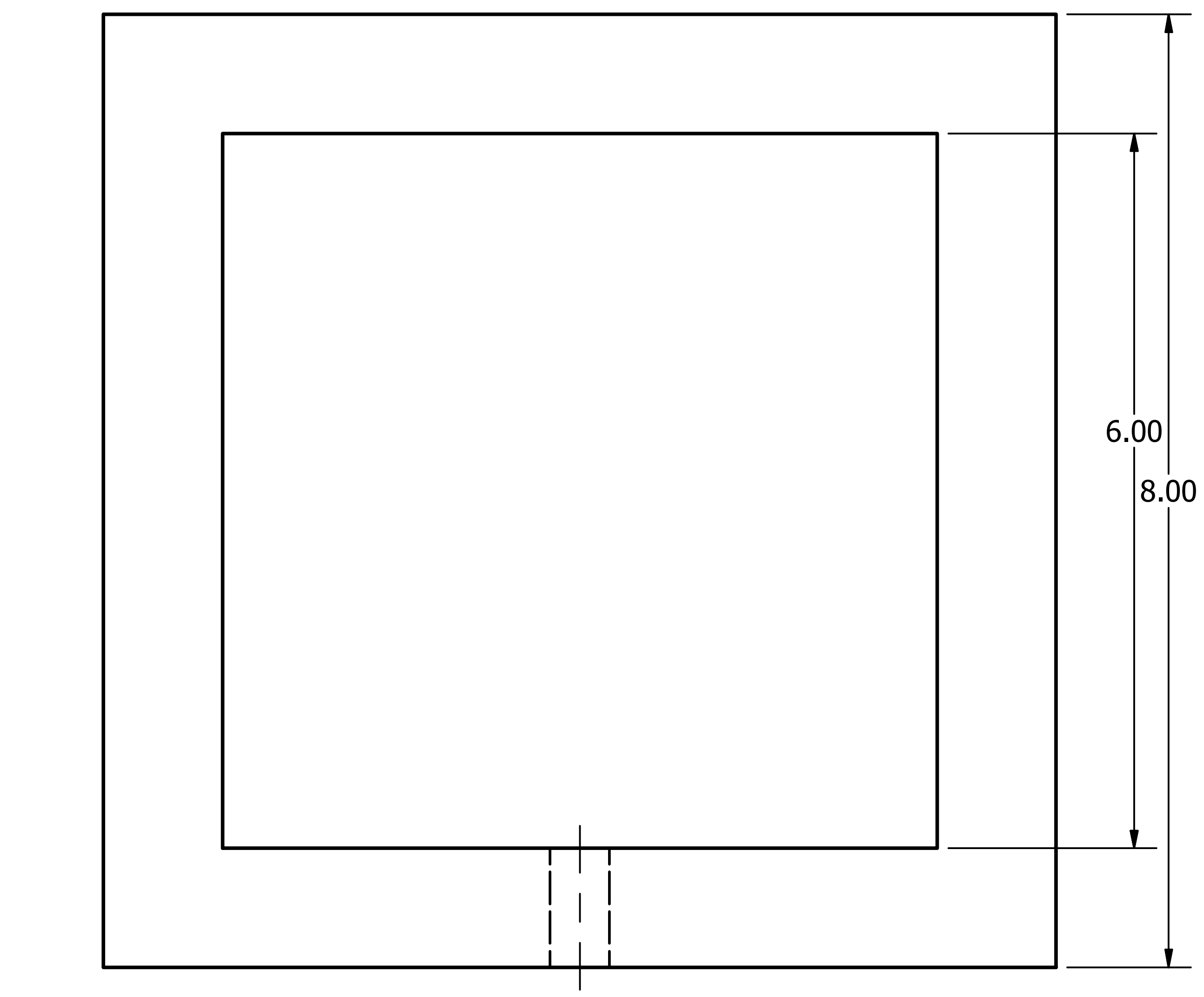


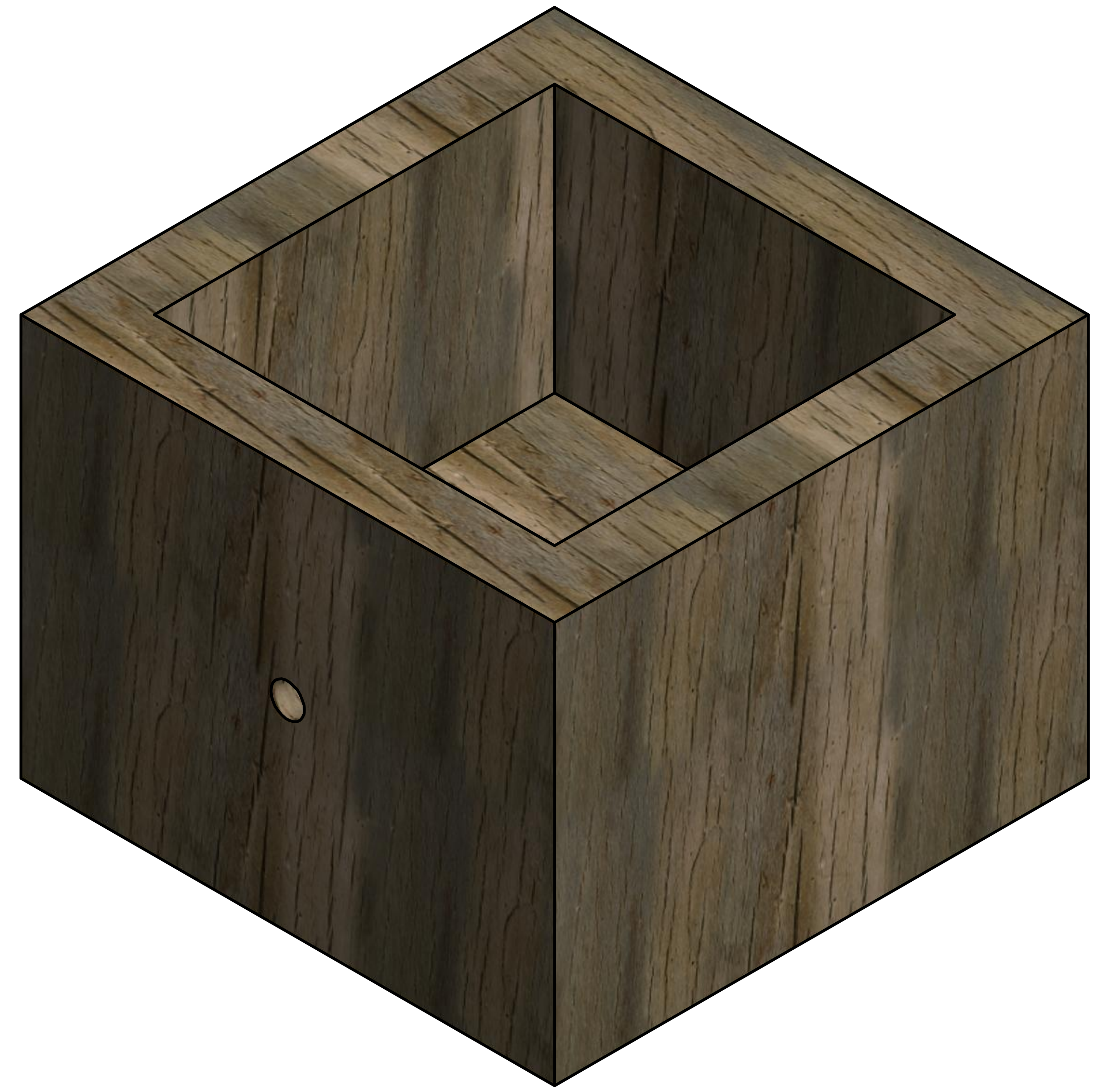
DRAWN Amit Blonder	10/16/2017	University at Buffalo	
CHECKED		TITLE	
QA		Blade	
MFG			
APPROVED			
		SIZE C	DWG NO Blade	REV
		SCALE 2 : 1	SHEET 1 OF 1

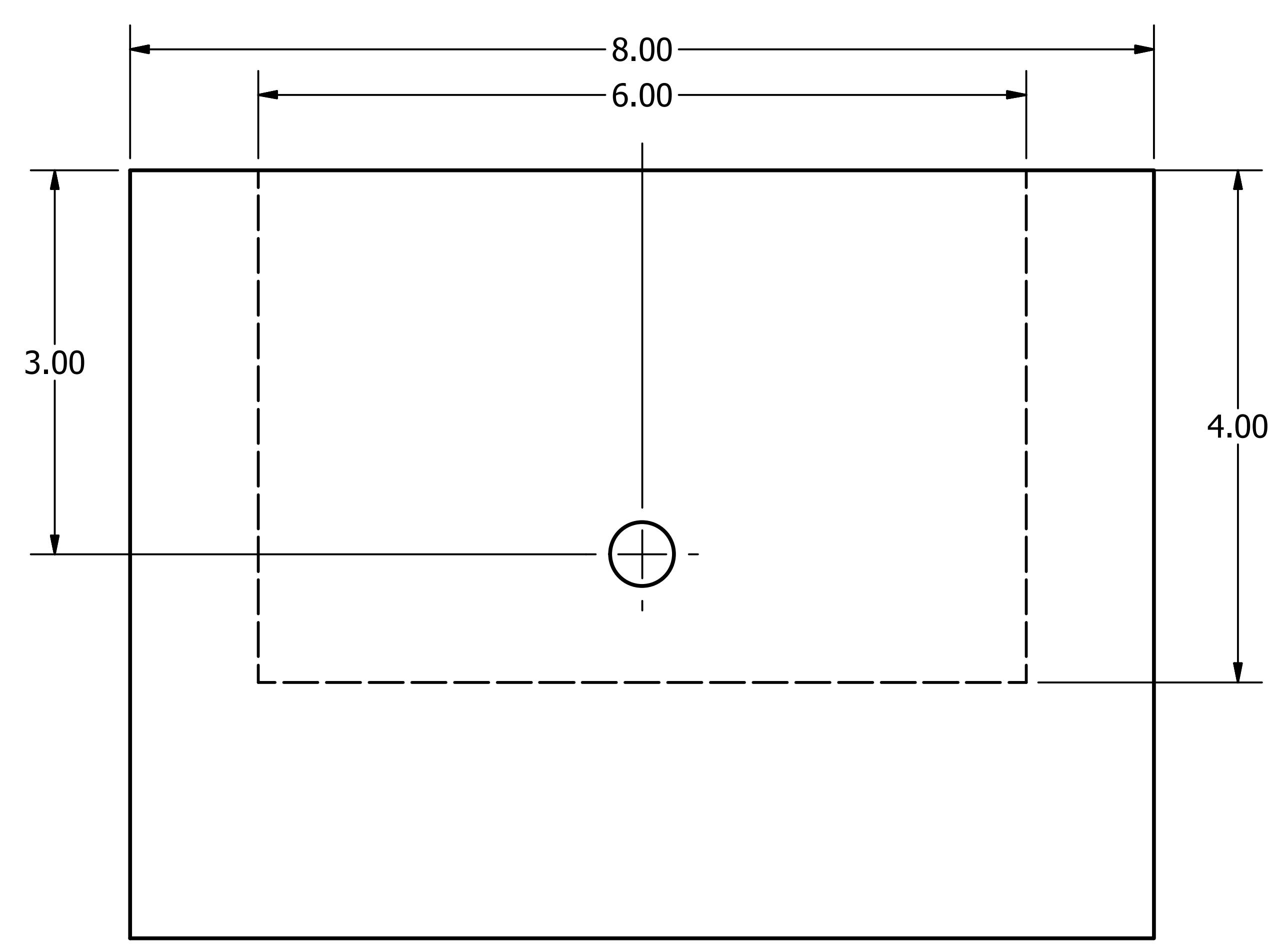




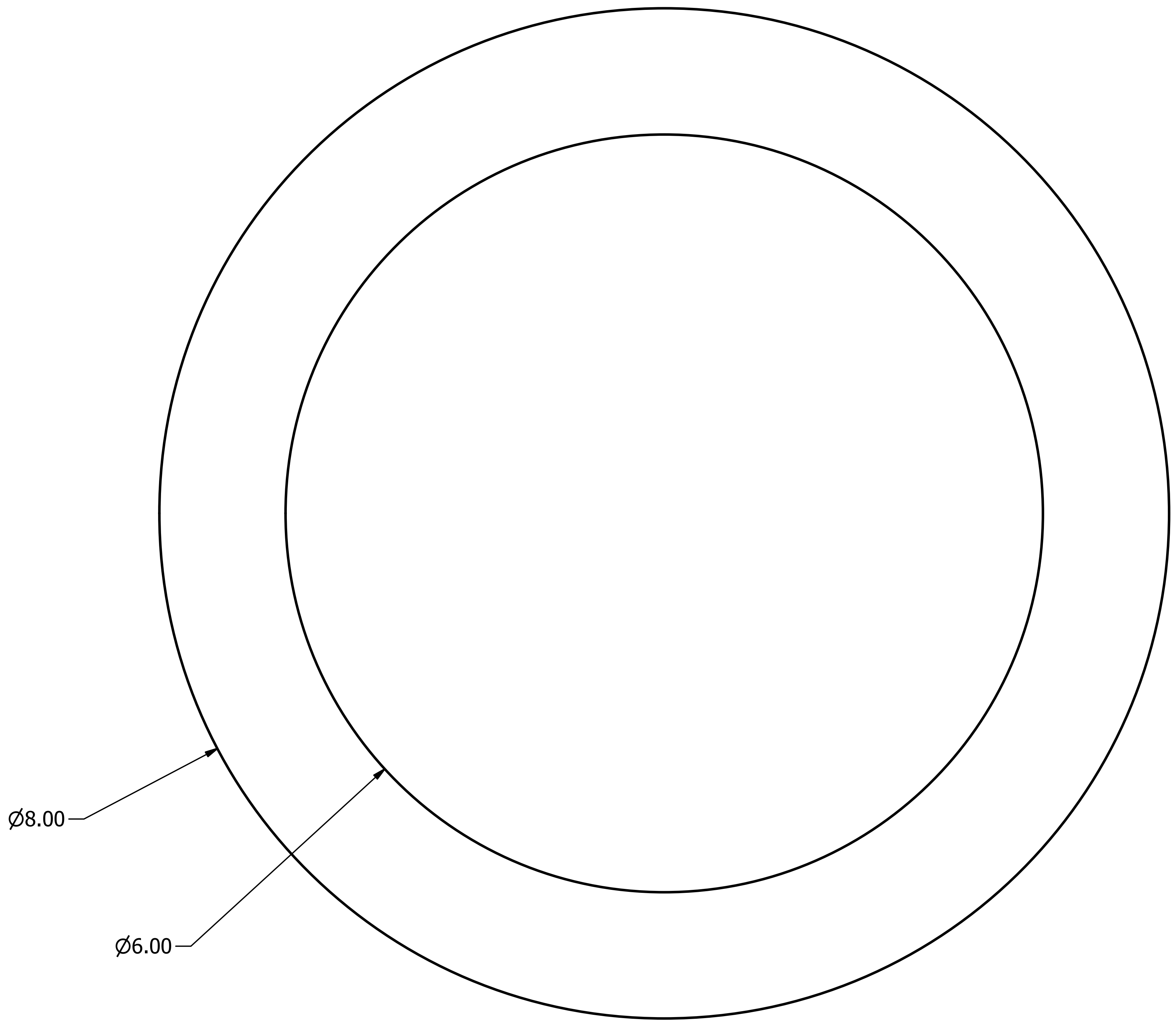
DRAWN Amit Blonder	10/16/2017	University at Buffalo			
CHECKED		TITLE			
QA		Gasket			
MFG					
APPROVED					
		SIZE C		DWG NO Gasket	REV
		SCALE 14 : 1		SHEET 1 OF 1	

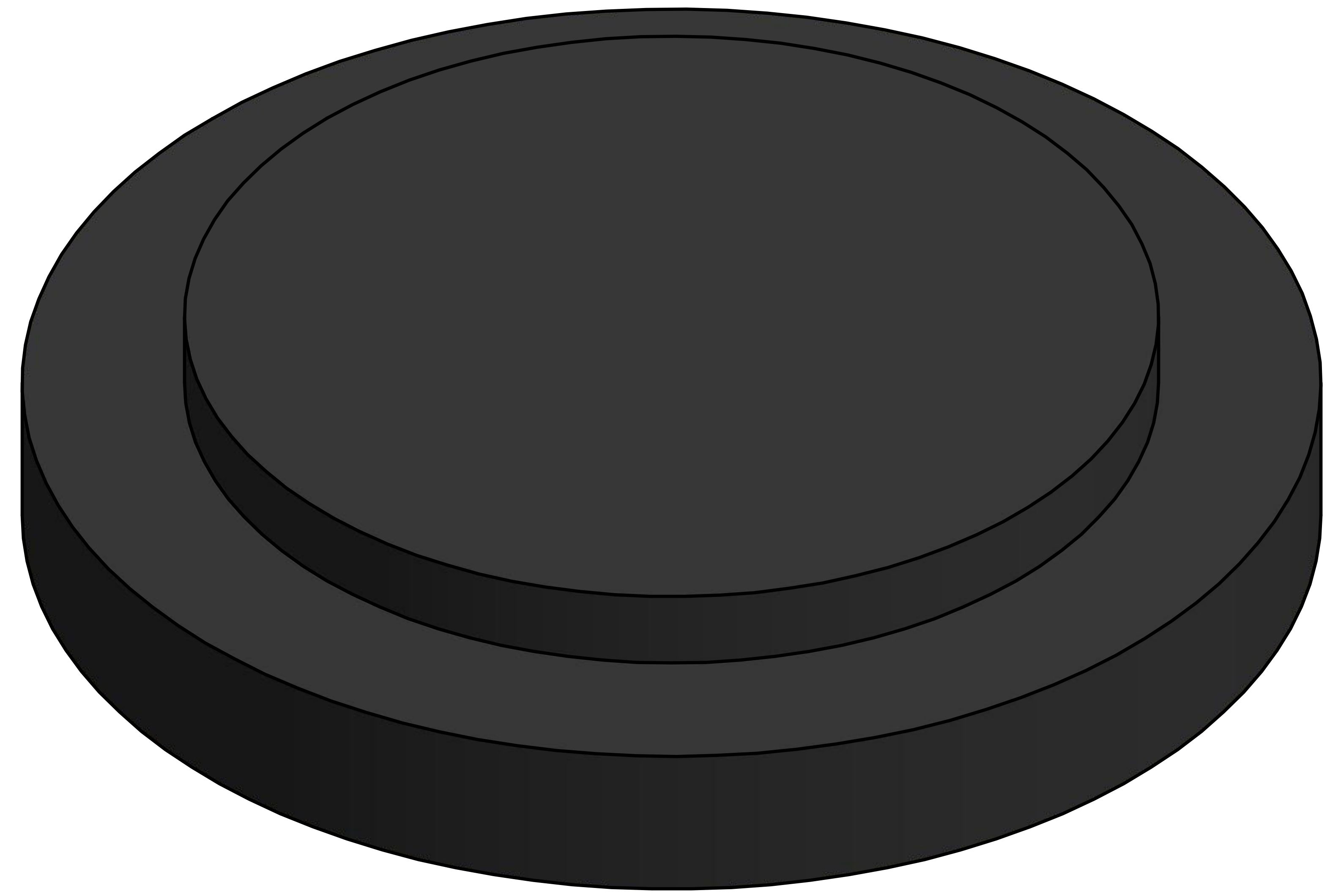


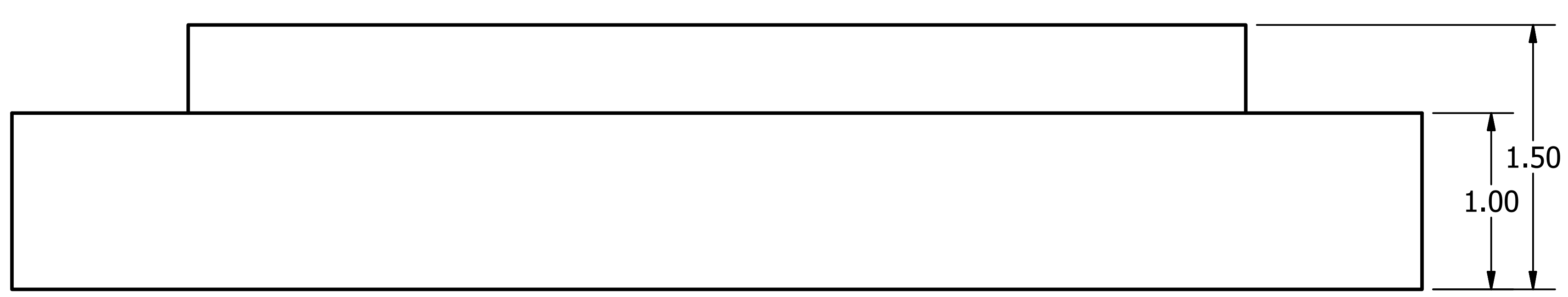




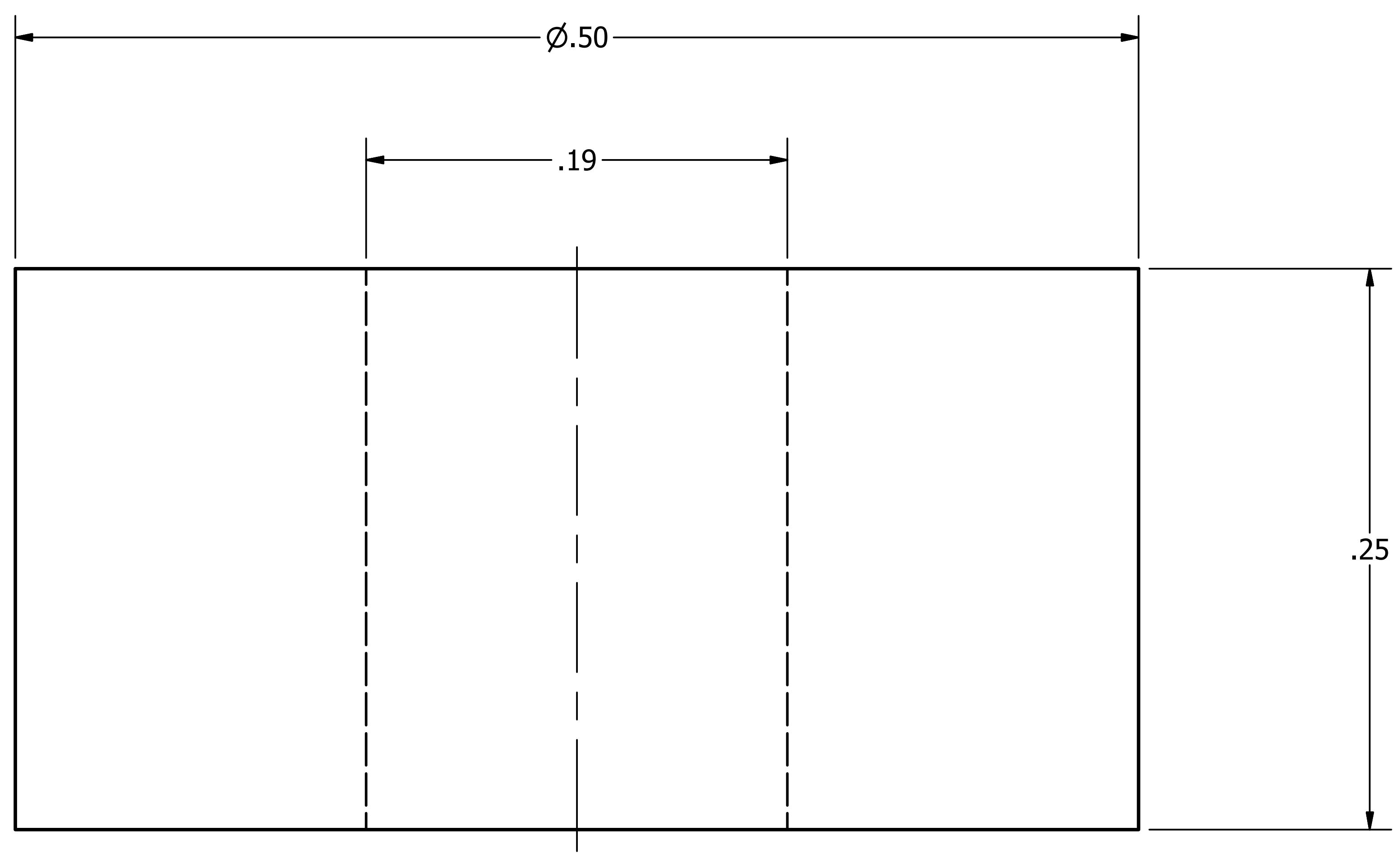
DRAWN Amit Blonder	10/16/2017	University at Buffalo
CHECKED		TITLE
QA		Housing
MFG		
APPROVED		SIZE C · DWG NO Housing · REV
		SCALE 2 : 3 · SHEET 1 OF 1

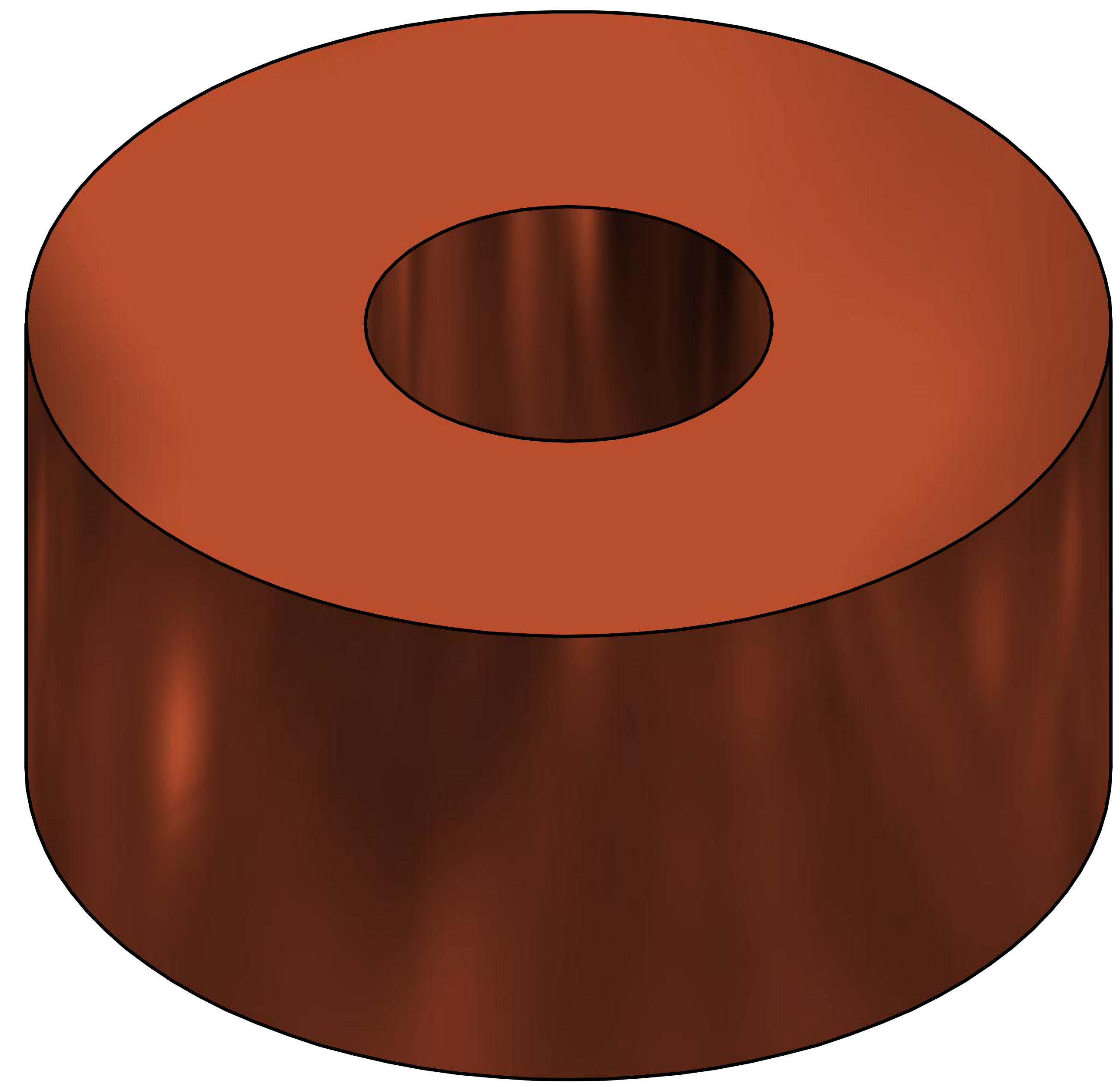






DRAWN Amit Blonder	10/16/2017	University at Buffalo		
CHECKED		TITLE		
QA		Lid		
MFG				
APPROVED		SIZE C	DWG NO Lid	REV
		SCALE 1 : 1		SHEET 1 OF 1





DRAWN Amit Blonder	10/16/2017	University at Buffalo		
CHECKED		TITLE		
QA		Motor		
MFG				
APPROVED				
		SIZE C	DWG NO Motor	REV
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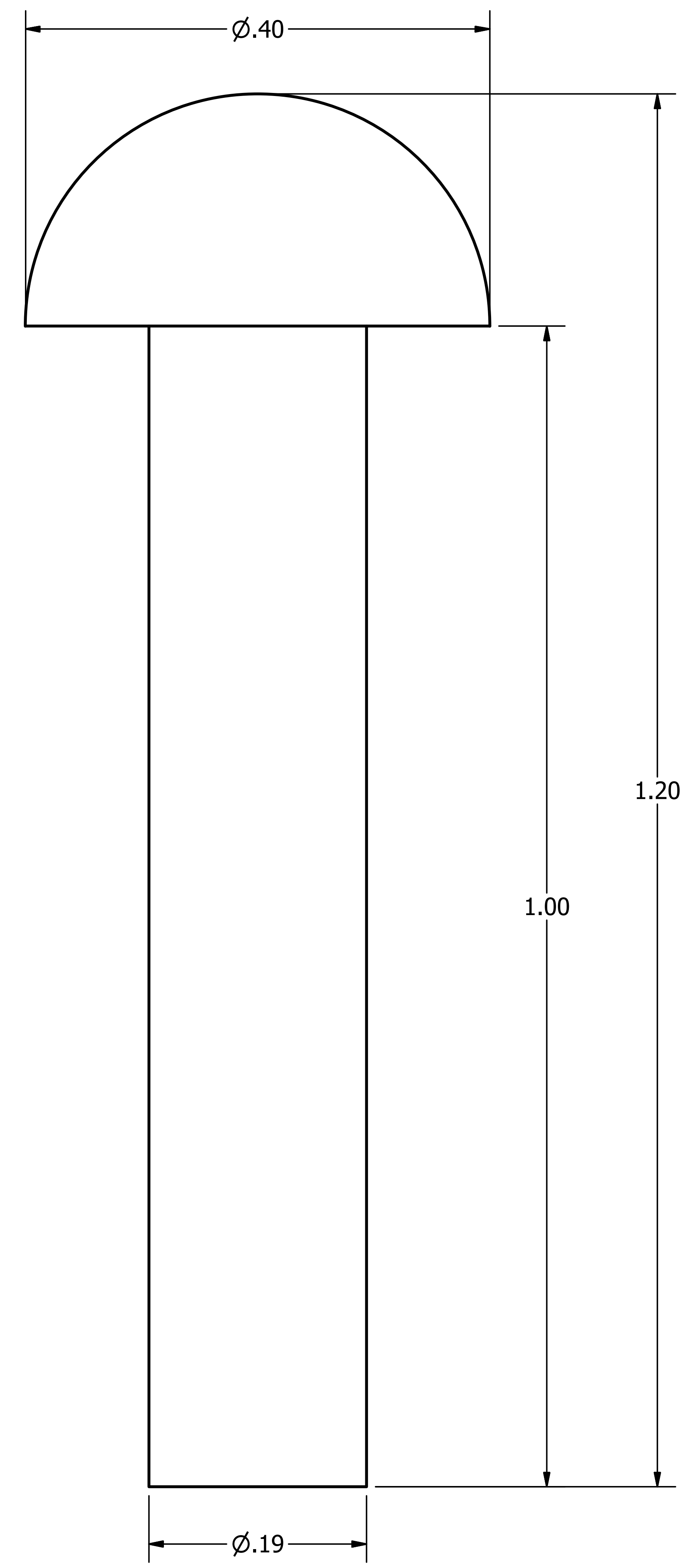

DRAWN Amit Blonder	10/16/2017	University at Buffalo
CHECKED		TITLE
QA		Spindle
MFG		
APPROVED		SIZE C · DWG NO Spindle · REV
		SCALE 8 : 1 · SHEET 1 OF 1