2020

ME 102b Final Project

OPTION 2: DYNAMIC ELEVATE

TIANA JOHNSON-KIDD

CAD Renderings Showing Key Dimensions

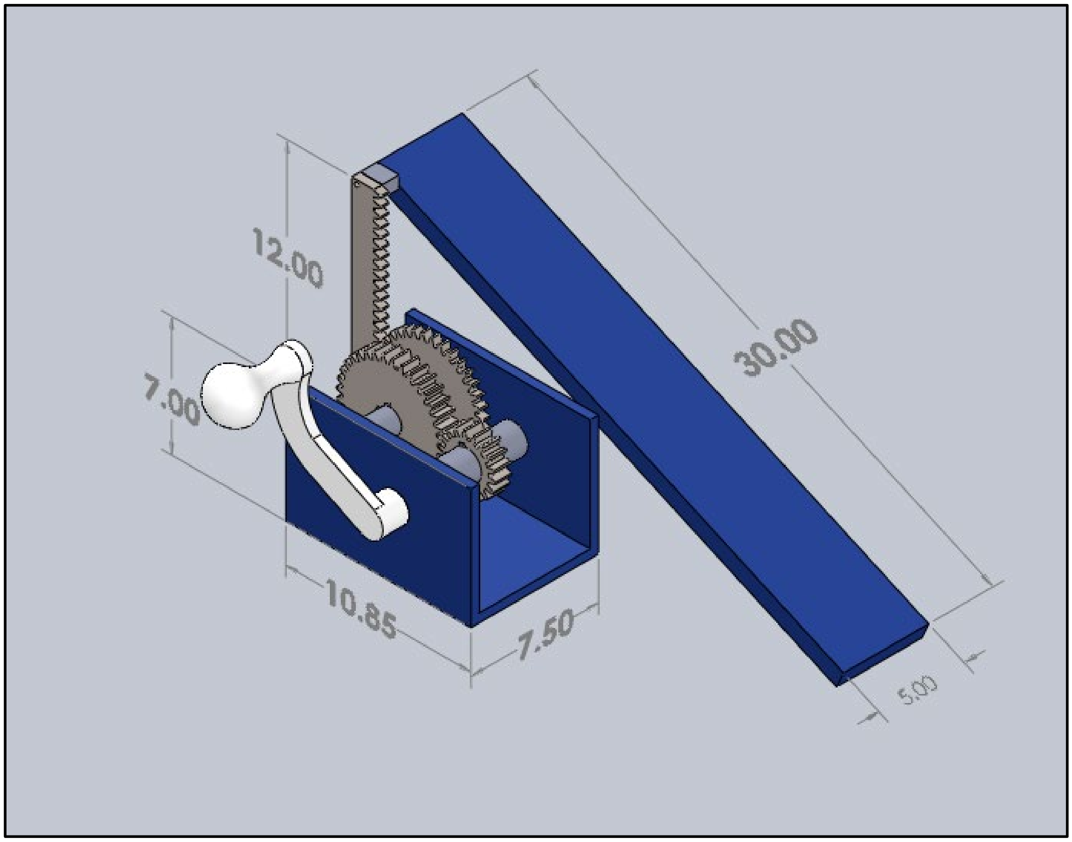

Figure 1: Isometric View of Dynamic Elevate Assembly

Description of the product.

My goal was to create a device that will help injured users in recovery. The idea came from personal experience as I recover from knee surgery. The Dynamic Elevate is intended to replace the use of pillows when propping up an injured leg. Elevating an injury above your heart level will help minimize swelling and allow fluid to drain from the area.[1] Pillows collapse under the weight of your leg over time and you often need to stack and balance multiple pillows on top of each other. These pillows fall as the night goes on when the user moves around while sleeping. The Dynamic Elevate intends to provide a comfortable and dependable solution to keeping your leg elevated for long periods of time.

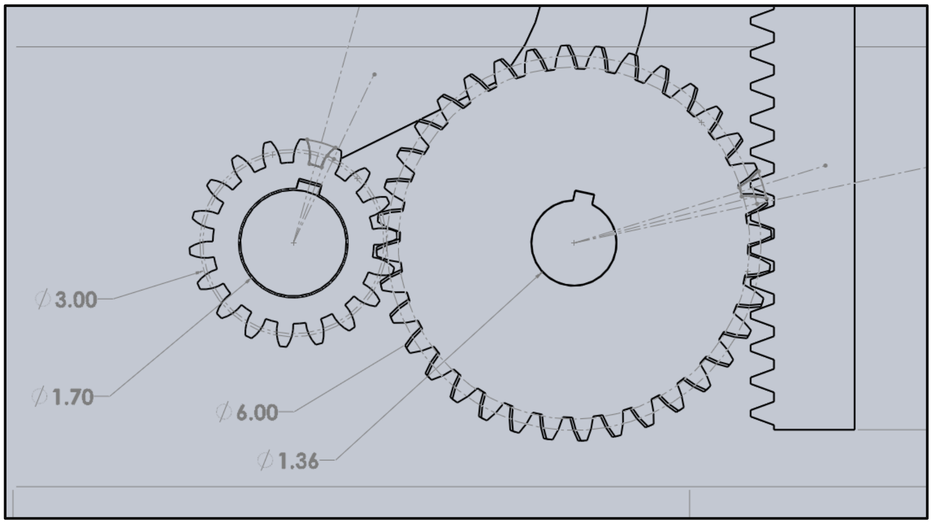

Figure 2: Gear Train View

The input force from the user comes from turning of the handle. It will be transformed into an output elevation of the pillow board at a desired height based on user comfort. The rotational torque generated by the user input will be transformed into translation motion as the pillow board moves up and down. The transmission feature that provides this controlled motion utilizes various gears and shafts. Figure 2 shows the gear train. The gears are meshed so that they can roll smoothly against one another. The input gear has a diameter pitch of 6 inches with 36 teeth. An amplified input torque will make it easier for the user to increase the height of the platform. A gear ratio of 2 was chosen; the output gear has a diameter pitch of 6 inches with 18 teeth. The output speed of the output gear is reduced by half while the torque is doubled. A gear rack, seen in Appendix B Figure 10, is used to change the rotational motion of the output gear into vertical translational motion. This will raise and lower the pillow platform to the user's desired height. The gear rack it attached to the compound gear consisting of the pinion gear and output gear. The gear rack has a diametral pitch of 6 inches. It is 12 inches tall to allow the user to get a max angle of 28 degrees. The pillow platform is 30 inches, near the average length of the human leg. [2] This platform will hold a pillow for consumer comfort as well as straps to secure the leg on the board. This device will allow for the user to have a secure and stable prop for their leg will elevating.

The biotech field has grown recently in the integration of medical devices with smart sensors. This product would benefit from the implementation of an embedded system. While this prototype is currently purely mechanical, in the future, it would include a "smart lever". In this case, a sensor could be monitoring the user's blood pressure and heart rate while they are laying down and the leg is elevated, if these values read too high or too low, the sensors will communicate with a microcontroller in the gear box. The microcontroller will send a signal to a stepper motor attached to the gear to adjust the positioning of the pillow platform. The microcontroller could also be used as a timer to adjust the height of the platform on intervals. This way a patient's leg can be moved to the correct position without having to wake them up. An FSD of this process can be found in Appendix C.

Complete List of Parts

Part	Size (inch)	Volume	Material	Manufacturer
Gear Box	10.85 x 7.50	108.21 in^3	ABS Plastic	Stortson Casting Co.[10]
Pillow Platform	30 x 5 x 1	150 in^3	ABS Plastic	Stortson Casting Co. [10]
Handle	N/A	23.35 in^3	ABS Plastic	Jacobs Innovation Lab
Input Shaft	1.7 at gear 1.36 at handle	17.06 in^3	Alloy Steel	SKS Die Casting & Machining[9]
Output Shaft	1.36	10.24 in^3	Alloy Steel	SKS Die Casting & Machining[9]
Input Gear	6-inch pitch diameter Module = .167	N/A	Alloy Steel	SKS Die Casting & Machining[9]
Output Gear	3-inch pitch diameter Module= .083	N/A	Alloy Steel	SKS Die Casting & Machining[9]
Pinion Gear	3-inch pitch diameter Module= .083	N/A	Alloy Steel	SKS Die Casting & Machining[9]
Rack Gear	6-inch pitch diameter 12-inch length	N/A	Alloy Steel	SKS Die Casting & Machining[9]
Screw	1/4-20 3A	N/A	Alloy Steel	SKS Die Casting & Machining[9]
Notch	.75 by 1 by 1.3	.975	Alloy Steel	Stortson Casting Co. [10]

The part views can be found in Appendix B.

The Manufacturing Processes of the Parts:

The gearbox, and pillow platform will be made using injection molding. They are simple shapes that would benefit from a fast manufacturing process. Injection molding is the process in which melted plastic is injected into a mold. Once the plastic cools it hardens to the configuration of the mold. It is beneficial in this instance because it has fast production, high efficiency, and low labor costs. Injection molding these parts will also reduce the amount of waste.

The handle will be printed using 3D printing. 3D printing is an additive manufacturing process were a CAD model is made into the 3D space. It is useful for the handle because it has a more complex shape. In future iterations it could include a softer material for the comfort in the grip. A disadvantage is that it is slower and more costly than injection molding.

The gears are manufactured in a variety of processes such as casting, forging, extrusions, and blanking. Machining is often used to complete the final dimensions of the gear. Our gears should have high tensile strength, high endurance, low friction, and good manufacturability. Gear blanks are often made from casting processes. After this they will be cut to the desired teeth requirements by hobbing and milling. The shafts and notch will be made using casting. This is similar to injection molding in that molten metal is poured into a hollowed cavity. Our locking screw will be made using a lathe, which is capable of cutting accurate and precise screw threads.

Our parts will be coming from multiple manufacturers and will then be assembled by hand. The handle will be attached in an interference fit, while the shafts and box will be a close running clearance fit. The gears will be assembled in a transition fit.

APPENDIX

All Dimensions are in inches

A. Alternative Assembly View

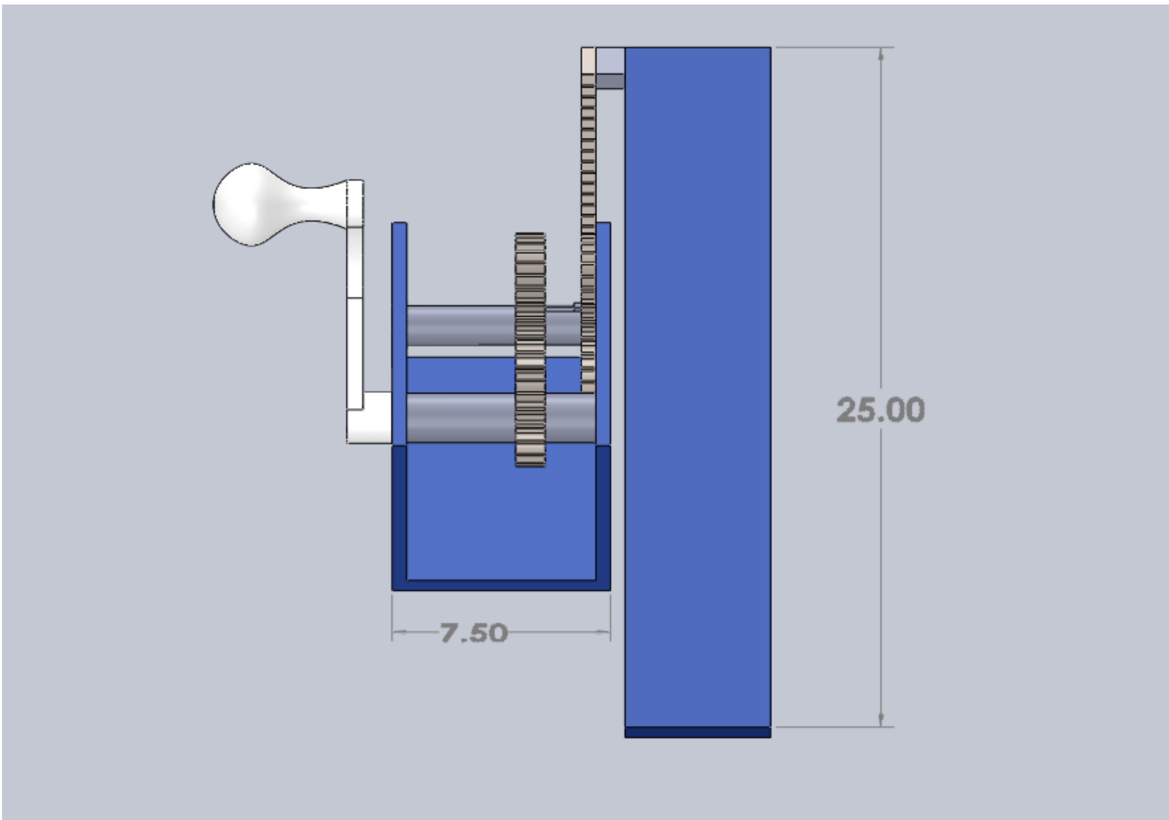

Figure 3: Isometric Side View of Assembly

B. PARTS

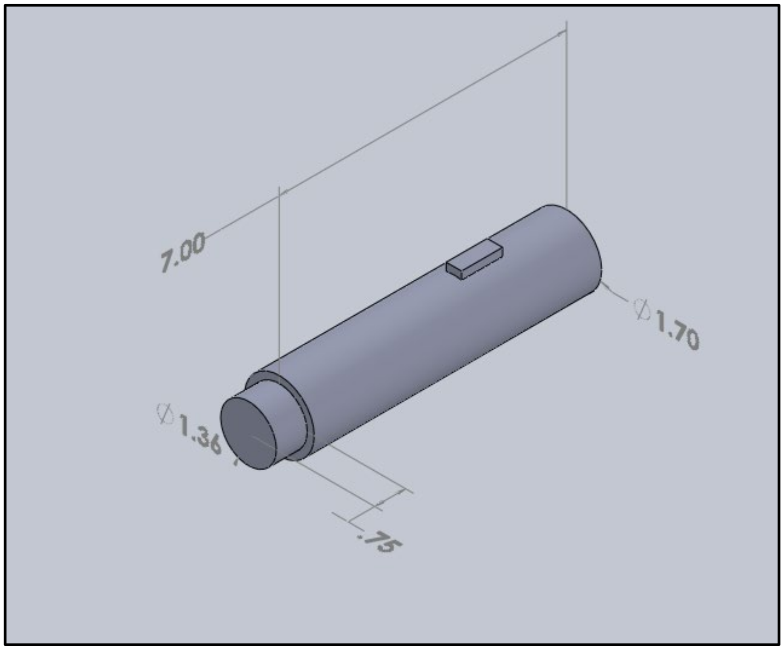

Figure 4: Input Shaft Isometric View (connects handle to input gear)

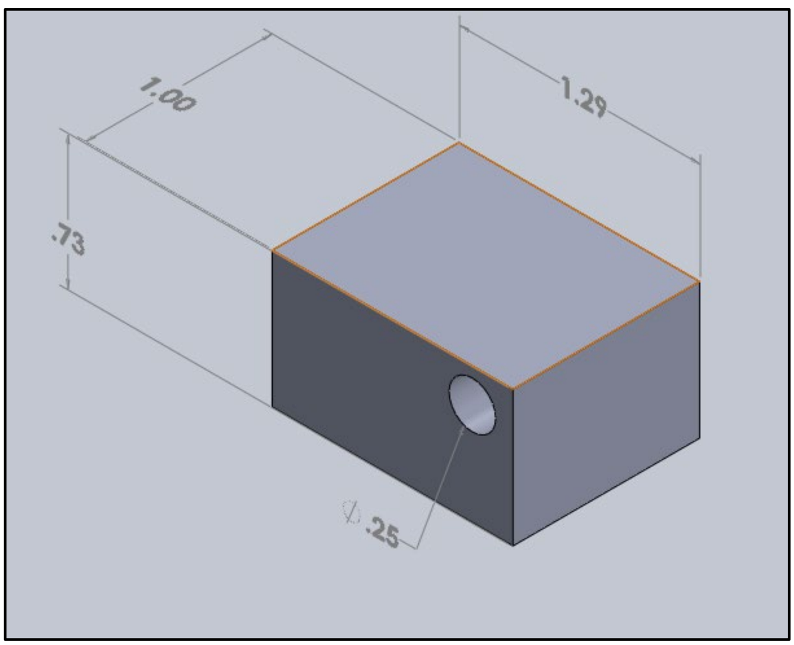

Figure 5: Notch Isometric View (connects rack gear to pillow board)

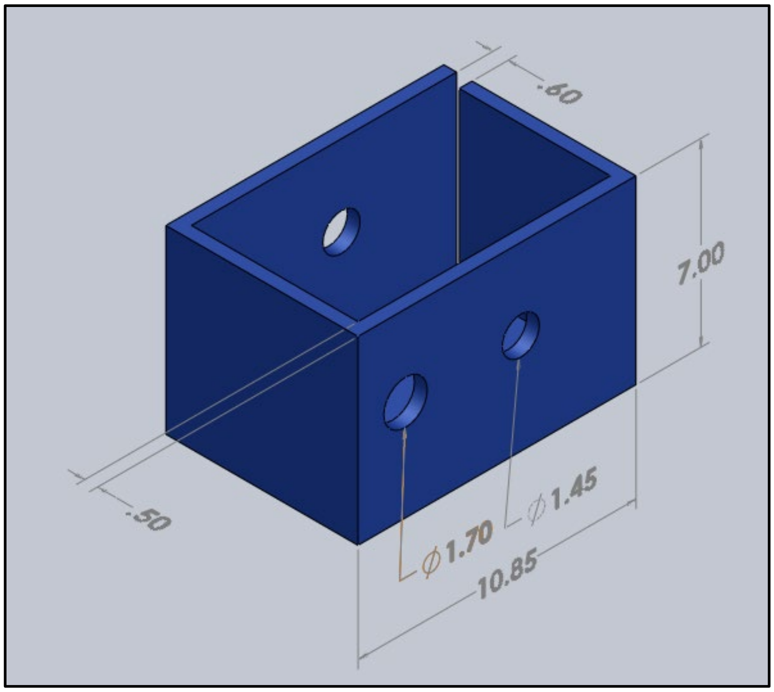

Figure 6: Housing Box Isometric View

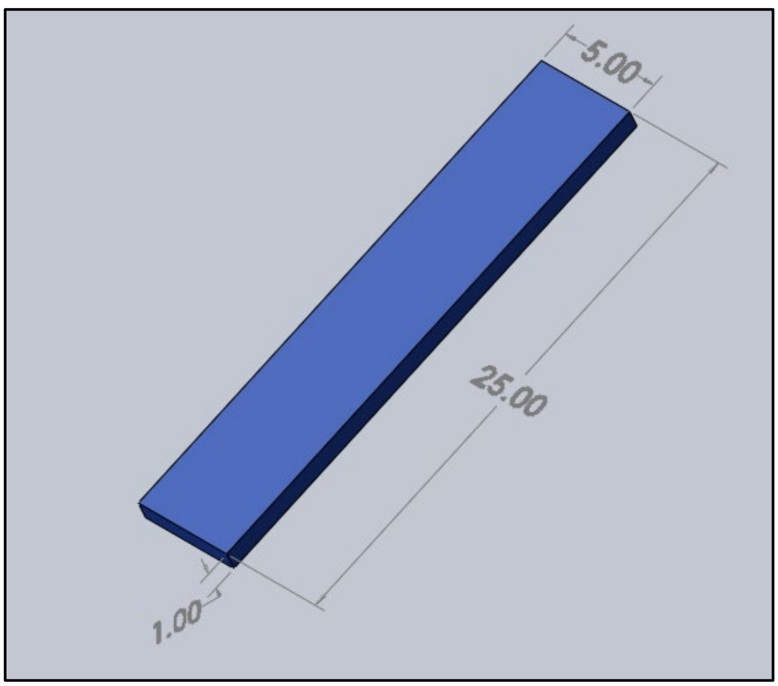

Figure 7: Pillow Board for Leg

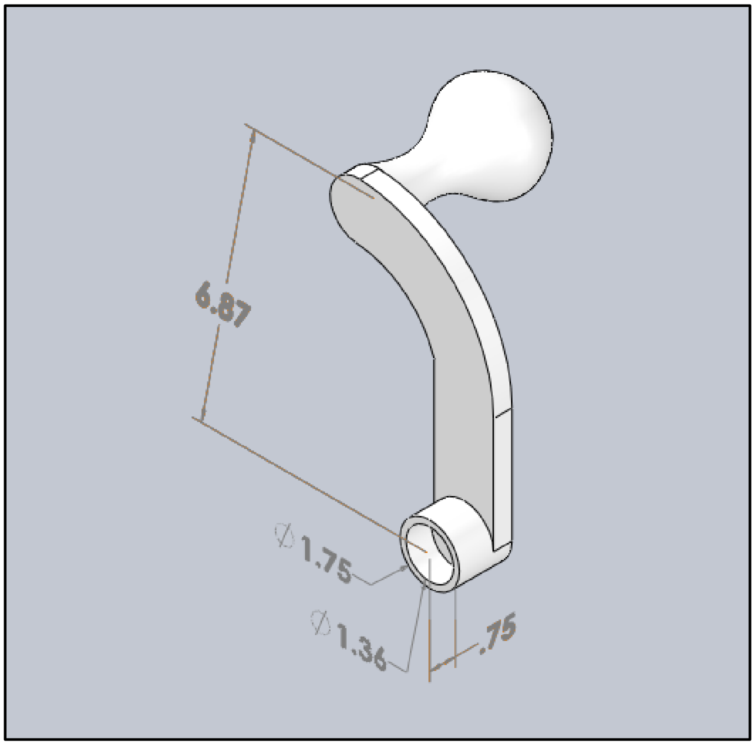

Figure 8: Input Gear Handle Isometric View

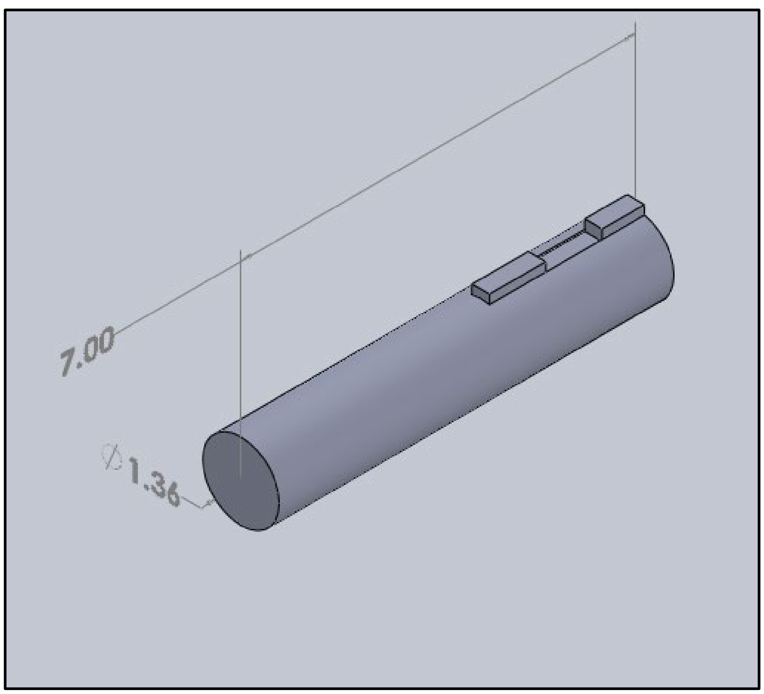

Figure 9: Output Shaft Isometric View

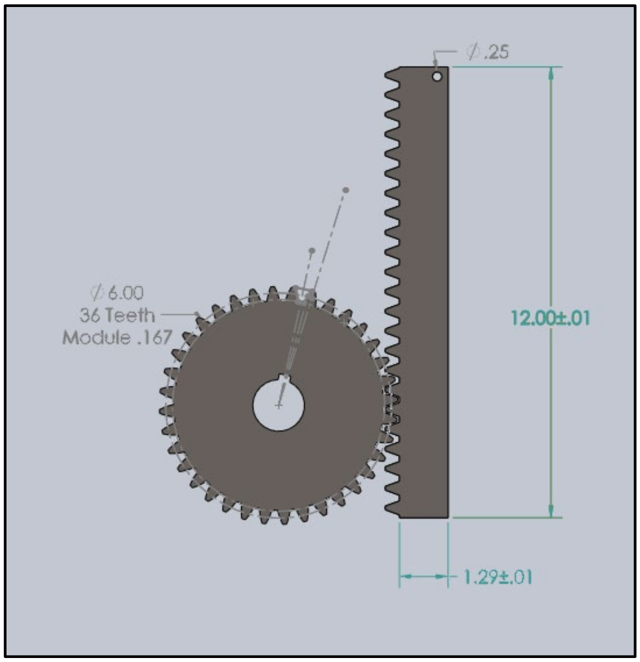

Figure 10: Rack and Pinion Gear Set

C. FSD of embedded data tracking system

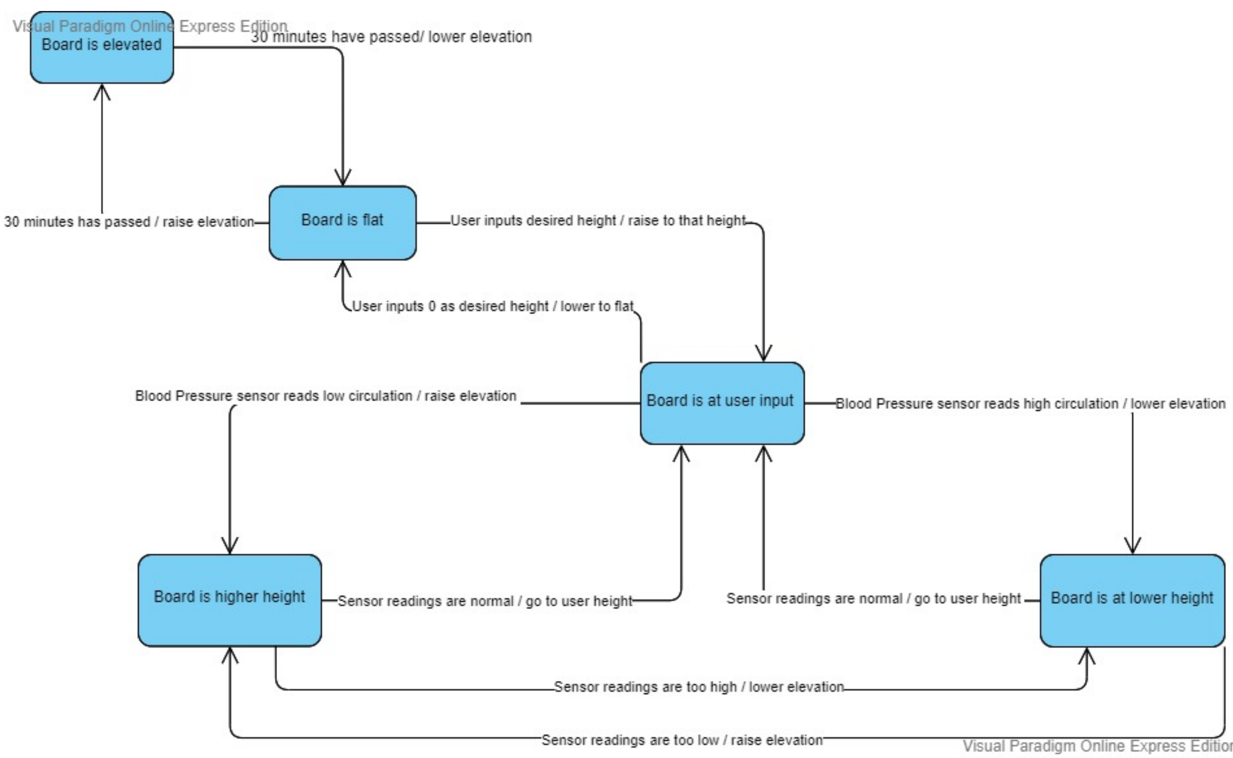

Figure 11: Rough FSD of sensor tracking system. (More studies on effects of leg elevation on blood pressure/heart rate will be needed)

REFERENCES

1. https://www.healthline.com/health/sports-injuries/treatment#:~:text=Elevating%20an%20injury%20above%20the,heart%20or%20close%20to%20it.
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2872302/
3. https://www.federalgear.com/blog/what-are-gears-usually-made-of-in-gear-manufacturing
4. https://gearsolutions.com/features/casting-forming-and-forging/
5. https://www.plastikcity.co.uk/blog/advantages-disadvantages-of-injection-moulding/
6. https://itstillruns.com/calculate-torque-through-gear-reducer-7628270.html
7. https://khkgears.net/new/gear_rack.html#:~:text=Gear%20racks%20are%20utilized%20to,meshing%20with%20the%20gear%20rack.&text=There%20are%20many%20ways%20to%20use%20gears.
8. https://technologystudent.com/gears1/gears3.htm#:~:text=A%20compound%20gear%20is%20a,slow%20down%20the%20final%20output.
9. https://www.sksdiecasting.com/
10. http://www.buzzfile.com/business/Stortson-Casting-415-861-6149