Problem Statement:

The initial problem presented by B9 Plastics in the PRP stated that the Manual Generator, which powers the Better Water Maker, in its current state requires too much effort to maintain the power levels required for sustained use. We were also instructed that women and children are mainly experiencing this problem.

Testing:

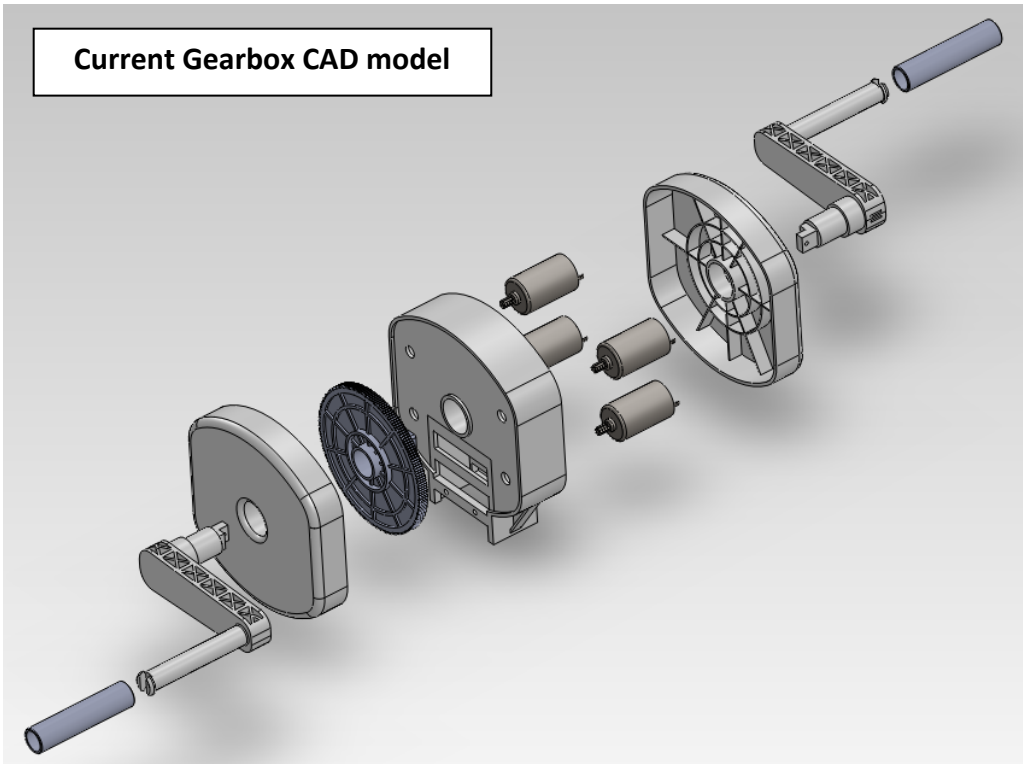
Through our preliminary testing, we verified B9's conclusions by conducting V02 testing. We had two of our female group members operate the device while we measured their oxygen consumption and carbon dioxide production. After just a short period of time (under 3 minutes) they were so fatigued they had to stop using the generator.

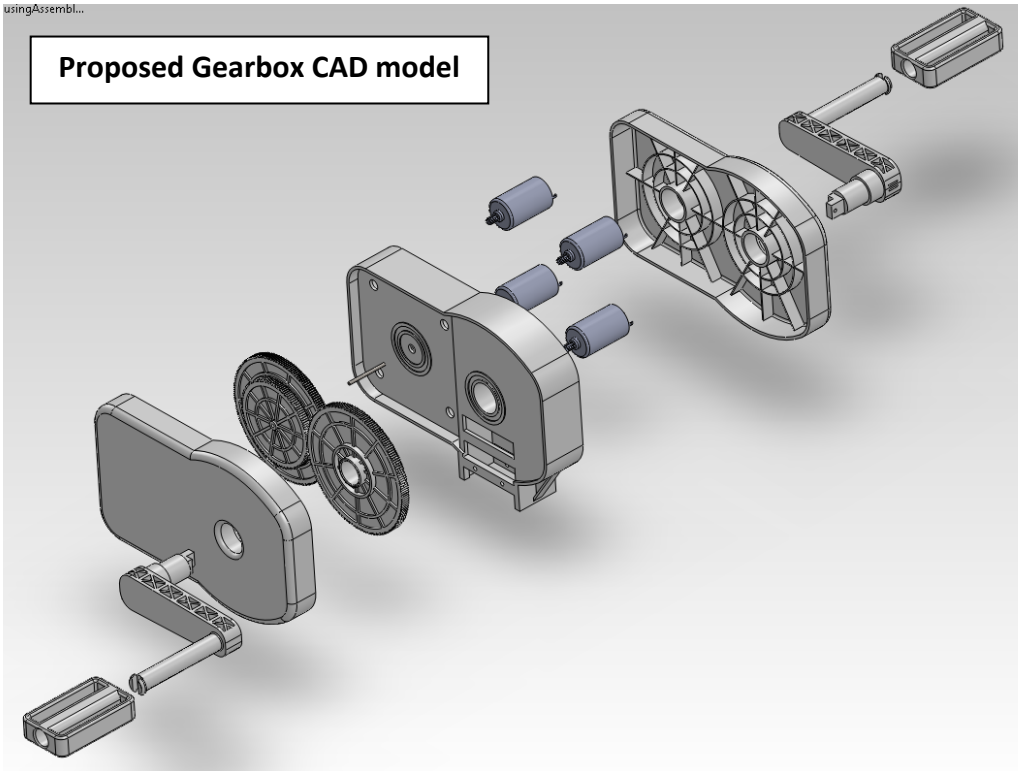
Approaches:

Our group concluded the problem stemmed from the high rotations per minute that needed to be met to produce sufficient power. In combination with a low resistance, it is nearly impossible to maintain a continuous smooth pace while cranking. It was decided to focus on reducing the required RPM's and increase the resistance of the device. Two courses of action were followed:

1. **Design a new gear box** – The new gear box would be able to slow the crank speed to meet the requirements we set. The current gear box needs to be operated at 130 RPM's in order to produce the required power output. Several new crank speed variations were calculated and tested including 50, 60, 75, 85 RPM's. The speeds that were tested are specifically for converting the generator from a hand crank device to a foot pedaled device. So a user's body can sustain longer periods of use and higher resistances. The major drawback with this option is the added tooling costs that would be incurred if we extended the housing to add the required gears.

2. **Find a new motor/set of motors** – A new set of motors, whether that be four, two or even just one could also get us the crank speed we require. The current motors are rated to experience a max efficiency between 3400 and 4000 RPM at the motor pinion. However, current speeds only reach 2800 RPM at that location so we are losing efficiency and power. If we find a motor that operates with peak efficiency at an RPM closer to what we are capable of generating we could increase our power output, reduce RPM and increase resistance. This would mean that no major changes to tooling would be required.





Conclusions:

After researching both options, we have found it to be more feasible to go with option 1, Design a new gear box. Despite the added tooling costs, the cost to manufacture a unit would be much less, $56.55

when going with this option. There are three gear ratios we will test and decide upon based on optimal test results. Each gear combination (gear ratio) will be able to fit in the "Proposed Gearbox" housing shown above, which allows for one sized housing to accommodate all three possible gear ratios.

The goal of lowering the RPMs required at the directly driven crankshaft can only be accomplished with a trade-off. In this case, the trade-off is lower RPMs with higher torque required to maintain the RPMs. This will not be a problem because the proposed gearbox is driven using leg muscles. Pedals have replaced the crank handles, which allows for the user to operate the generator with the biggest muscle group in the human body. In order to accommodate the use of legs, the generator support structure has changed.

The new gearbox will allow the user to turn the crank at 70RPMs, 80RPMs, or 90RPMs, while requiring a torque input of 92in*lbs, 81in*lbs, and 72in*lbs, respectively. These torque values can be compared to the current 50in*lbs required to maintain the current generator power.

We found that finding motors that can be operated at the low RPM we need is extremely difficult. They are specialty items, and are not produced and held in-stock in large quantities. So we could in theory be replacing four $4 motors with four $10 motors and that price difference is too great. The price would increase from an estimated $50 dollars for the current design to $77.70 dollars per BWM.

The following deliverables we expect to be able to give our customer at the end of MSDII:

- Complete, tested SolidWorks models of the current generator and the new gearbox generator
- A new seating system which is designed around operating the generator by foot
- Complete, tested SolidWorks model for seating system
- Complete mechanical drawings for each model (Both gearboxes and seating system)
- Complete schematics with simulation of the current Generator Regulator Circuit board and Pump Circuit board
- Complete schematics with simulation of proposed improvements to current Circuit boards
- Proposed Circuit board layout
- Prototyped board on breadboard with documentation (BOM, assembly instructions)
- Complete Bill of Material with costs
- Prototyped New Gearbox Generator BWM
- Project Overview binder for our Customer