Reverse Engineering Project: Jigsaw

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Figure 1. Hammerhead Jigsaw

Abstract:

The goal of this reverse engineering project was to disassemble, understand, model, and improve a jigsaw that was given to us. We used photographs, freehanded dimensioned drawings, and visual analysis to design each of the parts of the jigsaw into Fusion 360 models. We chose to model the structural, human interface, and drivetrain systems of the jigsaw. We evaluated material choices, assembly relationships, and performance to propose improvements to the jigsaw. We were successfully able to model, animate, and dimension all the parts of our systems that we chose. This project was important for us to develop and test our fundamental skills in mechanical engineering. Overall, the project gave us a great opportunity to develop a comprehensive understanding of the jigsaws design and demonstrated how reverse engineering can result in meaningful design improvements.

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Introduction:

A jigsaw is a household hand tool made to cut wood, metal, or plastic. Jigsaws combine multiple systems for thermal control, electromechanical transmission of power, structural support, mechanical motion of a drivetrain, and the human interfaces required to operate the jigsaw in order to create an efficient hand tool. These individual systems collaborate to create a uniform tool capable of work and use by anybody trained to use one. This report explores three of these systems; the drivetrain, structural supports, and the human interfaces, in order to understand how they work and why they were designed the way they were. A procedure was conducted to determine the components and the functions of the three selected systems in order to understand their functions and purposes. Additionally, the procedure was conducted to demonstrate the organization, communication, and effort required to complete a team project. Within the three systems, different components were identified, and their individual purposes were summarized through the form, fit, and function method in order to understand how the components worked together to create the overall system. The procedure also allowed for the suggested improvement of an individual part within each system.

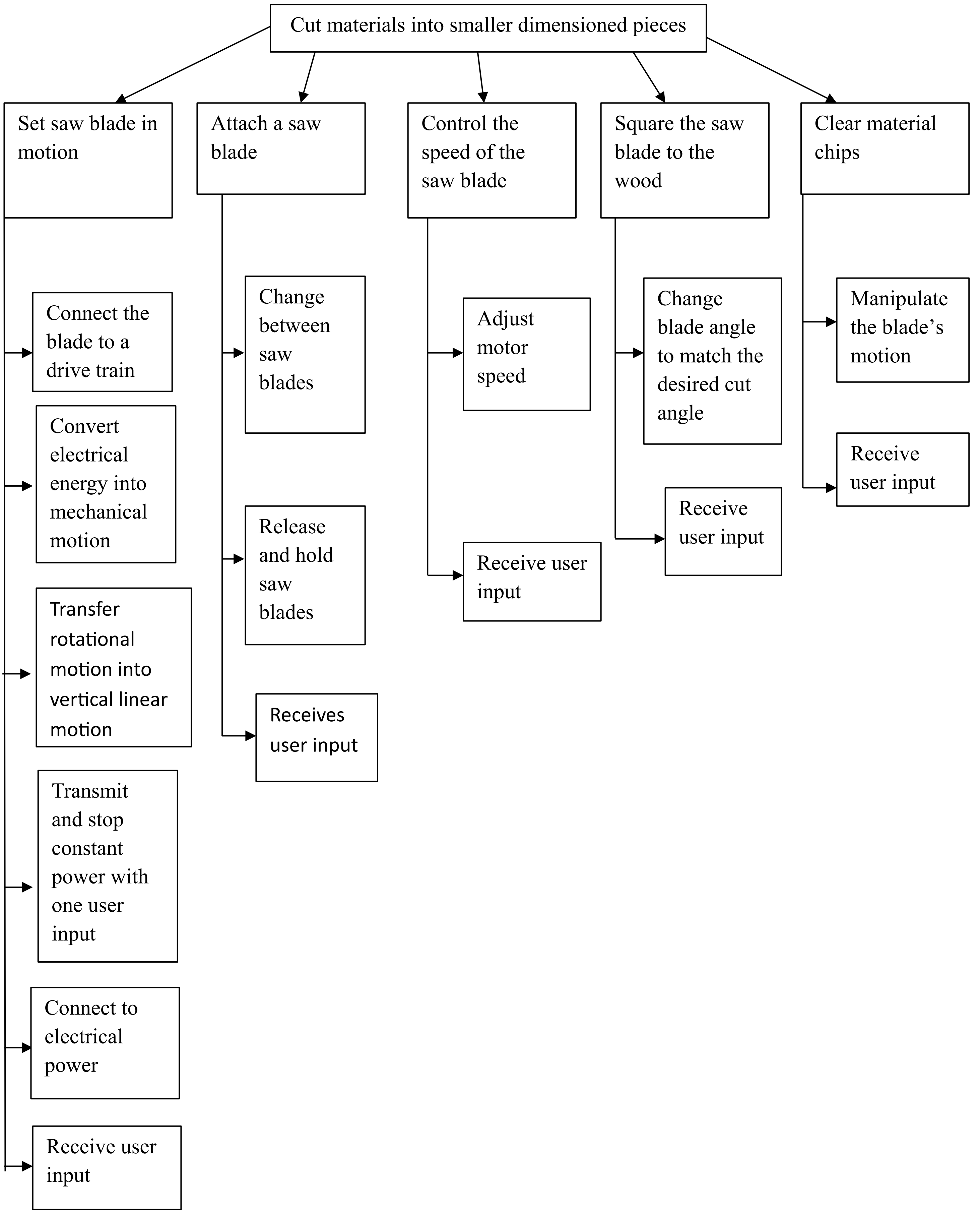

Figure 2. Functional decomposition tree of the jigsaw.

Functional Decomposition Tree Description

The overall function of a jigsaw is to cut materials; wood, plastic, or metal; into smaller pieces for different projects. The main sub-function required to cut a material are attaching a saw blade that can be set in motion, controlling the speed of the blade, squaring the blade to the cutting surface in a definite angle, and clearing the cut material away from the saw and the blade. Attaching the saw blade requires a component to release and hold saw blades and therefore change between them through a user input to the component. In order to move the saw blade, it must connect to electrical power and a user input to turn the saw on and off alone as well as constantly allows the saw to convert electrical energy into mechanical motion. Transmitting the mechanical motion into linear motion and connecting the saw to the overall drivetrain allows the blade to be set in motion. Controlling the speed of the blade requires an interface to throttle the motor speed through a user input. Holding the saw at a controlled and specified angle requires the ability to change the angle of the saw blade to the cutting plane through receiving a user input. Removing the chips and material cut by the blade requires a component that can be changed by a user input depending on the cut or material.

Procedure for Decomposition

- Team donned safety glasses
- Gathered necessary tools including screwdrivers, pliers, and Ziplock bags for small pieces
- Started Teardown by removing two screws from the silver guide plate underneath the device
- With the silver guide plate unscrewed and detached, the shoe plate was also removed from the main assembly
- Continued onwards into the inside of the device by removing twelve screws around the casing of the jigsaw.
- Opened the jigsaw case, revealing three easily removable pieces: the on-off switch, the speed control knob, and a thin rod which came through holes in the casing to the underneath the jigsaw
- Removed on-off switch by sliding out of casing socket
- Removed speed control knob by sliding from outside of case to inside and arranging wires in a way to easily remove the knob from the rest of the assembly
- Pulled heavily curved thin rod by the curved section, allowing for the piece to exit from the inside of the casing
- Our team noted that the speed control knob was connected to the rest of the electrical system through wiring
- The side of the casing which didn't have the motor screwed in had the Pendulum Angle Set attached to it
- Begun detachment of the Pendulum Angle Set by removing the ball bearing and spring providing it stability
- The disruption created from the previous step allowed for the washer holding the Pendulum Angle Set to fall out along with the Pendulum Angle Set itself
- The side of the casing with the motor attached needed to be disassembled further.
- The process started by taking out the Blade Release Lever, the Blade Release Lever Holder also came out in the process
- Upon removing the Blade Release Lever, the Filleted Cylinder attached to the end of the larger helical gear was exposed and removed

- To disassemble the rest of the Drive Train, our team had to remove two screws from the smaller helical gear holder which attached the drive train to the casing
- Upon the removal of the two screws mentioned above, the entirety of the drive train assembly loosened
- Our team directed attention to the other end of the casing which veered into electric system territory
- Detached two metal connectors that directed electricity from wires into the motor system.
- Positioned wires within the assembly to be out of the way
- Removed entire Motor, Drive Train, and Wiring systems from the Casing
- By this point our team had stripped the casing of all extra components, meaning the casing could now be put aside as a completely torn down part.
- Disassembled the Motor further by separating the Rotor from the Stator
- The Stator was connected to the outlet plug as well as the speed controller via wiring, meaning that the entire electric system had been disassembled
- The Rotor, however, was connected to the Drive Train further along the assembly
- Disassembling the Drive Train started by detaching the Large Helical Gear from the Gear Holder
- Upon pulling the previously mentioned two pieces apart, a fitting cylinder meant to ensure constant friction between the Large Helical Gear and the Gear Restrictor also fell out
- Detached the Gear Restrictor from a specially-design washer between the smaller helical gear holder and the Gear Restrictor, along with the washer
- Attempted to detach the smaller helical gear holder from the rotor assembly, however the bearing holding the smaller helical gear was too strong to be knocked out with a hammer resulting in the top of the helical gear becoming splayed.
- Further attempts were not carried out for fear of further damage.
- Having detached most pieces from the Rotor, the drive train was completely considered completely disassembled
- Ended the decomposition process and began measuring as we successfully tore the assembly down into its most basic pieces and were easily able to identify which pieces belonged to which subsystems.

Form, Fit, and Function Human Interface:

Blade Release Lever:

Figure 3. Blade release lever

Figure 4. Engineering drawing of the blade release lever assembly with no hidden lines in the isometric view.

Form: The blade release level assembly is 117.83 millimeters tall, and the oval shaped cup halfway down is 41.17 millimeters wide. The handle where a person's fingers interact with the release is 32.47 wide and 19.73 millimeters tall. The part that allows human interface is blue plastic and the shaft of the lever, the oval shaped cup, and the two pieces that slide along the shaft are metal.

Fit: The blades of the jigsaw have a t shaped protrusion towards the base of the blade that allows the blade release mechanism to hold onto the blades during operation. Additionally, since the blades attach to the blade release mechanism the entire blade and blade release mechanism must move in order for the jigsaw to cut. So, the shaft of the blade release uses a dowel and hole configuration in order for the gear on the motor to attach to the blade release. The gear has a dowel of a similar diameter to holes present on the shaft of the blade release allowing the two assemblies to connect and move the blade up and down. Function: The blade release acts as a way for the jigsaw to receive user input in order to allow the blades to be released and changed. This allows different blades to be used for different materials or for different types of cuts. Being able to change the blade also allows the blade to be maintained and changed once its dull or if teeth break off.

Speed Control Wheel:

Figure 5. Speed Control Wheel

Figure 6. Engineering drawing of the front view of the speed control knob with dimensions and limited hidden lines.

Figure 7. Engineering drawing of the back view of speed control knob with dimensions and minimal hidden lines.

Form: The speed control wheel is a blue plastic ring with a small disk in the center perpendicular to the walls of the cylinder. The disk in the middle supports a dowel on either side. There are 7 sections of 7 semi circles along the outside of the cylinder. The ring is 26.08 millimeters in diameter and the disk in the center is 1.44 millimeters in thickness.

Fit: The speed control wheel connects to a circuit board through a friction fit between a plastic switch that is oval shaped with the diameter of the inner circle that closes a circuit when the speed controller is at zero. The plastic switch is soldiered to the board through three pins.

Function: The speed controller acts as a way for the jigsaw to receive an input from the user in order to determine the speed of the saw blade. Being able to control the speed allows the user to cut different materials or create different kinds of cuts within a similar material. The speed control wheel also has groups of semicircles that act as a grip for turning the wheel and separating the different speeds.

Lock on Switch:

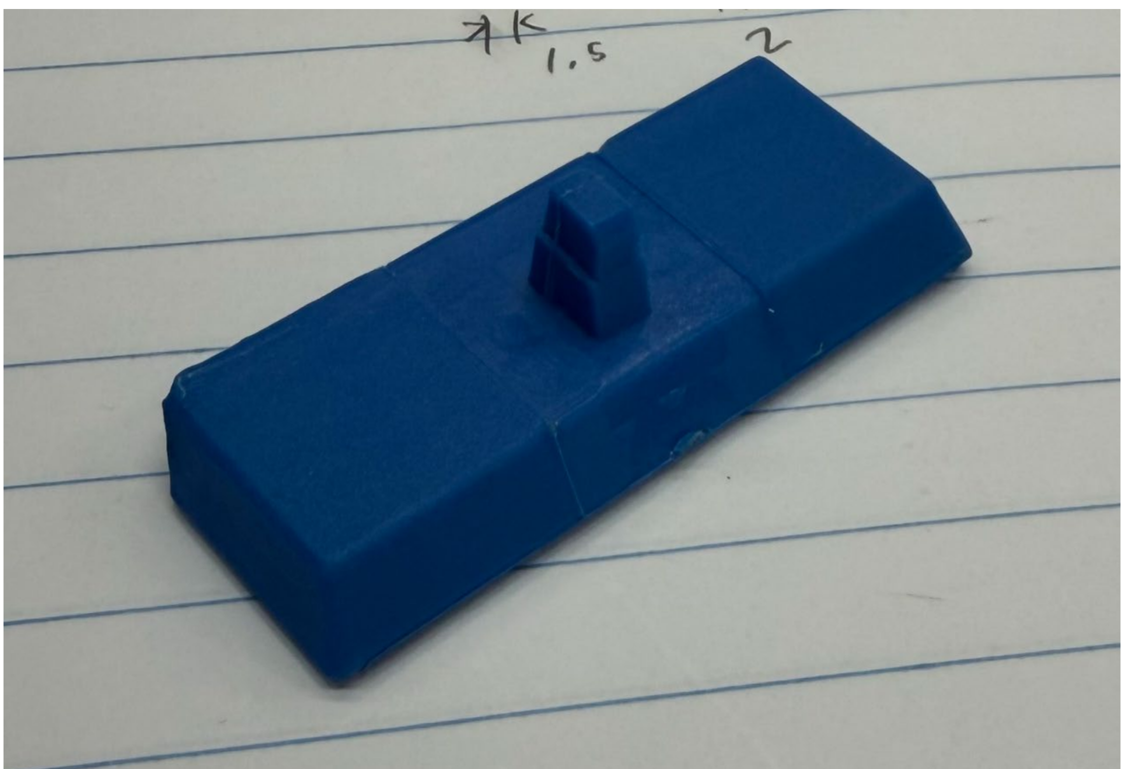

Figure 8. Lock on Switch

Figure 9. Engineering drawing of the lock on switch assembly including the spring.

Form: The lock on switch is a trapezoidal shaped base 51.4 millimeters by 16 millimeters that is hollow with support structures within the hollow shell. A protrusion sits on top of the base that is rectangular in shape with a bevel on one of the top edges. The protrusion is 7.35 millimeters tall and sits 21.43 millimeters in from the left and right edge and 2 millimeters from the right in the side view. The entire piece is made of blue plastic, and the spring is some metal.

Fit: The lock on switch fits into the handle of the jigsaw and allows the user to press the switch in and out while the trigger is pulled. When the trigger is pulled a small tab molded into the trigger allows the top notch of the lock on switch to hold the trigger down. The spring depresses when the lock on switch is pushed and creates tension between the case and the switch. The spring compresses and fits into an opening on the underside of the switch that holds it in place.

Function: The lock on switch acts as a human interface allowing a user to keep the trigger on continuously while making a cut.

On/Off Switch:

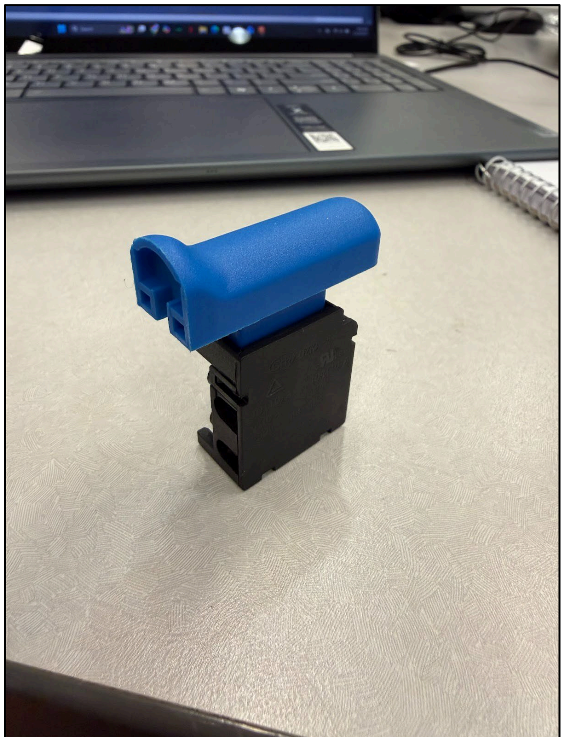

Figure 10. On/Off Switch

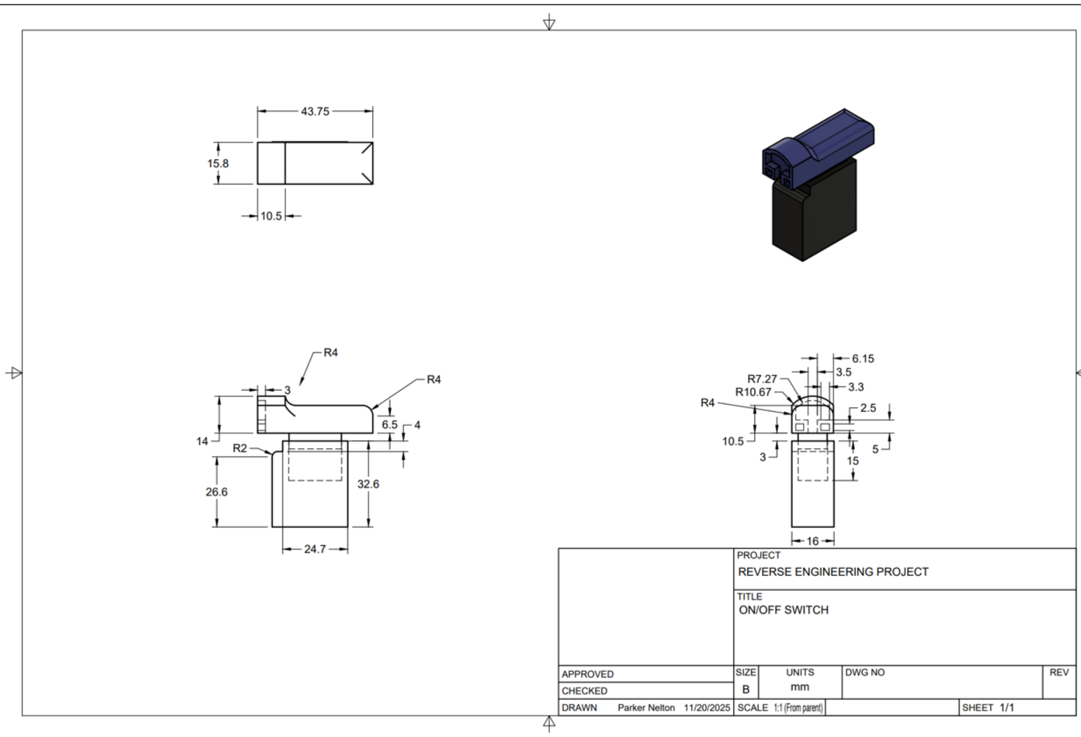

Figure 11. On/Off Switch Assembly Drawing.

Form: The On/Off switch is composed of the electronic switch that opens and closes the circuit with the movement of the top of the switch that the user interfaces with. The switch has a maximum height of 43.6 mm and is 16mm wide at the base. The button is 43.75mm long. The top of the switch has rounded edges with radii of 4mm all around. The top of the switch is made of blue plastic, and the base of the switch that involves the electronics is made of hard black plastic.

Fit: The On/Off switch fits into the handle of the jigsaw and lies right where the user's fingers would rest when wrapped around the handle of the jigsaw. This allows the user to easily press the button to start and stop using the jigsaw. The switch includes a spring that pushes the switch back to rest in the off position so that anytime the user's hand is removed, the jigsaw will automatically be turned off.

Function: The function of the On/Off switch is the button that allows the user to engage and disengage the jigsaw action when using it.

Pendulum Angle Set:

Figure 12. Pendulum Angle Set

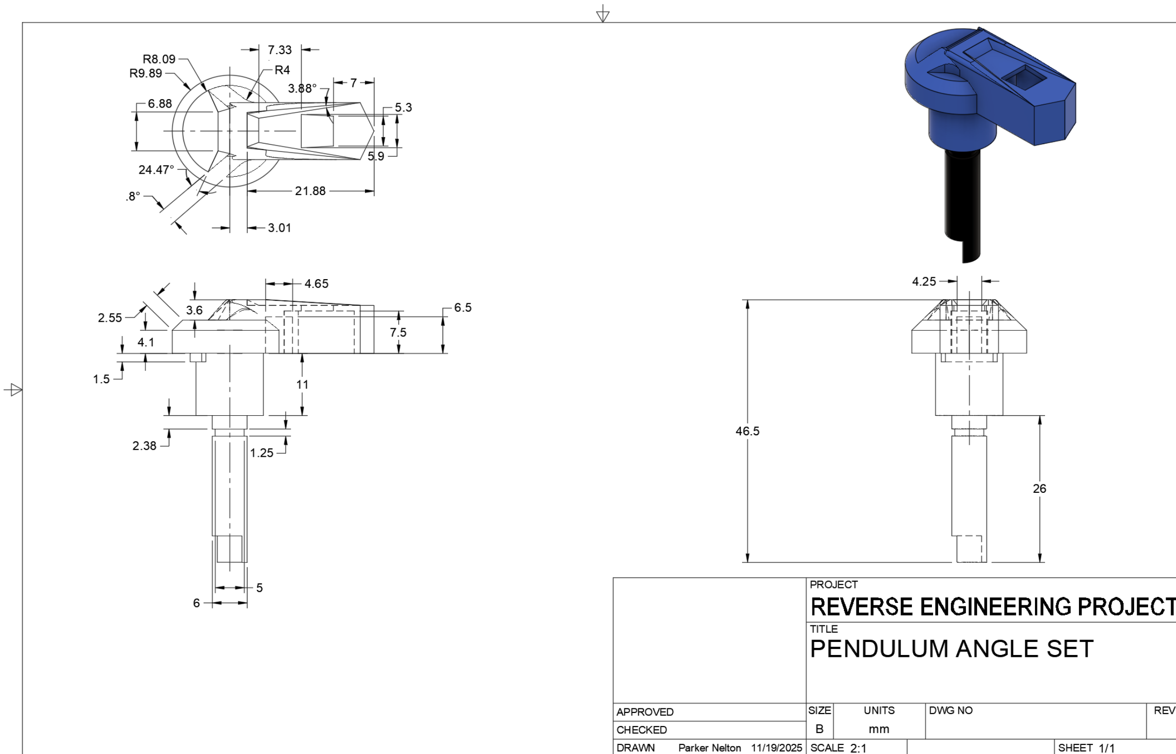

Figure 13. Pendulum Angle Set Drawing

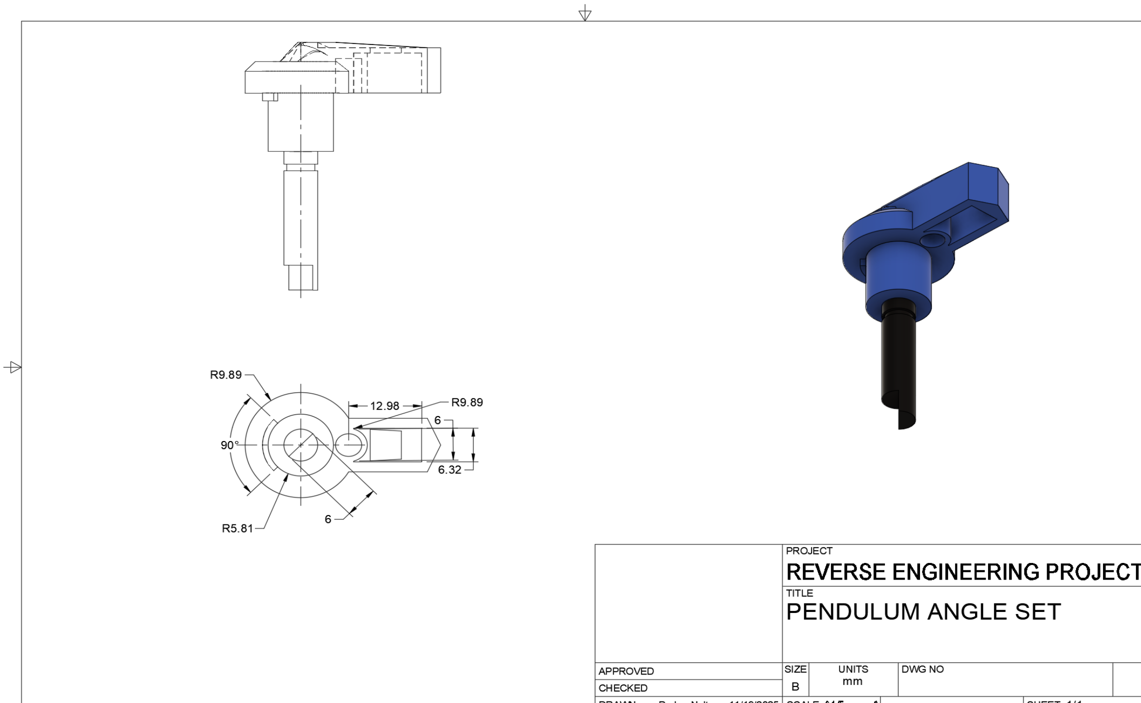

Figure 14. Bottom View of Pendulum Angle Switch Drawing

Form: The Pendulum Angle Set consists of a black metal rod that sticks out of the bottom of the visible switch. The rod sticks out 26 mm and has a semi-circle at the bottom that locks into a circular piece inside the jigsaw. The top is made of blue plastic and has a unique shape that is ergonomic for the user. The top has a circular base with an extruded piece that allows the user to use leverage to move the switch.

Fit: The Pendulum Angle Set fits into the base of the jigsaw near the blade. It has 3 settings including 15, 30, and 45 degrees. The switch is easily accessible for the user to adjust the blade angle. Once the switch is moved to a certain position, the switch becomes stationary to prevent accidental movement and unwanted angle changes.

Function: The function of the Pendulum Angle Set is to give the user the ability to adjust the vertical angle at which the blade repeatedly contacts the cutting material.

Proposed Improvement for Human Interface System:

Explains need/weakness. Provides clear and specific variation/improvement to one or more components. Provides detailed, logical justification including how it would address the weakness and how it impacts cost, lifespan, and user experience. Reliable sources used where appropriate.

Figure 15. Existing lock system in an on and locked position.

In the original lock on/off switch design the trapezoidal locking tab slides left or right onto the two tabs molded within the switch in order to lock the jigsaw on. When using the saw during a short test the lock was applied and it required two hands to lock the jigsaw. In order to release the lock, the trapezoidal lock tab was moved with both hands back to its centered position. While there is a spring to push the lock to its original position it is not strong enough and the shape of the lock binds it against the case stopping it from turning off. This poses a danger when the user stops paying attention to the moving blade to focus on removing the lock which can result in injury or harm. Additionally, the lock is not designed to be failsafe to protect users.

Figure 16. Engineering drawing of the improved lock and switch system with the dowel and hole design. The jigsaw is off and the lock is not engaged.

Figure 17. Engineering drawing of an enlarged view of the improved lock and switch system with the dowel and hole design. The jigsaw is off and the lock is not engaged.

Figure 18. Engineering drawing of improved lock with the lock not engaged.

In order to fix this problem, we replaced the trapezoidal lock and the molded tabs for a dowel that slides into a hole in the switch shown in Figures above. A hole in the case allows for a guide to be mounted that a small plastic dowel slides through. A hole is also made into the switch and the body of the switch at the same level as the dowel is mounted allowing the dowel to slide into the switch. A small slot shaped plate with two holes the diameter of the dowel is added to allow a spring to rest between a shoulder added to the dowel and the switch itself. Finally, a cut out is made into the box below the switch to allow the plate to slide up and down with the switch.

Figure 19. Engineering drawing of improved lock system with lock engaged.

Figure 20. Engineering drawing of improved lock with the lock is engaged.

The dowel and hole locking system works when the user depresses the switch and presses the dowel shaped lock into the hole of the switch and the switch's body as shown in figures above. The force from the switch to return to its original position due to a spring mechanism in the box creates tension on the dowel and holds it in place leaving the jigsaw on. The spring between the dowel's shoulder and the plate attached to the switch acts as tension to return the dowel to its original position meaning that touching the switch again released the tension on the dowel and the spring on the dowel presses the dowel out of the locked position and turns the jigsaw off.

While the trapezoidal locking mechanism requires the user to use both hands, the improved design of the dowel and hole permits the user to use a finger to press the lock in place. This allows the user to focus on the cut and moving blade rather than undoing the lock. The addition of the spring between the switch and the dowel also creates a failsafe for users in which the user can squeeze the trigger again to undo the lock rather than use both hands to undo it.

When the trigger is squeezed it releases the dowel and therefore turns the jigsaw off creating a safer user interface than undoing the trapezoidal lock mechanism.

The dowel and hole design does not impact the cost of manufacturing as the external guide is molded into the case plastic, the dowel is a small plastic part that substitutes the trapezoidal lock, the plate is molded into the switch as well as the holes, and the spring from the trapezoidal lock is moved to around the dowel. Overall, the cost and amount of material between the original lock system and the improved one is equal and requires different initial molds for the plastic and a larger spring. The improved design increases the lifespan of the jigsaw as it can be turned off quicker than the old lock system allowed therefore decreasing the amount of work the motor does therefore, extending the motors life. The improved design also allows users to use one hand near the handle for the switch and lock instead of required both hands to do and undo the lock. This means users can focus on the moving blade the cut being made. Using designs from other reputable brands of jigsaws we redesigned the system. https://www.milwaukeetool.com/products/6268-21 Additionally, using other jigsaws with this design of lock was easier and safer to use so the design was imitated.

Fit, Form, and Function Drive Train:

Motor Assembly:

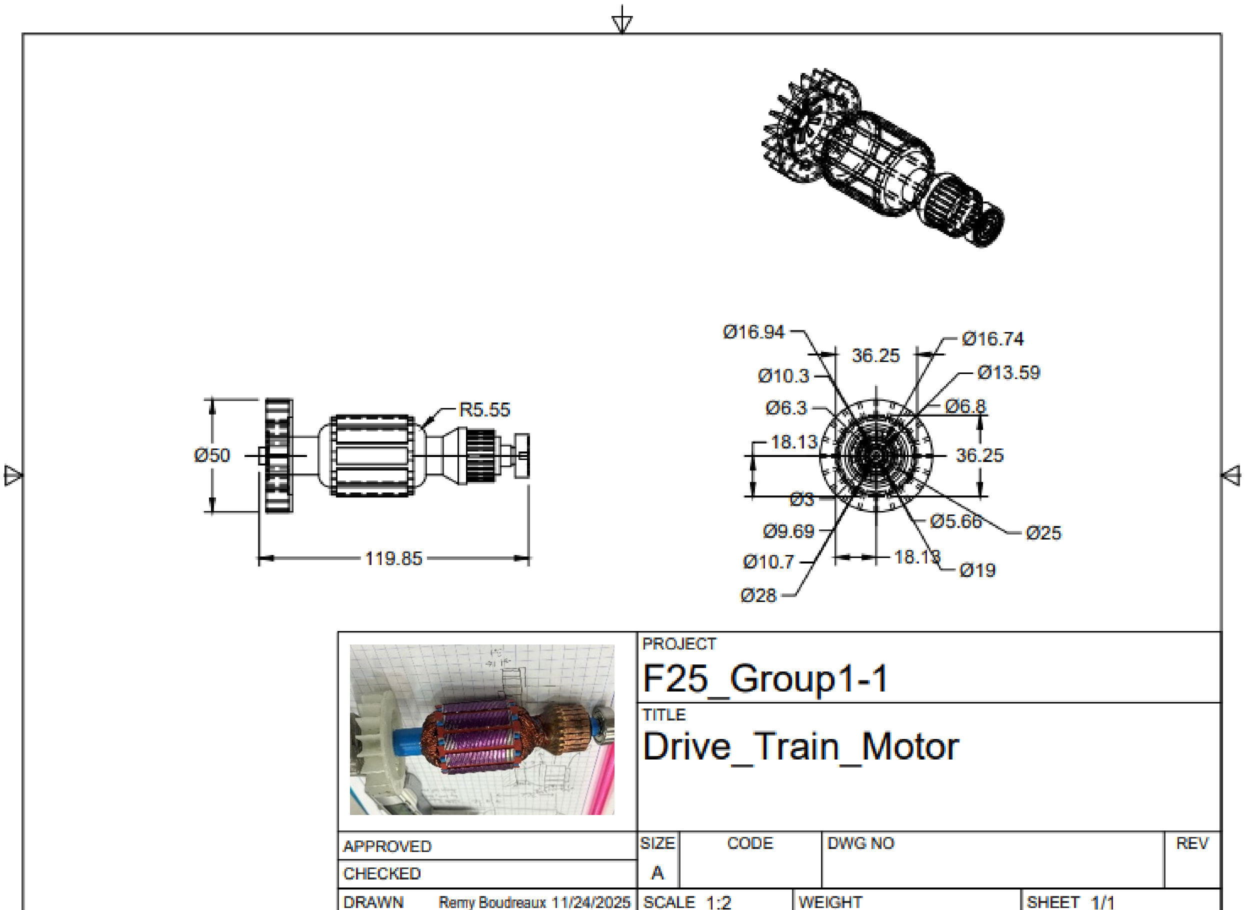

Figure 21: Engineering Drawing of Motor Assembly

Form: The Motor assembly is made up of 3 major pieces, a fan and a connector to a different piece on the left, the rotor in the middle, and an end bell on the right. The entirety of the assembly has a length of approximately 120 mm. The fan on the left side has 20 fins, and the connector on the left connects to a spline-like piece shown in a different piece. The rotor has 12 laminations with 12 accompanying magnets. Copper wires envelop both ends of the rotor and are displayed as the filleted ends of the rotor. The end bell on the right is a ball bearing assembly meant only to distribute rotational energy from the unused side of the motor.

Fit: The Motor assembly fits into the main casing and connects to the rest of the drive train including: The Stabilizing Joint, The Gear Restrictor, and finally the gear itself where most of the rotational velocity is being carried to.

Function: The function of the Motor is to use electromagnetic forces to create rotational motion which will eventually be changed into linear motion by the gear. The rotational motion created also doubles as a cooling system via the fan attachment to the motor rod.

Stabilizing Joint between Motor & Gear Restrictor:

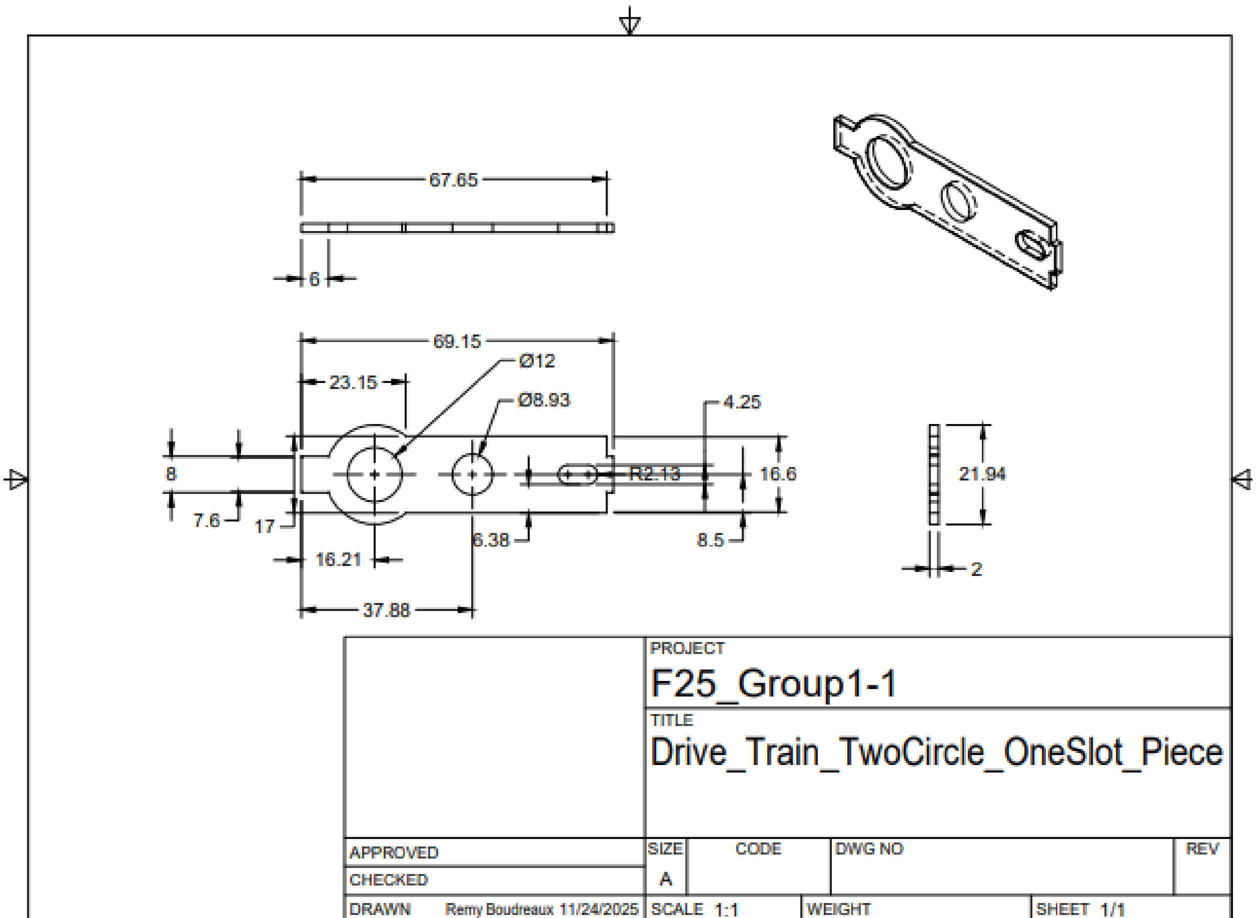

Figure 22: Engineering Drawing of Washer-Like Piece situated between The Motor & The Gear Restrictor

Form: The Joint between The Motor & The Gear Restrictor is approximately 70 mm in length and 22 mm in width. It is a thin piece of metal (2 mm in depth) with 2 circles and 1 slot within the center of it. The left-most circle is larger than the middle circle by 3 mm and the slot on the right has a radius of 2.1 mm on both ends.

Fit: The Joint is sat between two active and essential pieces the object. This piece is in place to reduce the stress on more essential pieces of the drive train such as the gear restrictor and the motor rod. This piece connects perpendicularly to the motor rod and fits the gear within the spline-like pieces which transfers the rotational energy from the motor.

Function: The fit is important in understanding the function because it essentially relates to the function of the object. This piece is in place to reduce the stress on more essential pieces of the drive train such as the gear restrictor and the motor rod. The function is accomplished via its placement inside of the drivetrain. It allows for the rod and the gear restrictor to be comfortably connected.

Blade-Release Lever Holder:

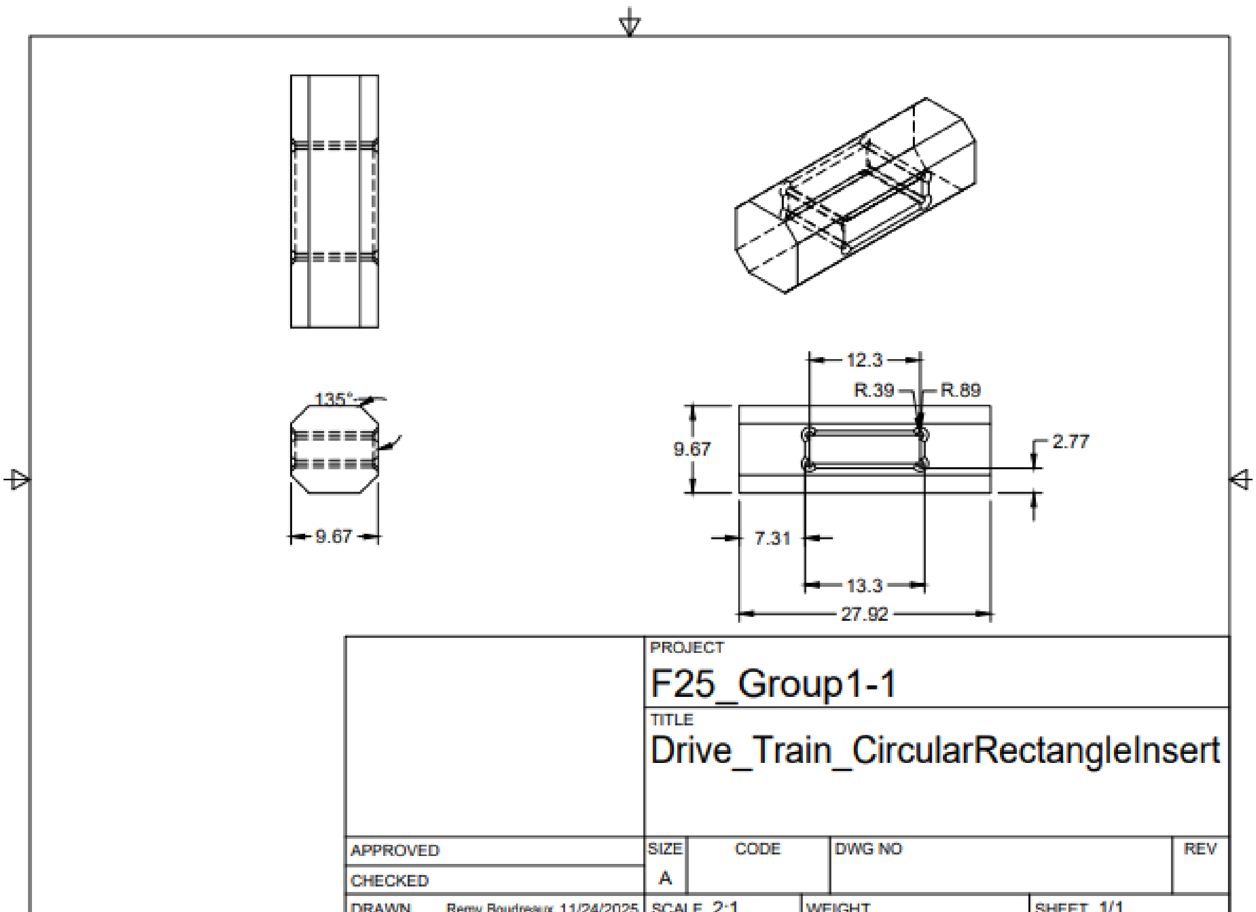

Figure 23: Engineering Drawing of The Blade-Release Lever Holder

Form: The Blade-Release Lever Holder is in the shape of a rectangular prism with chamfered edges and a rectangular shaped cut through the center of it. The cut within the center of the object is chamfered on the inside and has small circular cuts in the corners of the rectangular cut.

Fit: This piece fits comfortably into a plastic slot formed in the casing and within the assembly of the drive train this piece does not move. When the Blade-Release Lever is moving back and forth due to the gear, this piece provides a fitting for the end of the lever to enter.

Function: Utilizing a metal piece for consistent strain and friction is preferable to plastic, thus a separate metal piece was constructed to complete the function of smoothness, stability, and longevity.

Gear Restrictor:

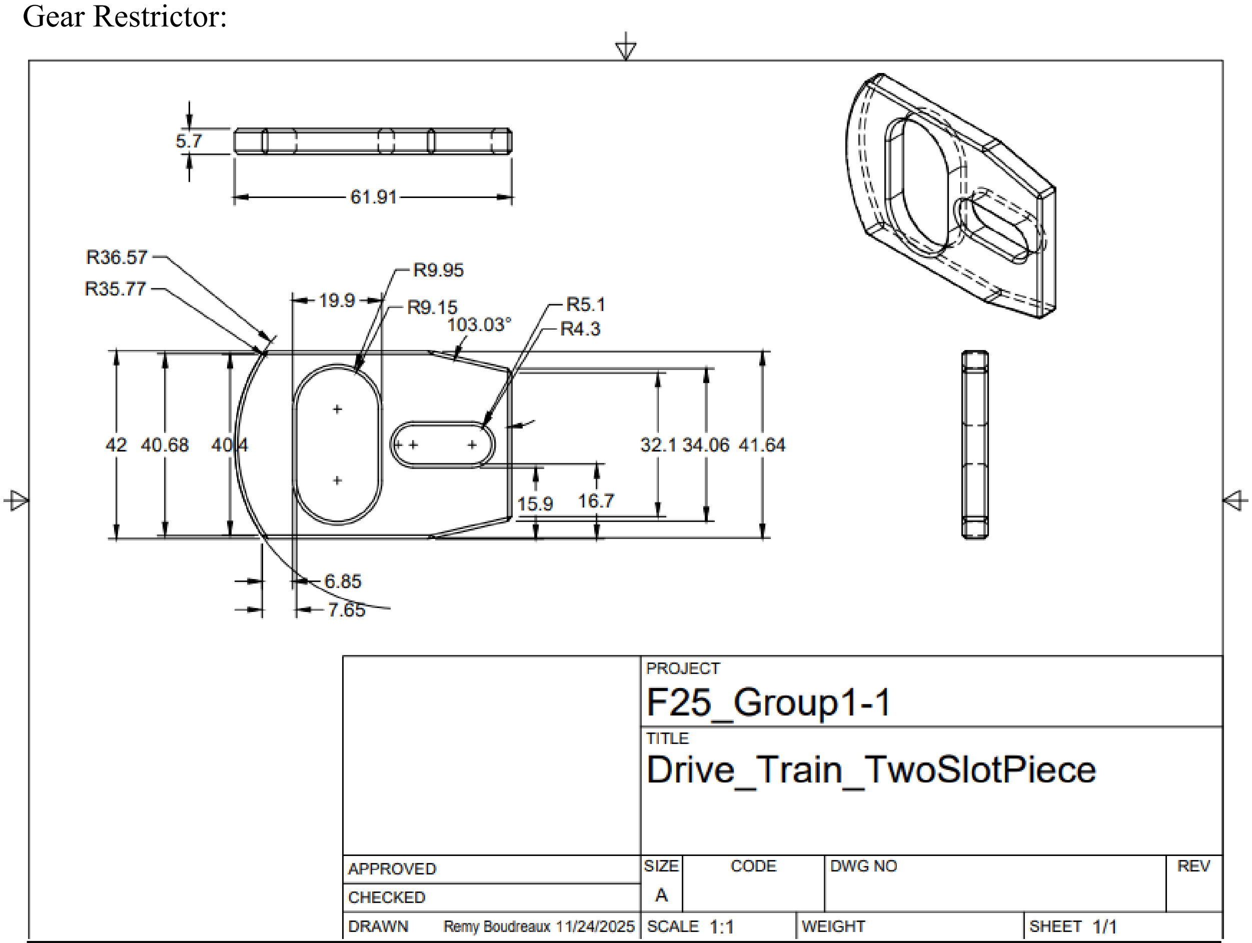

Figure 24: Engineering Drawing of Gear Restrictor

Form: The Gear Restrictor is a relatively thick slab of metal with two slot-shaped cuts made into the middle of the piece. Every edge of the piece is slightly chamfered, and the two slots lay perpendicular to each other. The larger of the slots has a radius of 9.15 mm and the smaller slot has a radius of 4.3.

Fit: The Gear Restrictor connects to the gear and the spline-like piece attached to the motor. The spline-like piece goes through the smaller slot, the circular extrusion from the bottom of the gear fits into the larger slot. Both attached pieces have enough space to slide in a singular direction within their respective slot.

Function: The restriction of the gear's movement pairs with how the gear is designed to create a continuous linear back and forth flow of the blade-release lever. This feature results in the device being able to "saw" through materials. Essentially the restriction of certain degrees of freedom alongside the design of the gear allows for the rotational motion from the gear to turn into linear motion.

Large Helical Gear

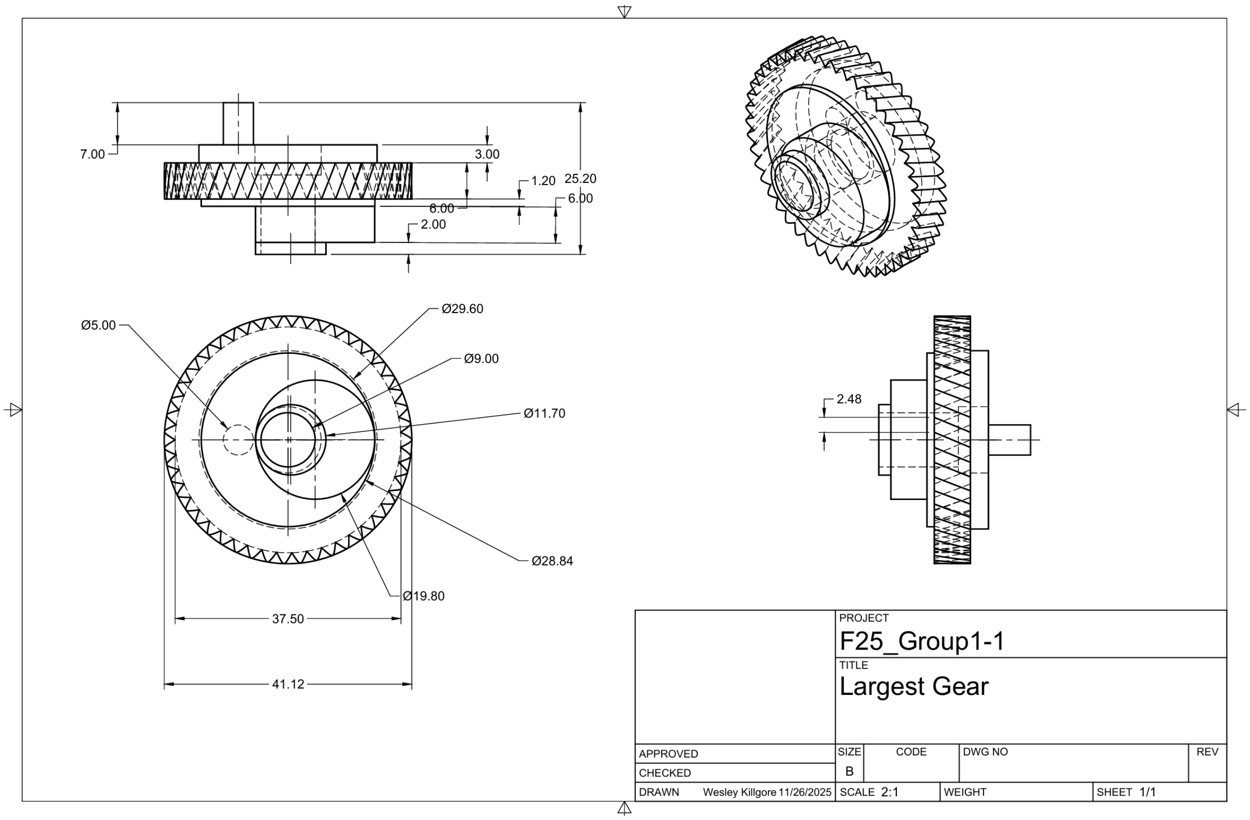

Figure 25: Engineering drawing of Large helical gear

Form: This is a relatively large helical gear with a diameter of 41.12 mm. There is a hole down the center with diameter of 11.70 mm and a depth of 18.2 mm. It has 47 teeth that make a 7.66-degree rotation to create the spiral seen above. On one face of the gear there is a peg that protrudes 7.00 mm. On the other face there are larger cylindrical protrusions that are almost tangential around the center hole. The larger cylinder has a diameter of 28.84 mm and protrudes 6 mm. The smaller cylinder has a diameter of 11.70 mm and protrudes from the larger cylinder by 2 mm.

Fit: The hole in the center of the gear fits around the small bearing that sits on the axle that protrudes from gear holder. The larger cylinder that protrudes from gear fits inside the slot of the gear restrictor piece. The teeth of this gear intertwine with the teeth of the screw-like gear. The peg that protrudes from this gear fits into the slot that is on the blade release lever.

Function: This gear is rotated by the screw-like gear. The larger cylinder section of the gear rotates around the axle causing the gear restrictor piece to move in a up and down motion. The peg that is on the other face of the gear orbits the center of rotation. The orbit of the peg is transferred into the slot of the blade release lever which will move up and down as the peg moves up and down the vertical plane.

Figure 26: Photo of Gear holder, screw-like gear, and large bearing

Figure 27: Photo of Gear holder, screw-like gear, and large bearing continued

Screw Like gear

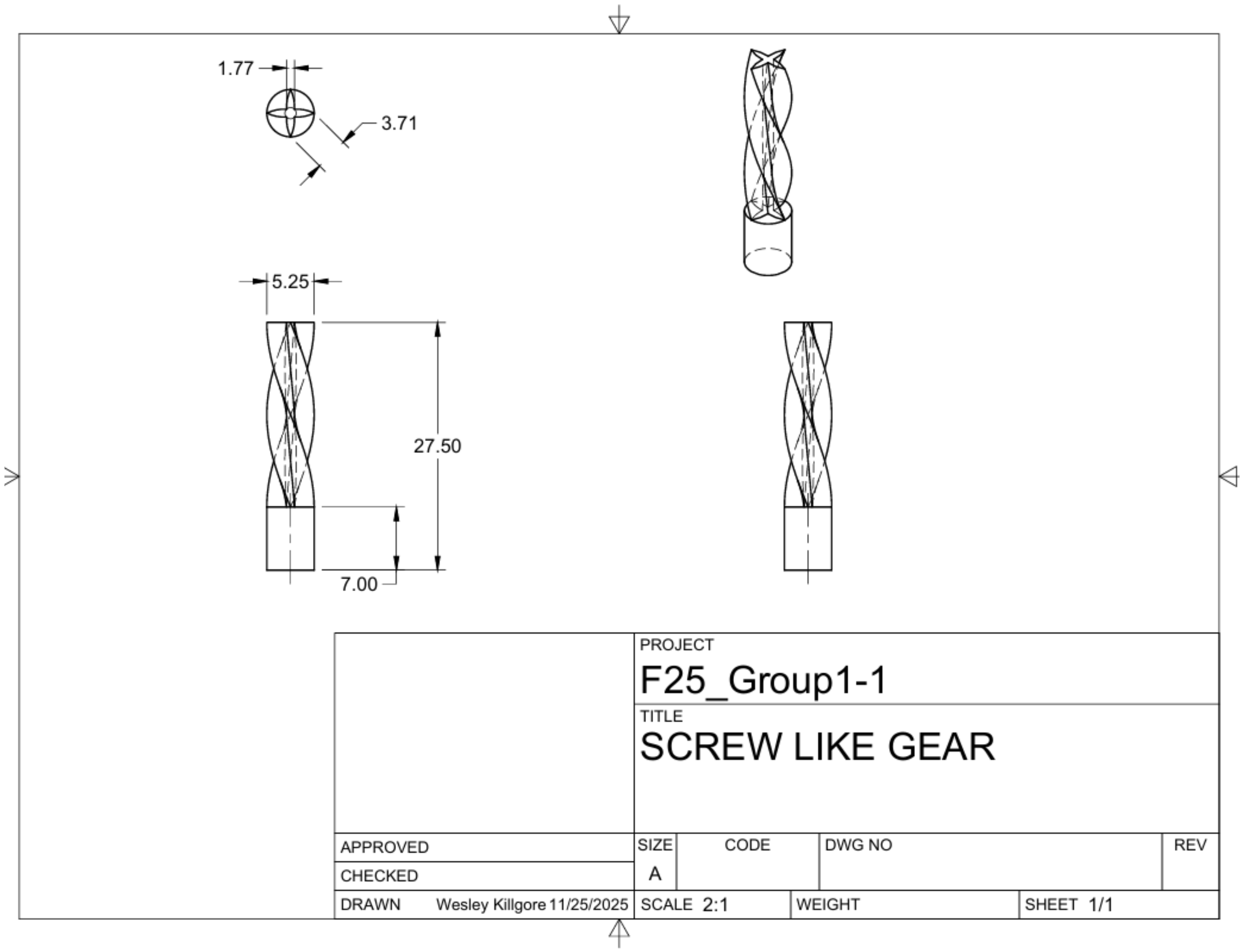

Figure 28: Engineering Drawing of Screw Gear

Form: This piece of the drive train is an elongated, thin helical style gear. It has four teeth that make a 180-degree rotation around the vertical axis to create the screw like spiral you see above. The whole piece is 27.50 mm long and 5.25 mm in diameter. At the bottom of the gear there is a 7.00 mm section that does not contain teeth, making a short cylinder at the bottom.

Fit: The short cylindrical section located at the bottom of this piece fits into the hole in the center of the bearing. The teeth of this gear intertwine with the teeth of large helical gear. The bottom of the gear attaches to the motor piece as well.

Function: The motor that this gear is attached to applies rotational force the gear. The bearing that the gear is inside of allows the gear to rotate without getting out of control. The rotation of this gear transfers to the large helical gear through the intertwined teeth, resulting in the rest of the drive train coming into motion.

Gear Holder

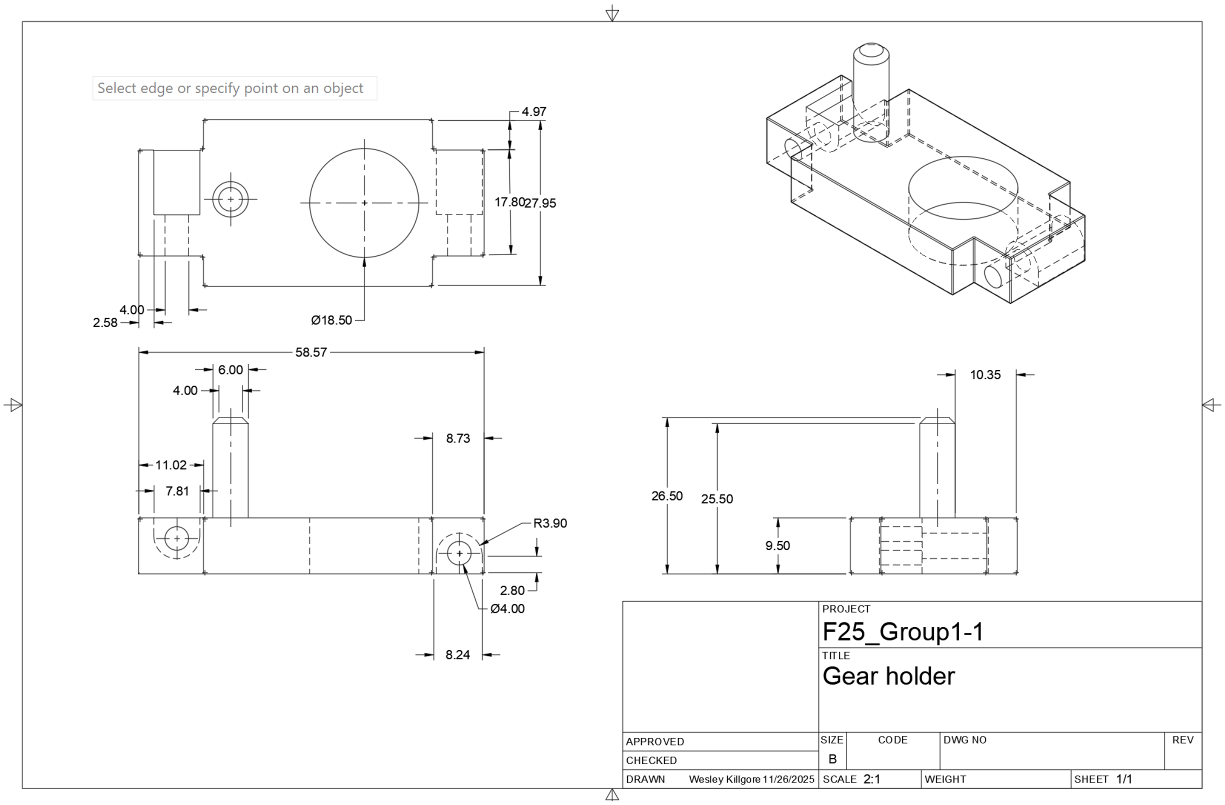

Figure 29: Engineering drawing of Gear holder

Form: The majority of the gear holder is made up of rectangular prisms. The largest prism has a width of 27.95 mm, length of 38.82 mm, and height of 9.50 mm. Two smaller prisms stick out from the left and right of the largest prism (looking at the part from the top view). All have a height of 9.50 mm. The length and width of the left prism is 17.80 mm and 11.02 mm respectively. The length and width of the right prism is 17.80 mm and 8.73mm respectively. Both widths are symmetrical around the centerline of the width of the largest prism. On both smaller prisms there are holes cut out for screws (can be seen above). On the top face of the piece there is an axle that protrudes 17 mm. It has a diameter of 6.00 mm that tapers to 4.00 mm the last 1 mm of its length. An 18.50 mm diameter hole is drilled in this piece from the top face all the way through the bottom face.

Fit: A bearing fits into the large hole that is drilled through this piece. Screws fit into the smaller holes on the side of the piece, fixing it to the shell of the jig saw. The stabilizing joint, the slot of the gear restrictor, and the smaller bearing also all fit around the axle. The large helical gear fits over the smaller bearing that is stabilized by the axle. The screw-like gear fits into the larger bearing that is stabilized by the largest hole in the gear holder.

Function: The Function of this piece is to ensure that all the pieces of the drive train are kept at a position that allows for the correct motion of all components. While it is one of the only parts of the drive train that does not move, it is probably the most important due to its major role in keeping all the pieces in place.

Large bearing:

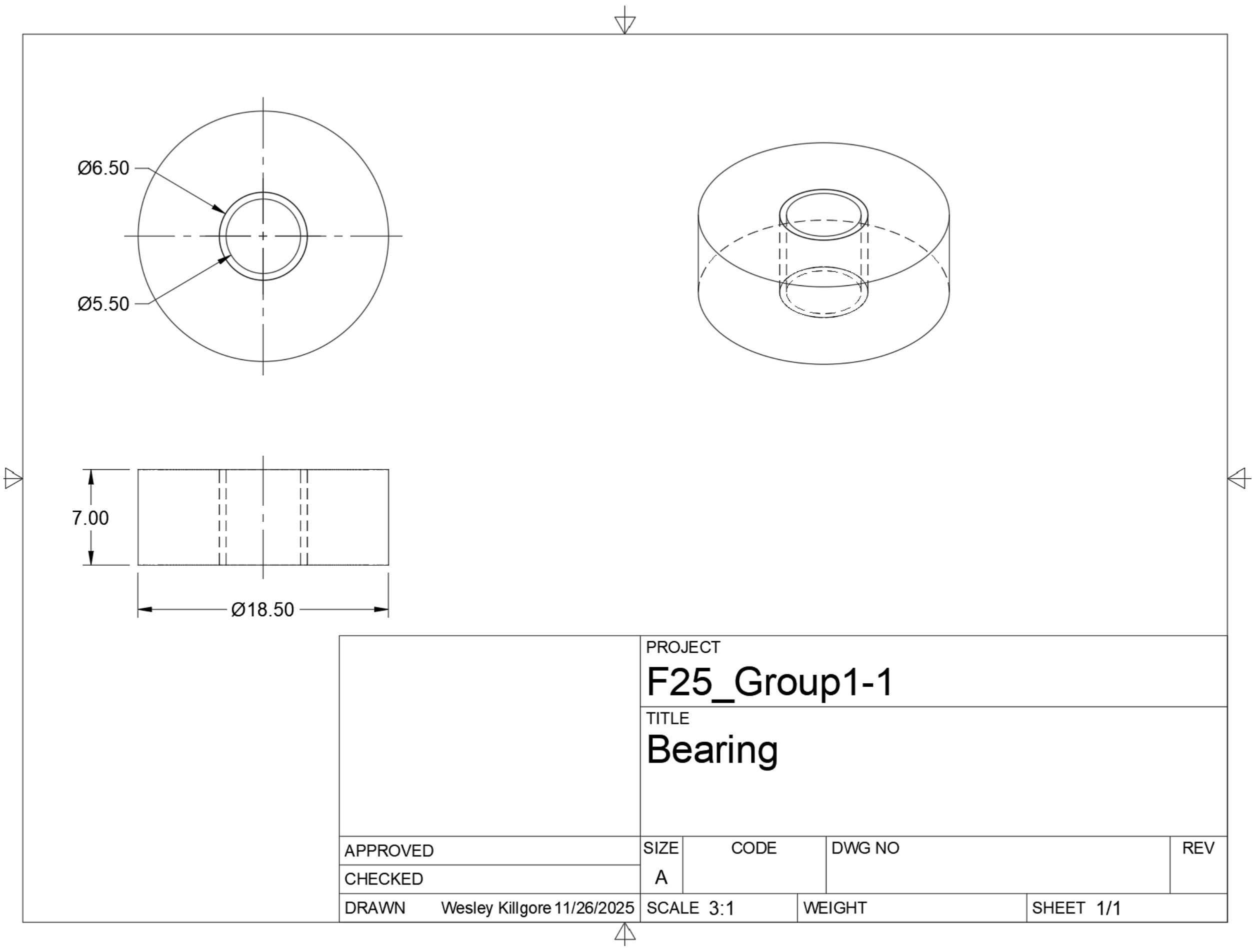

Figure 30: Engineering drawing of Larger Bearing

Form: This component is made of two cylinders, a smaller one fitting inside of a larger. The larger cylinder is 7.00 mm in height and has a diameter of 18.50 mm. The smaller cylinder is 7.00 mm in height and has a diameter of 6.50 mm and fits inside of a hole with the same dimensions. There is a hole in the smaller cylinder that is 5.50 mm in diameter and 7.00 mm in depth.

Fit: The bearing is fixed on the interior of the large hole that is drilled through the gear holder. The screw-like gear is fixed in the hole of the smaller cylinder of the bearing.

Function: The function of this bearing to ensure that the screw like gear is able to rotate smoothly while also keeping it in place.

Small bearing:

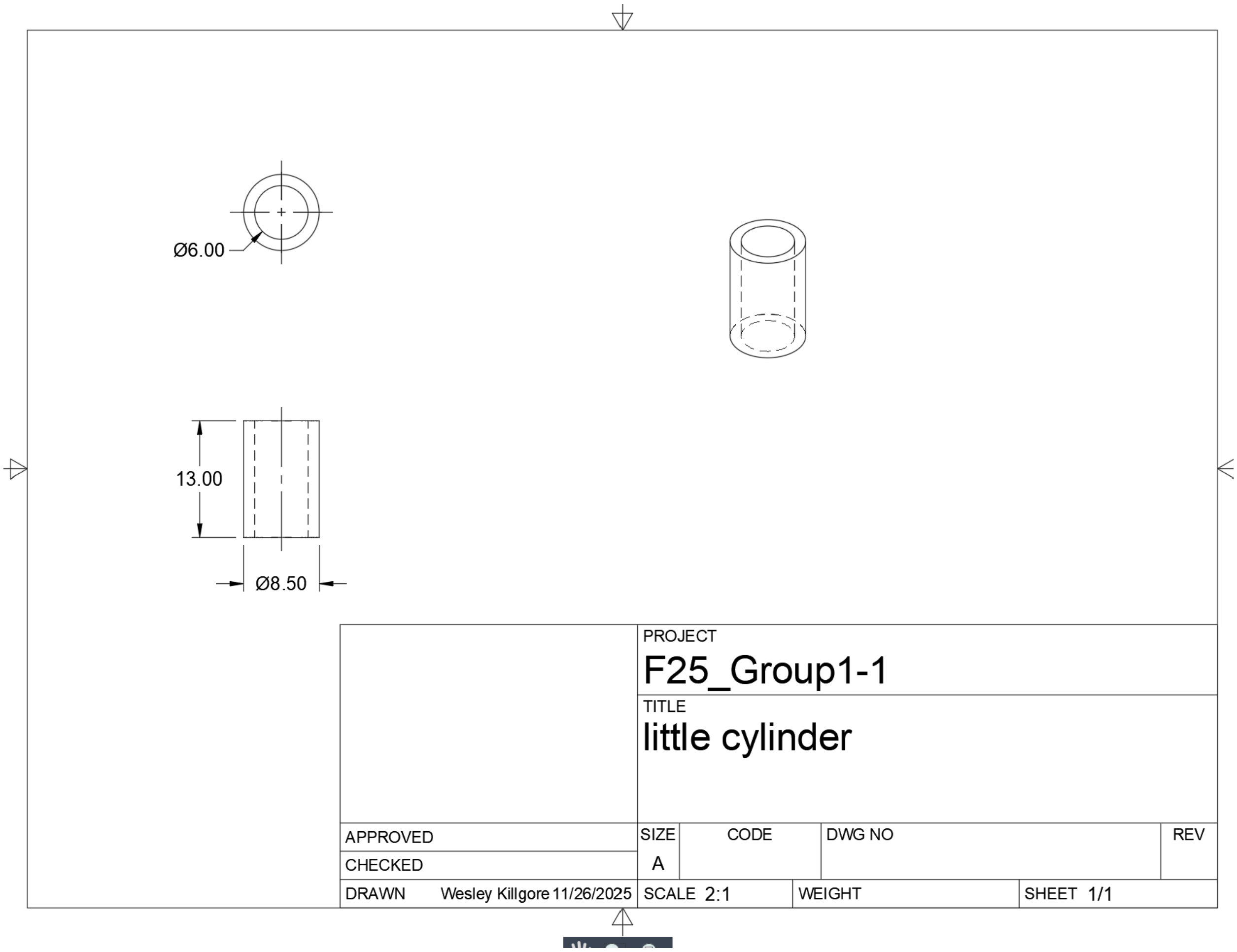

Figure 31: Engineering drawing of smaller bearing

Form: This extremely simple bearing is a cylinder with a hole drilled down the center. The cylinder is 13.00 mm in height and has a diameter of 8.50 mm. The whole that drills through cylinder vertically has a height of 13.00 mm and a diameter of 6.00 mm.

Fit: This bearing fits onto the axle that protrudes from the gear holder. The large helical gear is then fit over the bearing.

Function: The function of this bearing is to provide a smoother rotation for the large helical gear around the axle.

Proposed Improvement for Drive Train System:

An improvement that could be made to the drive train system would be implementing an easier way of disassembling the system for maintenance and repairs. The original drive train system had a small ring that held the large helical gear in place on the gear holder axle. This little ring took a lot of force to detach and was incredibly difficult to remove without being broken in the process. The reason behind our proposed improvement can be explained by the circular design principles, which basically states that parts should be designed for eventual recycling or upcycling, to reduce waste of energy and material. For someone who wanted to do some maintenance or repair work this would be very difficult and excessive to work with and could lead to the whole device ceasing to work. An improvement that could be made would be to make the disassembly mechanism something that could be reused and easily removed. One such disassembly mechanism that could be used would be a screw and washer. A washer that is held in place by a screw could do the same job as the original ring, but it would be extremely easy to remove and would not break. With this improvement, the issue of disassembly would be resolved, making it much easier without complicating things. (Pictures of improvement are below).

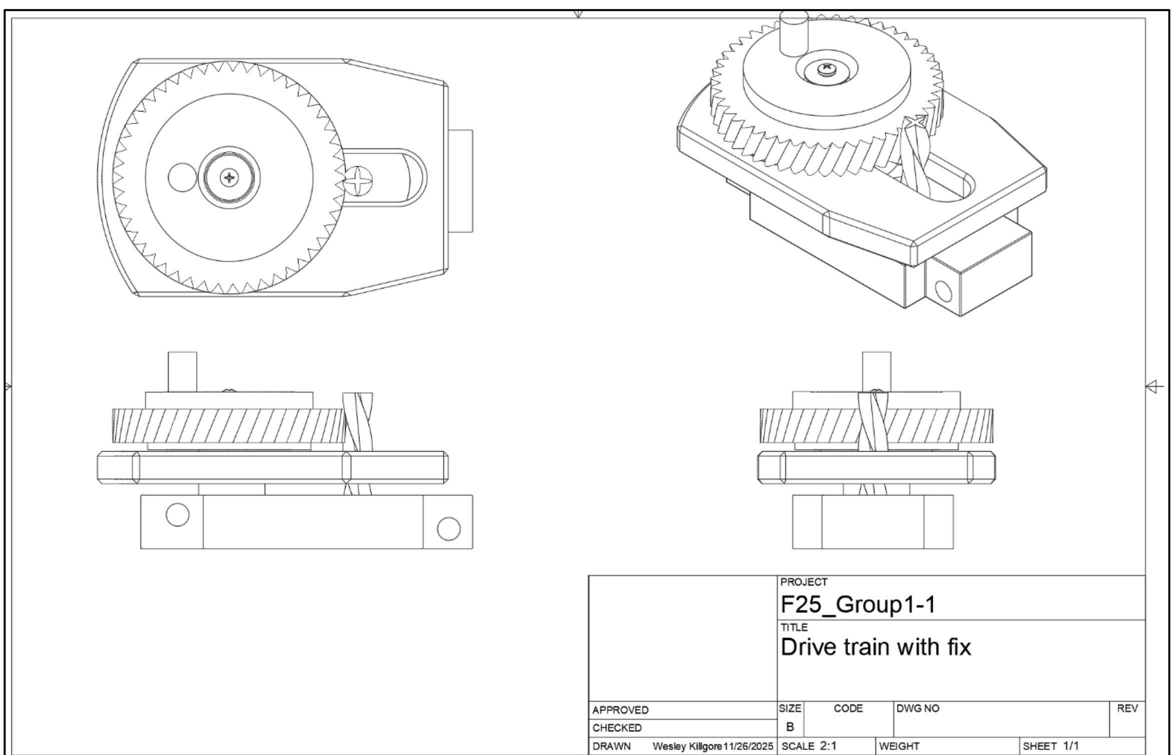

Figure 32: Design Implement drawing (Dimensions hidden for clearer view)

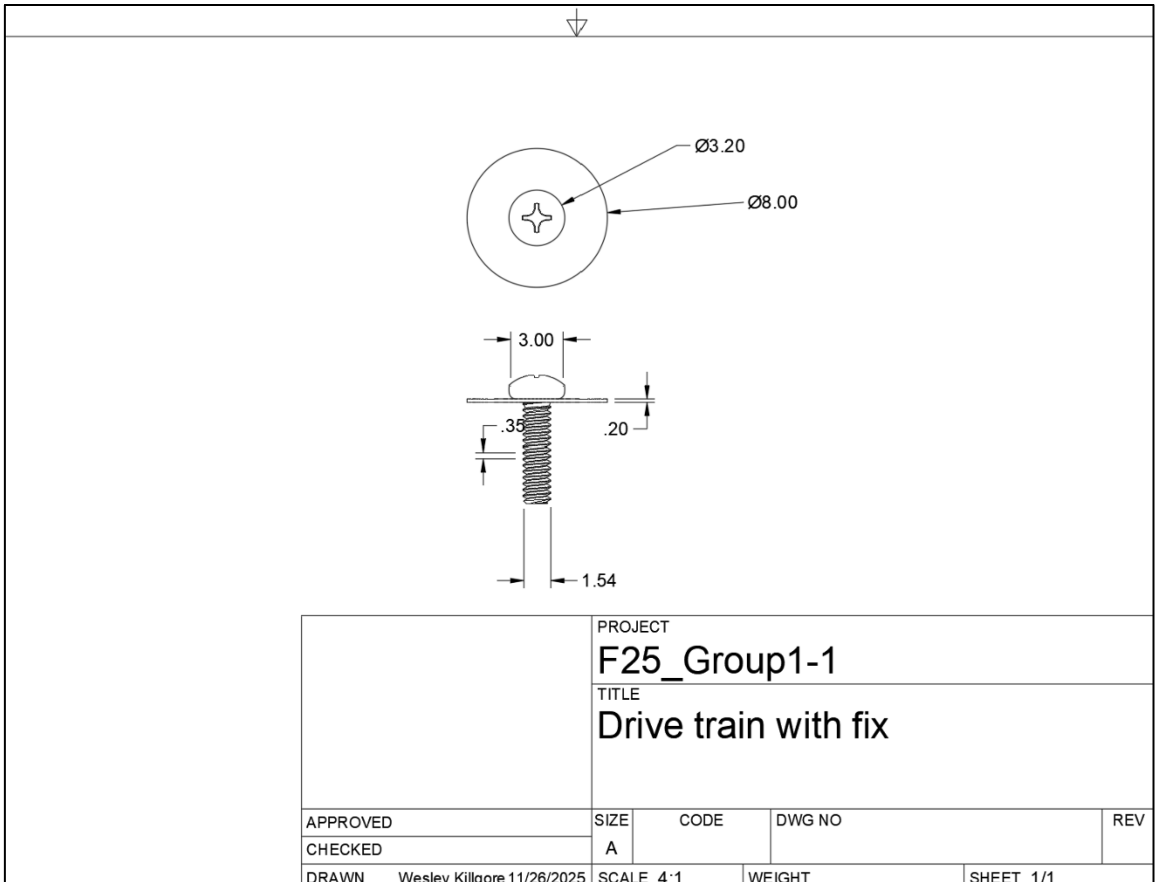

Figure 33: View of added parts without other pieces for better view. Basic dimensions.

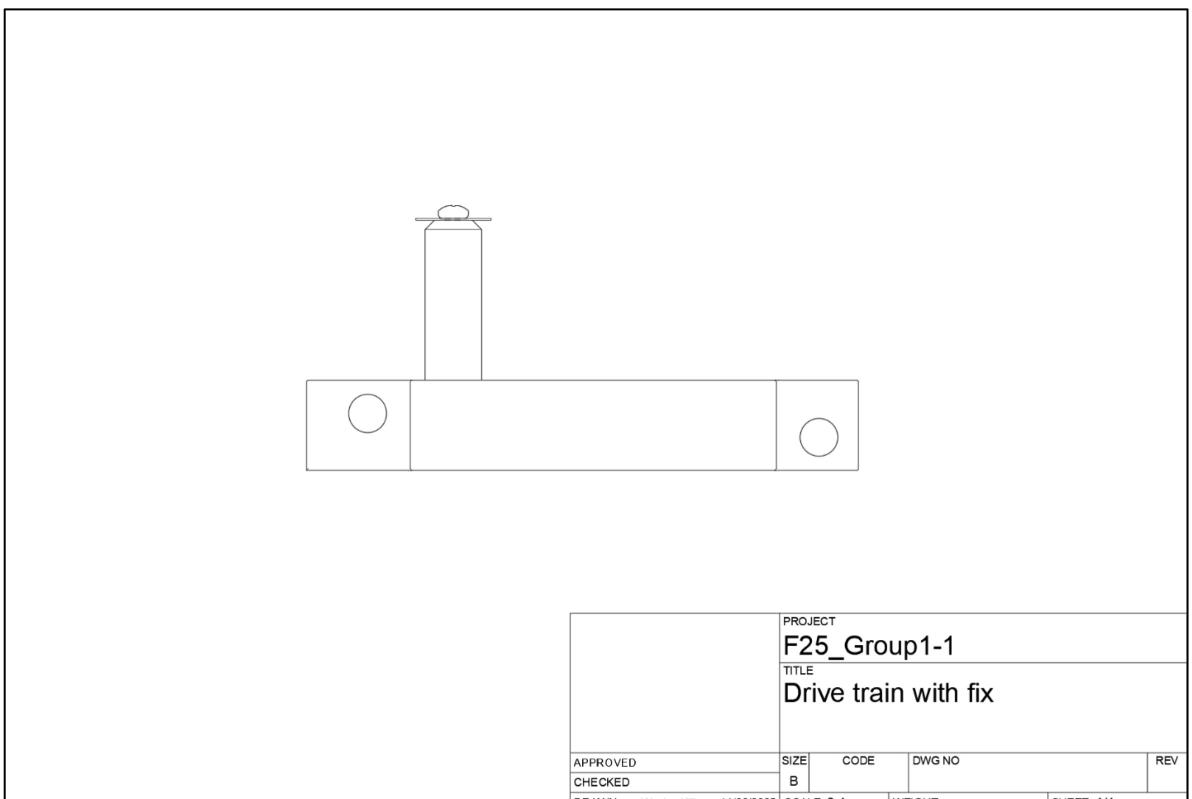

Figure 34: A side view of improvement without helical gear (for better view)

Form, Fit, and Function Structural:

Jigsaw Case:

Figure 35. Jigsaw case

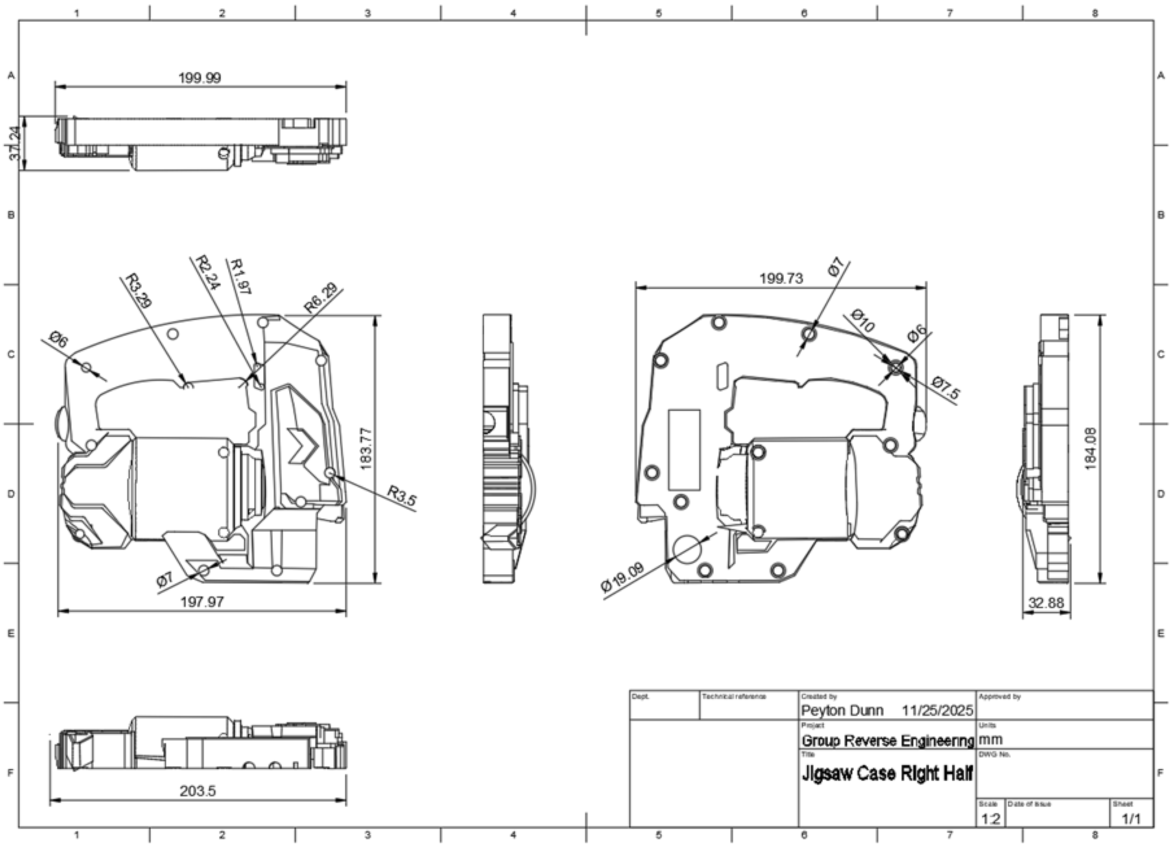

Figure 36: Jigsaw Case Right Half

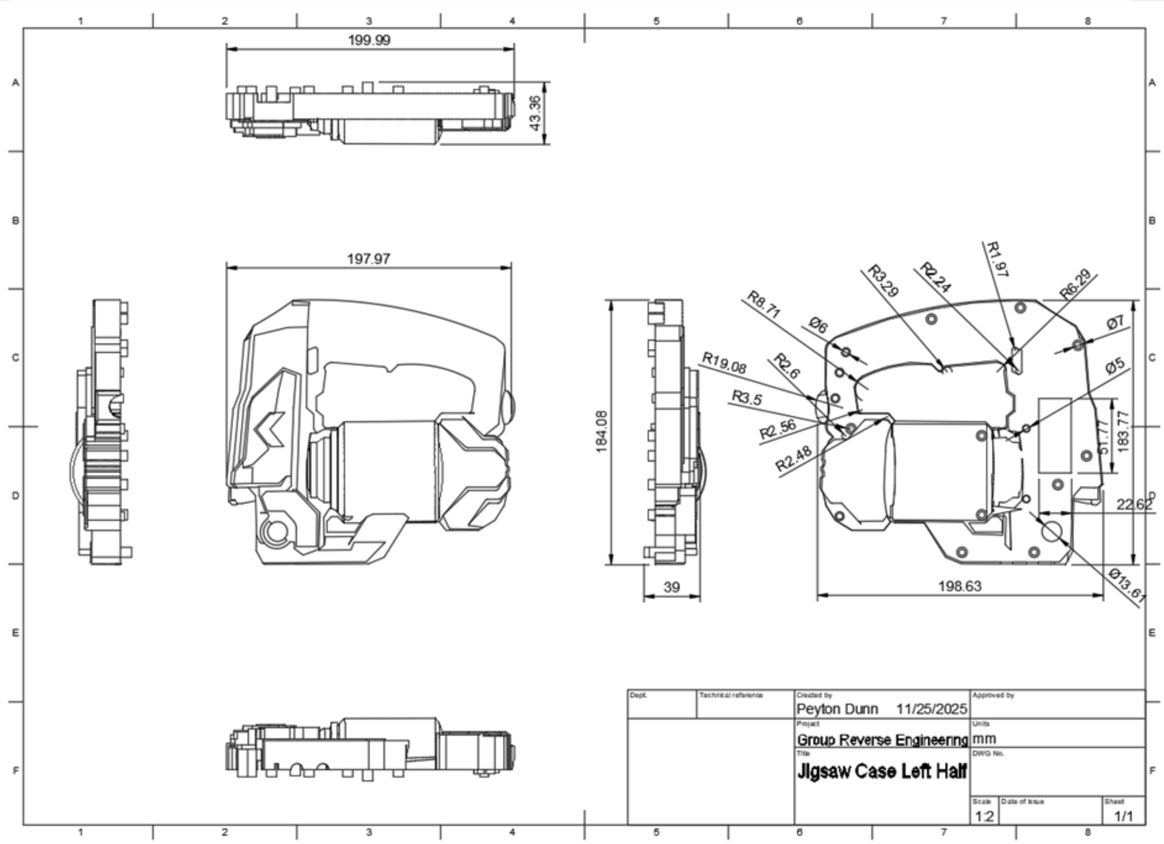

Figure 37: Jigsaw Case Left Half

Form: The case is one solid piece. It is made of hard, durable plastic. The maximum height of the full case is approximately 184 mm, the maximum length of the case is approximately 200 mm, and the maximum width of the case is approximately 71 mm.

Fit: The two halves of the case join using a series of screws, holes, and threaded holes. One half of the case contains extruded cylinders that are threaded to receive the screws. The other has holes for the screws to be inserted and fastened from the exterior. The interior of the case has mounting for the drivetrain system, as well as mounting for all of the human interface systems. The case is cut out in the areas where the human interface components are, to allow access to the user.

Function: The case is the protective housing for the interior components. Along with protecting the other components, the case contains cutouts and screw holes inside it for mounting and holding the other components. The holes that expose the interior allow access to the human interface components.

Saw Base Blade Guide:

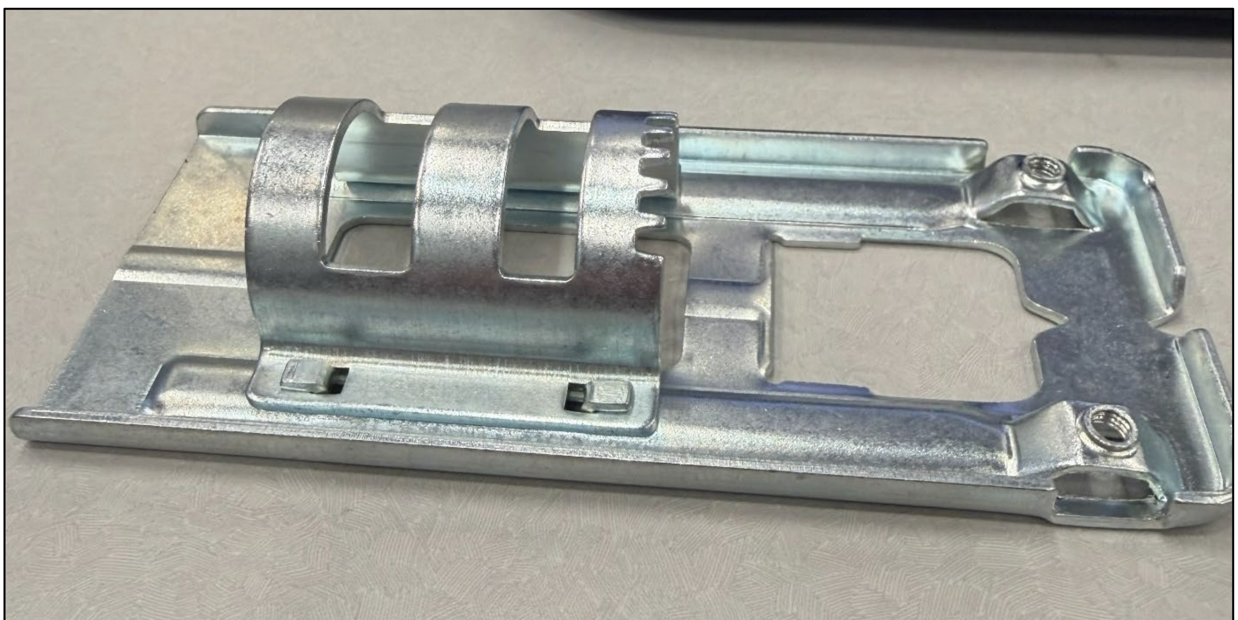

Figure 38: Photo of Saw Base Blade Guide

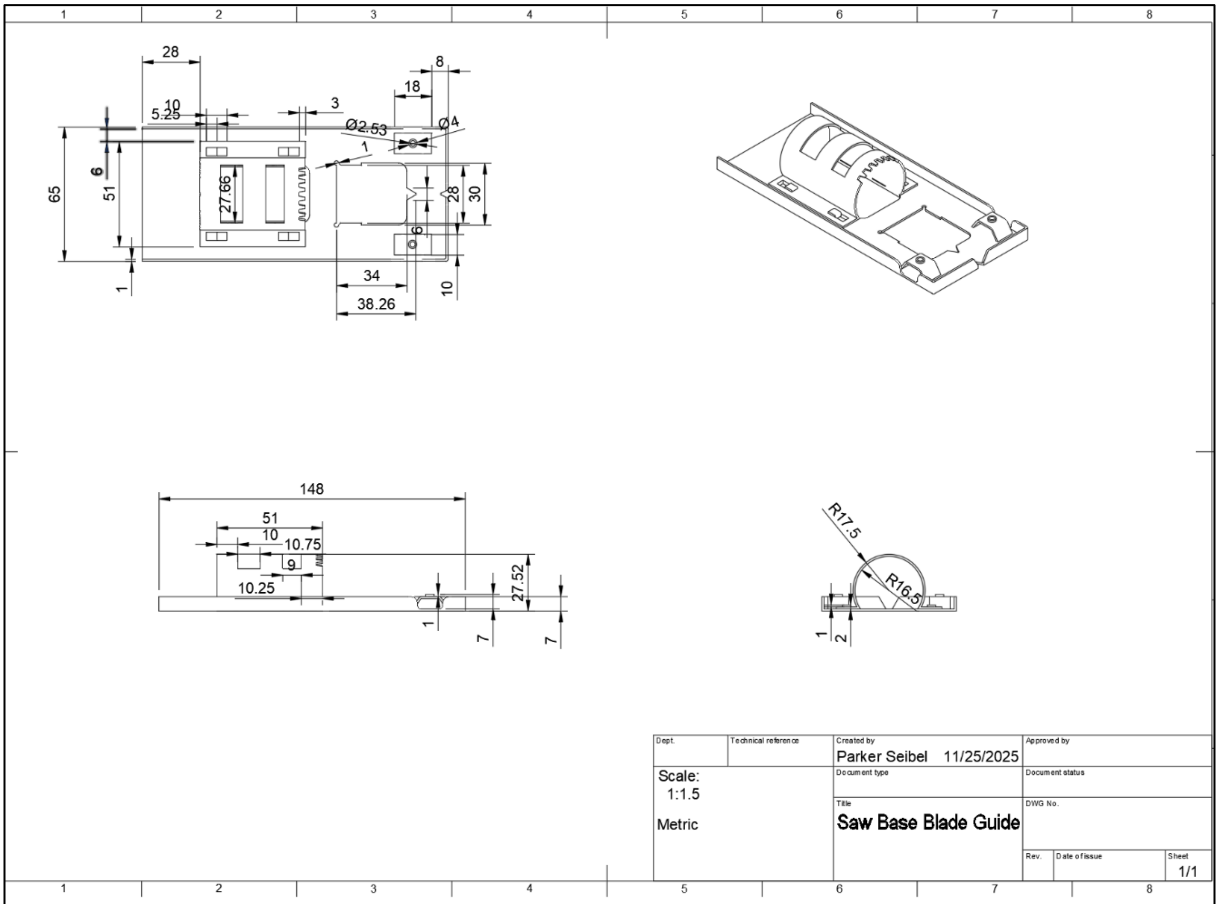

Figure 39: Engineering Drawing of Saw Base Blade Guide

Form: The saw base blade guide is a 148 mm by 65 mm plate with a 1 mm thickness all around. There is front and side walls with a hole cut in the front for the mark on a table to be visible for measurement and a hole in the side wall for the ruler piece to attach into. There is a 17.5 mm radius circular piece that is 51 mm long with 6 teeth forming 7 holes. There is a 34mm by 30mm rectangular piece that the blade goes through, and a 53mm by 26 mm hole under the circular piece. There are two 18mm by 10 mm arches that are 4mm tall.

Fit: This base attaches to the front of the jigsaw by aligning it with the holes at the front the jigsaw and black attachment piece, taking the silver attachment plate on the other side, and screwing in two screws to attach the pieces together. The circular part of the base allows for a vacuum to attach which sucks up the material chips formed from the cutting. There is also two metal arches that a metal ruler slides under which you can fasten with screws to allow measuring.

Function: This base supports the load of the jigsaw upon it, forming a flat surface the jigsaw can be guided with. The circular part is shaped the way it is with a circular shape and teeth to allow the user to select different cutting angles to cut at. You can tighten the pieces at different angles, which the blade will guide to, but the base remains flat on the surface you are cutting. The base is also 148 mm long, giving it a long surface to provide stablility with. The piece also holds a metal ruler.

Silver Attachment Plate:

Figure 40: Silver Attachment Plate

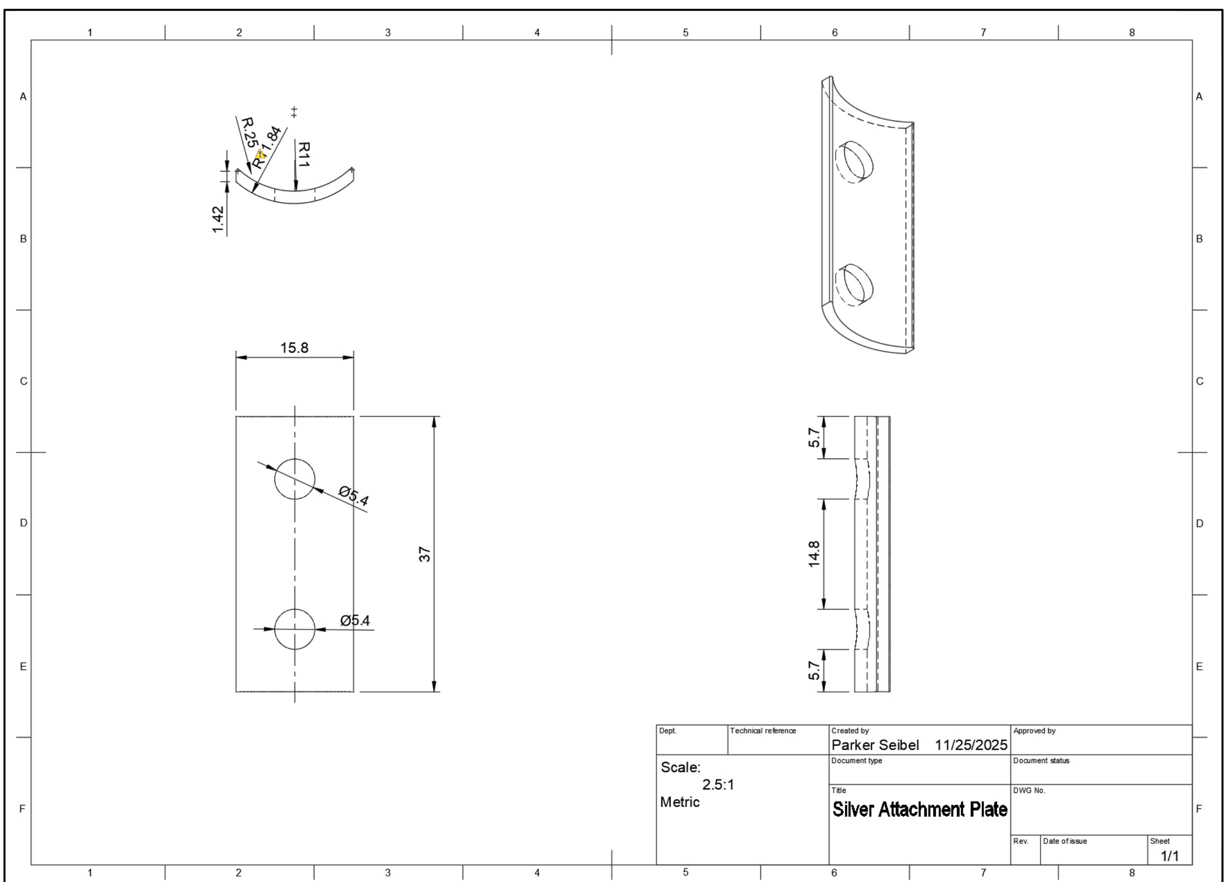

Figure 41: Silver Attachment Plate Drawing

Form: This is a bent plate piece that has a width of 15.8 mm and a height of 37 mm. The thickness is roughly 1.5mm, but it can be off in some places due to manufacturing. The holes have a diameter of 5.4 mm which are each 5.7 mm away from the edges respectively. The bend has a radius of 11 mm.

Fit: This piece goes on the underside of the circular part of the saw base blade guide (Figure 38), where it has two holes for the circular extrusions of the black attachment piece (Figure 42) and screws to fit into and secure it into position. The radius of the bent shape fits perfectly along the radius of the circular shape in figure 38

Function: The plate is designed to form a rigid joint between itself, the black attachment piece and saw base blade guide.

Black Attachment Piece:

Figure 42: Black Attachment Piece

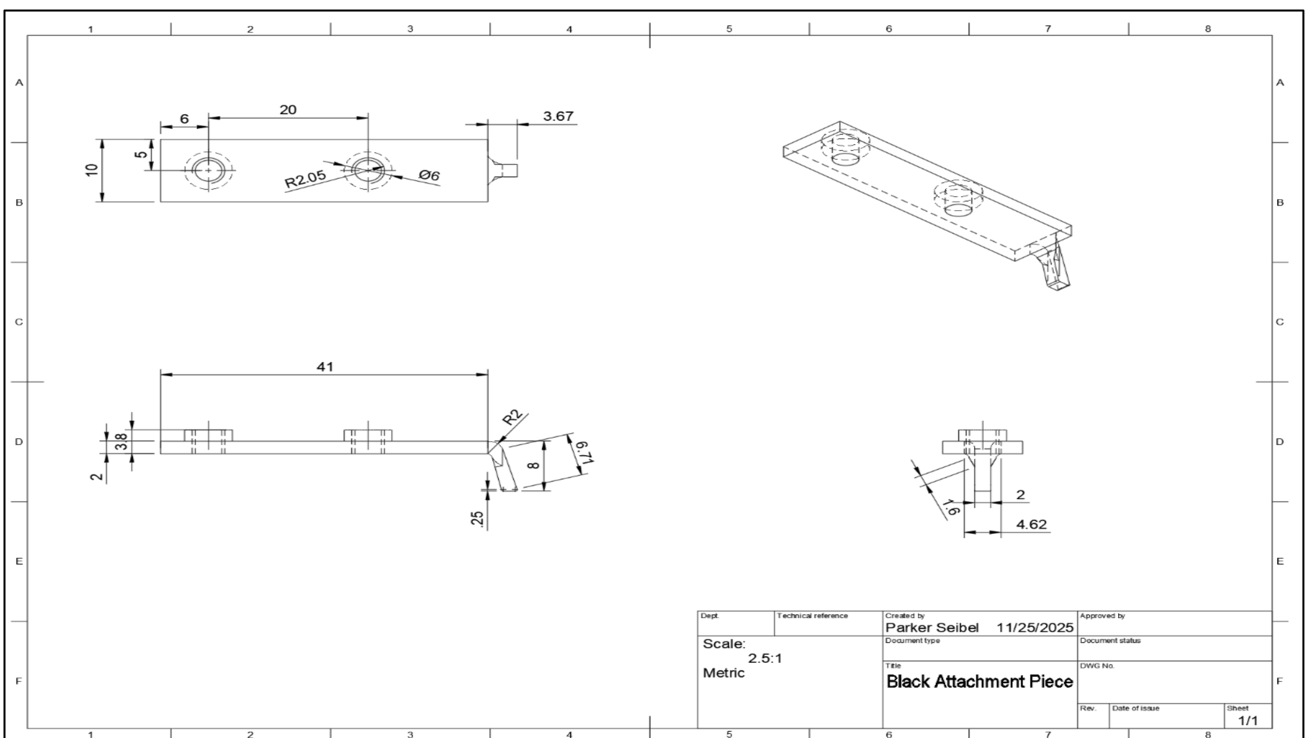

Figure 43: Black Attachment Piece Drawing

Form: This is a 41 mm by 10 mm black metal piece that has 4 mm holes in it that has a 1 mm thick rim that is about 2 mm tall. The first hole opposite the bent piece has a center that is 5mm from the edge. The second hole closest to the bent piece has a center that is 20 mm from the other holes center. The metal is 2 mm thick overall. There is a diagonal bent piece that is about 7mm long, that has a thickness of 2 mm as well.

Fit: This black attachment piece has threaded holes that align with holes on the jigsaw near the blade. The bent piece inserts into a hole in the jigsaw to give a more secure fit. The extrusions of this piece fit into the holes of the silver attachment plate (figure 40) and the rectangular holes formed by the circular piece in figure 38.

Function: This piece is an attachment point for the saw base blade guide to form to. It forms the other side of the rigid joint between this piece, the circular part of figure 38, the silver attachment plate (figure 40), and most importantly to the jigsaw (figure 35). Without this piece the saw base blade guide would not attach to the jigsaw.

Proposed Improvement for Structural System:

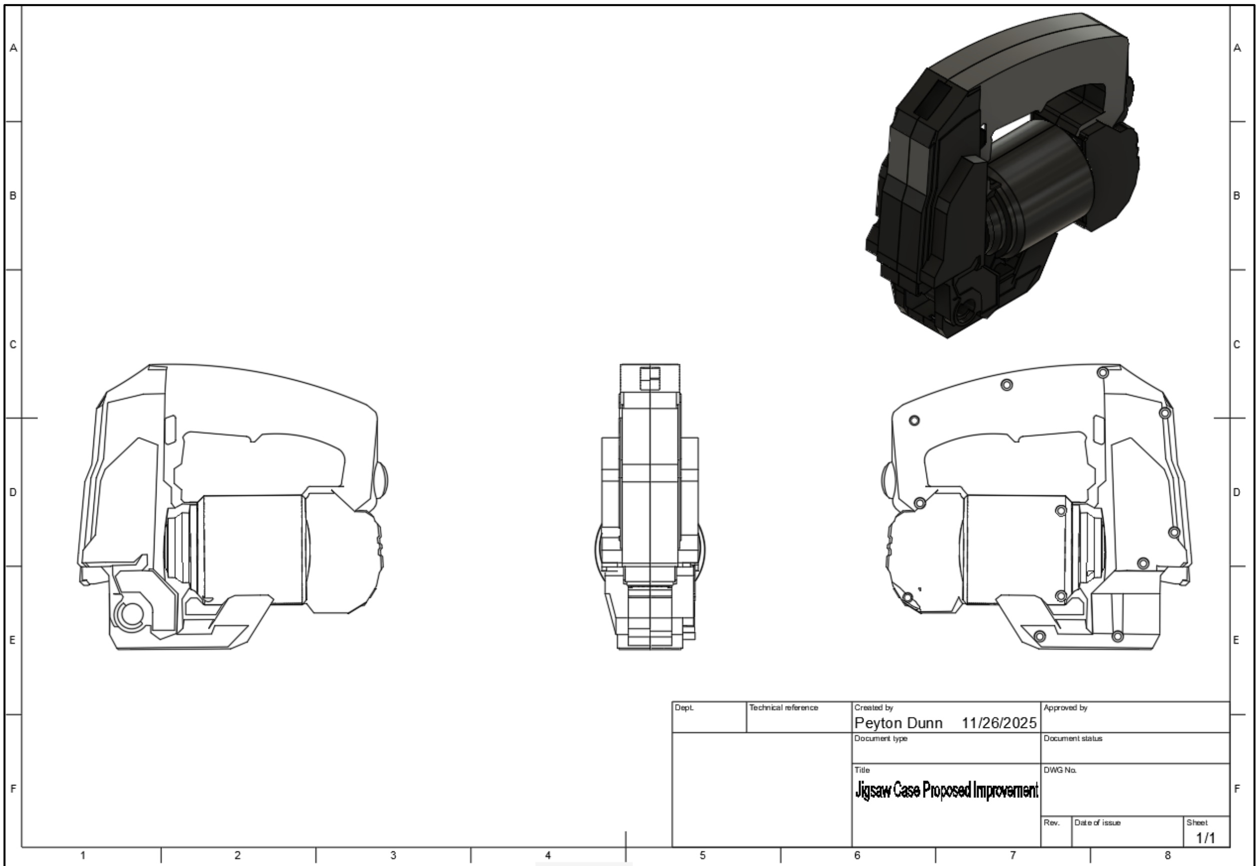

Figure 44: Improved jigsaw case – Simplified design

The current jigsaw casing incorporates excessive exterior details, including arrow-shaped extrusions on the sides near the front and additional extrusions near the end of the cylindrical body. While extrusions are structurally necessary to accommodate the internal components, many of the cosmetic features add no functional value. A way to improve this design would be to eliminate all non-essential extrusions while retaining the structural features required to house the internal components. This design change would preserve the full functionality of the case while simplifying the design. Simplified geometry could lead to greater manufacturing efficiency, by reducing the level of tooling required. Greater manufacturing efficiency would lead to a lower cost of production. Along with a lower cost of production, the improved case would also give the jigsaw a cleaner, less intimidating appearance. Mainstream brands such as DeWalt, BLACK+DECKER, and Milwaukee use a simple design, like the proposed design. This affirms that a simpler design fits into the current jigsaw market. With this improvement, removing unnecessary extrusions while focusing on functional geometry, the jigsaw case design would be structurally improved. This change lowers costs by streamlining manufacturing and aligns with the industry standards.

Figure 45. Gantt Chart page one.

Figure 46. Gantt Chart page two

Conclusion:

As a team, we were able to successfully disassemble the motor jig saw to study the various systems that contribute to the how and why of the inner (and outer) workings of this machine. Our team chose to focus on the human interface, drive train, and structural systems. By taking photographs and making detailed measurements of the components of the systems, we were able to successfully replicate the jig saw in a digital form. In doing this we were able to fully grasp the functions of the various components to develop a better understanding of the machine as a whole. By digitally reassembling the jig saw, we could visualize how each component interacted with the others. Throughout this whole process of studying and recreating, we found flaws in the design that we felt could be improved. An improvement for the human interface was a lock for the trigger that could be activated with one hand instead of two. For the drive train, a screw and washer assembly to keep the gears in place instead a breakable ring for easier and more efficient disassembly. And finally, for the structure, a simple exterior design for lower cost of production.