Operator’s Manual: RevoBike

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**Important Safety Instructions:**

There are several precautions that the user should take care to note before and while riding the RevoBike. The very first thing to consider is if the RevoBike is for this particular user. As the bike has many different customizable settings and positions the maximum weight capacity is 240 lbs (108.862 kg). This limit is in place because of the vertical actuator maximum load capacity. Secondly before even touching the RevoBike the user should read the manual in its entirety to become familiar with the product and understand any possible risks they may encounter. Once the manual has been read and understood the user should now relate the content in the manual to the bike itself. One of the first things that should be understood is the proper ways to sit in the bike. The special seat mechanism of the RevoBike is meant for sitting exercise purposes only.

The first part the user should become familiar with is the remote controls for the actuators. Obtaining an understand of which rocker switch controls which actuator is very important and even beyond that an understanding of which direction the rocker switch needs to be depressed to either extend or contract that particular actuator is necessary. This is one of the most important aspects of the RevoBike because is controls how the user gets in and out of the RevoBike as well as position themselves in the most comfortable position for their exercise. Depressing the incorrect rocker could potentially result in a sudden unanticipated movement that could cause injury or harm to the user, even as slow as the actuators move.

Once an understanding of how the seat mechanism is controlled by the three actuators and the remote control containing the three rocker switches the user should understand the electrical wiring of the system, in particular the battery. The battery is a 12 volt deep cycle battery rated for 75 amp hours. This means that anything connected to both terminals of the battery is receiving ~12 volts and if it is drawing one amp then the battery will last 75 hours. However if a short were to occur, meaning the positive and negative terminals of the battery were connected, the twelve volts will be traveling as fast as possible through the connection. This can be extremely dangerous is this connection is a person. For this reason the user should NEVER EVER touch both terminals of the battery as the same time. If the user approaches the RevoBike and notices that the battery terminals are unwired the user should carefully wire the negative (black) ground terminal first followed by the red positive terminal. It should be noted that the wire connecting the inverter may create a small spark because the capacitors within the inverter hold a small charge. This is not a cause for concern.

If the battery is wired the user can now position the console far enough away to provide enough room for the user to get in-between the seat and console. The user should then position the seat in the most forward and tilted position at the proper height making it most comfortable for the user to sit. From this position the user may decline the tilt becoming horizontal so that they are fully sitting. The user should now move the seat up vertically to the optimal height for that user and then back so that their feet may easily reach the pedal for a full revolution with a ~5° bend in the knee at the furthest position. Upon completion of one revolution the console will turn on and the user can set the program they would like to use as well as set up the DVD player to watch a movie or listen to music via an iPod.
Once the workout is complete the user should move the console away from the user or swivel it out of the way and then move the seat forward and down so that their feet can reach the floor and easily get off of the pedals. From this position the user should use the tilt actuator as a standing assist to help them stand again. Once standing, depending on the situation, the user can wipe down the machine and continue on or they can disconnect the battery. It should be noted that a slight grumbling sound may occur as the generator is spinning very fast and makes this grumbling noise.

**Parts and Accessories**

![Image #1: shows and labels the majority of the RevoBike from an aerial perspective]
Image #2: shows and labels the vertical seat cart mechanism

Image #3: shows and labels the rear platform
Features

The RevoBike offers several unique features that most ordinary stationary bikes do not. The two most unique features of the RevoBike are the motorized seat unit and the power generation system. Included in the power generation system is the entire self powered electrical system on the RevoBike based off of the 12 volt deep cycle battery.

The power generation system is started by the user’s kinetic energy of rotating the pedals around which thus turns the flywheel. The flywheel makes direct contact with the generator shaft wheel attachment. Therefore, when the flywheel rotates so does the generator shaft producing a voltage by the generator. The voltage is then passed through a full wave bridge kit to prevent the backflow of current turning the generator into a motor. The voltage is then run to the battery charge it and power any of the components active at that time.

The battery powers everything except the original console on the RevoBike; this includes the three actuators, the DVD player, and the inverter. The inverter is simply present to provide two 120Vac wall outlets for external appliances to be plugged in. It should be noted that there is a 30 amp automatic reset circuit breaker in line with the inverter to prevent any appliance from completely draining the battery. The DVD player is powered by a voltage regulator that converts...
the 12Vdc to 9.5Vdc. A car adapter was used because of the connector that plugs into the DVD player.

The actuators are all powered by the battery and controlled by a separate rocker switch for each actuator. The rocker switches are rated for twenty amps which works great for the smaller actuators, vertical and horizontal, which are rated for a maximum of six amps. Therefore the rocker switches are wired directly to the battery and the actuators. However the larger, tilt actuator can have a maximum of 23 amps. Therefore an H-bridge was constructed of automotive relays rated for 30 amps. The opposite sides of the H-bridge are activated by a signal voltage that is controlled by the rocker switch. Depending which direction the rocker switch is depressed determines which side of the H-bridge closes and which way the actuator moves, extending or contracting.

These three actuators make the seat mechanism very unique. There is yet to be any motorized seat in exercise equipment, never mind to the extent that the RevoBike is. The tilting actuator is extremely unique in that it provides sitting and standing assistance on top of just the X and Y movements provided by the horizontal and vertical actuators. These two smaller actuators provide a wider range of motion for the seat than the average stationary bikes' seat.

Some other features of the RevoBike is the power inverter with the two AC outlets and the Philips DVD player. The inverter allows the user to power appliances that require AC power via their workout. The Philips DVD players allows the user to watch a movie or listen to music on the iPod while the iPod recharges.
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1. Introduction

1.1 Overview

The project title is the RevoBike and this machine serves two main purposes. The concept for the bike is a machine that makes it easier for disabled, elderly, or otherwise injured and recovering people to use a stationary bike. The second concept is a way for the bike to feed excess power generated by the user’s kinetic energy into a 12 volt battery to store for later use.

The machine will be broken down into three main units, for easier assembly, manufacturing, and customizability.

The first unit is the head unit, which will house the user interface. The user interface contains a display board. This display board is the only thing not powered by the rider. The board is instead powered by two AA batteries. There will be a number of features on the display board including distance, speed, calories spent (total and per hour), output in watts (current and per hour), heart rate, and workout time. The head unit also contains a 7” (0.1778 m) LCD screen of a DVD player that also has an iPod port for both using and charging an iPod. This DVD player is powered by the 12V battery and thus the user’s kinetic energy. Surrounding the display board will be handrails which will also house the heart rate sensors. Under the display board on the console stand is the remote controls for the seat which are described in more detail below. The entire head unit has a wide range of adjustability with a swivel and pivot base as well as a

Image #5: shows the console of the RevoBike with first the DVD closed showing the exercise display and secondly with the DVD open

The second unit is the base of the system. The base unit contains the pedaling mechanism and the bulk of the electrical map. Since the machine is intended for rehabilitation purposes it operates at low Revolutions per minute (RPM). Most conventional stationary bikes will pause the display board or turn off the display when RPMs drop below 30 Revolutions per minute, but not the RevoBike. The base unit also contains the mounting area for the seat mechanism to be attached.
The third unit is the rehabilitation seat. The seat will perform two primary functions. One function will be to slide down and away from the machine to make it easier for users to reach the seat without stepping over the machine. This would prove very beneficial for users who usually need a walker to move around. It will then slide back up into the preferred position. This is all controlled by the user via the controls on the console stand in the remote control. The second function is to have a seating and standing assist function. This function lifts the back of the seat up and forward aiding the user to either sit into the seat or stand up from the seat. This will be very beneficial to the rehabilitation goal because many users in walkers are not capable of standing under their own power.

This system is powered by a 12 volt battery that is housed under and behind the seat and is recharged while the user is pedaling. The seat will mimic a typical bicycle saddle however a backing is available to provide support for positions in which the rider is sitting at an angle greater than 90 degrees. A second seat that could have been developed, but was not due to time and financial constraints was a seat developed strictly for gym and private use without the
motorized support. The adjustability would be similar to the rehabilitation seat, being able to 
move forward and back as well as up and down, but this would be done by a locking pin 
mechanism manually controlled. If necessary the back support could have been implemented 
into the conventional seat.

The benefit of using a 12 volt battery is that the RevoBike does not need a dedicated 
circuit to transmit its power output. Dedicated circuits are currently in use by gyms utilizing 
patron generated power.

In order to make the bike operational the user needs to remove the rear component cover 
and connect the battery terminals. The negative terminal should be connected first, followed by 
the positive terminal. Once that is complete, replace the component cover and the bike is fully 
functional.

1.2 Instructions
The following are step-by-step directions for using the RevoBike.
1. Approach the step-through area of the RevoBike
2. Set an appropriate height for the console using the knob on the console stand
3. Tilt or swivel the console away to allow more space to access the step-through area
4. Using the Rocker Switchbox, slide the seat forward and up to meet your body
5. Should you need the tilt assist, increase the tilt to accommodate your position 
a. Allow the seat to take your body weight as you decrease the tilt
6. Now that you are comfortably seated with your feet still on the ground use the horizontal 
   adjustment to slide the seat back to a comfortable riding position
7. Once the seat is back, raise the seat using the vertical adjustment and place your feet on 
   the pedals. Adjust for comfort.
8. Now you may tilt the console to an appropriate position
9. The fitness display has a variety of settings
   a. The mode button can select scan, program, speed, distance, time, calories and 
      pulse
   b. There are 6 preset workout programs to choose from
   c. Place your hands on the heart rate sensors to read your pulse as you ride
10. To use the DVD player, open the screen and slide the power button to on 
    a. Next either insert your DVD or iPod into the Player and enjoy
11. As you pedal you are charging the onboard energy system 
    a. Additional power is available via the power inverter outlets to charge devices 
       such as cell phones or a laptop while you exercise
12. When you have completed your workout, decrease the height of your seat with the 
    vertical adjustment until your feet are safely on the floor
13. Now slide yourself forward to the step-through area 
    a. Making sure to move the console to a safe position for exiting the bike
14. Once at the step-through area, you may stand and exit the bike safely
15. Should you need the tilt assist to stand, simply activate the tilt actuator as you see fit 
    until you are in a near standing position
16. The actuators can be left in any position, there is no danger of them moving when power is disabled.
17. Be sure to turn off the power to the DVD player and the power inverter before disconnecting the battery terminals.
   a. In order to minimize damaging the bike or creating a short circuit
18. Remove the component cover and disconnect the positive battery terminal and then the negative battery terminal.

The following shows a user entering the RevoBike, exercising, and then exiting it.

Step 1: Shows the user approach the bike

Step 2: Shows the user adjusting the height of the console

Step 3: Shows the user swivel away the console to enter the bike

Step 4: Shows the user move into the step-through area of the bike
Step 5: Shows the user using the tilt assist function to transfer his weight to the bike.

Step 6: Shows the user fully seated on the bike with feet still on the floor.

Step 7: Shows the user sliding rearward and adjusting the height of his seat with the rocker switches.

Step 8: Shows the user cycling and watching a movie on the DVD player.

Step 9: Shows the user with feet again on the floor and the seat in the forward most position.

Step 10: Shows the user using the tilt assist function to stand up from the bike and transfer their weight back over their feet.
2. Maintenance

The maintenance that needs to be performed on the bike is very minimal. A great deal of which comes down to simple checks of the bike's mechanical integrity before each use to make sure it is in safe working condition.

Actuator Maintenance:

Periodically check the actuator shafts for grease. If the actuator shafts are dry, add a multi-purpose grease to the shaft and run the actuator through its travel. Observe the actuator shafts as they move through their travel for any sign of bending or excessive wear which could indicate mechanical failure due to fatigue. Each actuator is mounted at two ends. Check both anchor points to make sure they are bolted or pinned securely. The horizontal actuator is attached with Clevis Pins. Always check to make sure the locks are on the pins prior to using the RevoBike. Make sure that the bolts for the tilt actuator are tightened and secure at both anchor points.

Periodically check the wiring around the actuators for areas where they could become pinched or damaged from use over time. There are two limit switches for the tilt actuator. Check before use that these two switches are secure and not damaged. Also check that they are in fact functioning correctly.
Periodically check to make sure the wires for the vertical actuator feed correctly through their guide loop as the horizontal actuator proceeds through its travel.

Seat Mechanism:

Separate from the actuators there are other parts of the seat mechanism that need attention from time to time. Should the pivot for the tilting seat mechanism develop a squeak or seem to impede the pivoting motion, then it needs to be greased. In order to do this, make sure the seat mechanism is in its standard lower position. Unscrew the pivot bolt from the assembly and remove the brass bushing. Grease the bushing and insert it back into the assembly. Tightly refasten the pivot bolt and run the seat mechanism through several tilt cycles to ensure successful lubrication.

Another part to observe is the seat cart and its wheels. The primary contact wheels are the front wheels and the central wheels. Observe for wear and make sure that the axles are tight and have no play or freedom of motion. Periodically look over the welds for the vertical seat track and make sure there is no sign of metal fatigue or cracking. The same goes for the welds on the horizontal actuator bracket.

The next part to consider is the seat bracket, which is one of the most complex components of the bike. Check every aluminum weld for cracking or damage. Some of the highest stresses exist in this seat bracket when in use. Check every bolt to make sure it is tightly fastened. Make sure each roller is properly aligned with the vertical track and making good contact. Make sure the roller axles are tight and there is no freedom of motion.

Use a general surface disinfectant to clean the seat of the bike.

Console Stand/Console:

The console stand itself requires very little maintenance. Should tilting or swiveling the stand become sticky or begin to squeak, simply apply lubricant to the interface between the swivel base and tilt bracket, or the console stand and tilt bracket.

Make sure that the bolts for the swivel base and tilt bracket are tight and secure. These bolts are critical for the stability of the console stand. The next place to consider would be the console mount at the top of the stand. Make sure the two securing bolts are tight. Should the batteries need to be replaced in the exercise display, remove the top cover for the console. After the top is removed, unscrew the exercise display from the back of the console. With the exercise display away from the console, remove the back cover and recycle the old batteries. Replace them with 2 new AA batteries and reattach the exercise display and console cover. The console and DVD player can be cleaned by dampening a cleaning rag with a disinfecting surface cleaner and wiping down the surfaces. DO NOT SPRAY THE CONSOLE DIRECTLY. This could destroy the DVD player.
Basic Frame Maintenance:

Keep bike in clean, dry environment. If it is exposed to excessive moisture the surface of the steel frame could begin to rust. Periodically check the welds of the frame for fatigue and stress cracks. Check the frame for warping due to metal fatigue over time; this could eventually compromise the integrity of the frame.

Generator:

The generator like the rest of the bike has little necessary maintenance. Being a magnet based generator it is prone to collecting metallic dust and small metal objects. For general maintenance, keep the generator free of clinging debris. Another thing to consider is the wear of the generator wheel over time. Being in constant contact with the flywheel will cause the rubber of the wheel to eventually wear down and lose contact. Should this happen, a simple fix would be to loosen the shaft key of the wheel and slide the wheel so that a new section of previously untouched rubber is contacting the flywheel. Should the entire wheel be worn down, contact your nearest machine supply store for a replacement part.

3. Technical Description
Image #8, below, is an overall picture of the completed RevoBike prototype. The bike is fully functional with all of the capabilities specifies earlier in this report.

Image #8: shows the overall prototype
The image below shows the step-through area of the bike between the console stand and the pedal assembly. The step through height is approximately 2 inches, allowing users to easily access and exit the machine without having to lift their leg over a large section of the machine.

Image #9: shows the step-through area

Image #10 shows the seat in the farthest back position on its track.

Image #10: shows the seat track with vertical and horizontal actuators contracted
The following dual image shows the seat in its lowest position on the left and extending vertically through its travel on the right as the vertical actuator is engaged.

Image #11: is a dual image showing the performance of the vertical actuator

This dual image provides a close up of the vertical seat track and bracket mechanism. This mechanism reduces the rotational forces acting on the vertical actuator which could potentially damage the device. It also maintains a linear travel path for the seat.

Image #12: is a dual image showing the vertical seat bracket and track
Image #13, below, shows the seat mechanism with both the vertical and horizontal actuators extended.

The two images below simply shows the overall seat mechanism and actuator assemblies.
Here is a simple image of the seat mechanism as shown previously in its standard position.

Image #15: is a close up shot of the actuator mount on the seat track I-beam

Image #16: shows the seat mechanism in a standard position
Below is an image of the seat in a tilted position, with the tilt actuator somewhat extended.

[Image #17: shows the seat mechanism in a tilted position]

This image depicts an optimal entering and exiting seat position for the bike. With the seat elevated and tilted forward it allows a user to enter and exit the bike from a near standing position.

[Image #18: shows the seat mechanism in an optimal position for entering and exiting the machine]
The dual image below shows the console and handrails of the bike. The left side shows the console with the DVD player closed and exercise display exposed. The right side shows the console with the DVD player open.

Image #19: shows the console with DVD player closed (left) and open (right)

The following image shows a user with their hand on the adjustment knob. This knob allows the user to set their preferred height for the telescoping console stand.

Image #20: the adjustment knob for the telescoping console stand
This dual image is intended to depict the functionality of the telescoping console stand. In the left picture the console is elevated slightly and in the right image, it is compressed to one of the lowest settings.

Below is an image that displays the swivel base and tilt bracket that allow the console to tilt and swivel at its anchor point.
This image shows the console and stand swiveled away from the bike to allow for easier entry or exit from the machine.

Power Generation

The power generation system for the optimal design has been simplified. The flywheel, driven by the pedals, drives the crankshaft of an iron flywheel that houses the magnetic resistance mechanism via a belt. The team has incorporated the Windstream© Power DC Generator (443541) into the drive train of the bike. The generator is of permanent magnet design and has a maximum charging current of 10 Amps. By measuring the diameters and then calculating the circumferences of the flywheels and estimating a 2.25” diameter (0.05715 meters) attachment to the generator shaft, it has been found that the ratio of the pedal assembly’s RPMs to the generators is ~1:37. This means that for a patient pedaling at 70 RPMs the generator will be rotating at ~2500 RPM, which corresponds to a 13 volt output of electricity according to the generator manual. The system chosen for attachment of the generator shaft wheel to the flywheel is direct contact because it is easier to implement and takes less space than belt driven.
Directly following the generator is a full wave bridge kit. This element serves to prevent the backflow of current back into the generator, turning it into a motor. The full wave bridge kit is then wired to the battery. Because the battery can handle voltages up to 14 volts there is no need for a transformer or voltage regulator as previously thought. This concludes the power generation portion of the electrical system; however the battery is used to power many different parts of the RevoBike.

The first few components to be powered by the battery are the three linear actuators. All three of the actuators require a 12Vdc source and therefore no voltage regulator is necessary. The rocker switches used to control the actuators are momentary switches so that they actuator only move while the rocker is depressed in one direction and upon release stops. However, the largest of the three actuators has a max load of 22 amps while the smaller two have a max load of six amps and the rocker switches are only rated for 20 amps at 12 volts. For this reason the larger actuator must have an H-bridge built of four automotive relays rating for 30 amps. This H-bridge serves as a gated switch. A signal voltage must activate which gates are open; this is done via the rocker switch. When the rocker for the larger tilt actuator is depressed to go up the gates allowing current to flow forwards through the motor close thus moving the 12 volts from the battery through the motor. The smaller actuators do not need this H-bridge configuration because

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of the lower current rating and can be used directly through the rocker switches. The two smaller actuators, horizontal and vertical, have limit switches and fuses internally installed. The larger tilt actuator had to be equipped with limit switches to prevent it from unkeying itself if extended beyond its maximum limit.

Image #26: shows the rocker switchbox for the actuator controls

Image #27: shows the H-bridge for controlling the tilt actuator and implementing the limit switches

Image #28: shows the tilt actuator extending outward, tilting the seat mechanism
The next group of components, deal with the user interface and head unit. The current console is powered by two AA batteries giving it a 3V source. This system is maintained because it was found that when the console is powered through a regulator and then an actuator is activated there is a severe enough voltage drop causing the console to reset in the middle of a workout. After doing some research the Philips LCD DVD player is best powered by an AC source unless using the car cigarette adapter. The car adapter was thus taken apart and wired to a voltage regulator of 12 volts to 9 volts. Because the DVD player draws very little current to begin with there is no need for a fuse or breaker.

In the situation where the user would like to power an external appliance that requires AC current the student design team has a Duracell 1500W power inverter implemented onto the RevoBike. This inverter converts the 12Vdc to 120Vac and has two ac outlets to power the
smaller appliances or rechargeable batteries. Because the inverter can easily deplete the battery charge very quickly if an appliance such as a refrigerator is plugged into one of the two AC outlets, a 30 amp breaker is installed in line with the inverter to prevent more than 30 amps from being drawn at any point through the inverter.

Image #31: shows power inverter and AC outlets on the prototype

Image #32: displays the Ultiboard map for all of the regulators, this one in particular is for 12V to 3V
Image #33: displays the Multisim map for all of the regulators, this one in particular is for 12V to 3V

Image #34: displays the entire electrical map created in Visio
4. Troubleshooting

In the RevoBike there are many electrical parts and therefore there could be many electrical issues. It could be difficult to identify these issues because majority of them all have the same source and because there are so many wires running along the bike, over 200 ft (60.69 meters) of wire. To go through this troubleshooting process for the electrical parts it is most convenient to run through each part one by one and to also have a digital multimeter handy. All of the following situations have the assumption that the battery terminals are wired correctly five black wires to the negative ground terminal and four red wires to the positive terminals. A second assumption is that the proper wire awgs are being used for the required currents.

The first and most simple part to diagnose is the old console. This is on its own circuit and is powered by two AA batteries; therefore if the console is not working the user should check the batteries to make sure they are not dead. If the batteries still have some juice and are inserted with the correct polarity then the user should check for wire connection internally. If the console still does not work then it is most likely broken.

The second appliance that will be analyzed is the DVD player. The DVD player is powered through a voltage regulator from the battery. The first step to check the DVD player to make sure the power switch is switched to the on position. If the switch is on but the player will not operate then the internal battery is likely dead and needs to be charged. Make sure the power cord is plugged into the charging port onto the DVD player. If the cord is inserted correctly and no power is reaching the DVD player the problem could either be with the regulator or a wire has come disconnected somewhere beforehand. With the digital multimeter test the voltage of the wires coming into the regulator and make sure there is a 12V source. If there is no force than either the 12 volt battery is dead or there is a bad connection on the wire connecting the battery to the regulator. Next test the output of the regulator, it should read 9.5 volts. If the voltage reads higher than ten then the problem is that the ground has become disconnected and needs to be resoldered. If the voltage coming out of the regulator is correct then the user should check the wire connections going from the regulator to the DVD player. If the DVD connector is reading the correct 9.5 volts and the DVD player is still not working then there is a problem with the Philips DVD player whether is just be the power port or an internal issue. The Philips DVD player manual should be consulted.

The second and third possible issues are nearly identical in the horizontal and vertical actuators as they were designed the exact same way. The first thing to test with these actuators is use the digital multimeter and make sure that the middle two terminals of the rocker switch are ground and twelve volt source. If this is not the case then there is a bad connection in the wire between the battery and these terminals and needs to be addressed. Once the source voltage is corrected it is important to recognize that each direction of the rocker switch needs to have opposite polarities, meaning the power source (red wire) on one switch side needs to be on the opposite terminal as the other, otherwise both directions of the switch would move the actuator in the same direction. The next step is to make sure that the rocker switch is still functioning correctly. To do this use the digital multimeter to test the two terminals on one side of the switch while depressed while a source voltage is connected to the middle terminals. If the rocker is
broken it needs to be replaced. If the rocker switch is working properly then the issue must be wiring the switch terminals to the actuator itself. Because the actuators only have two inputs, positive and negative (ground), the wires need to be grouped together. It is important that the two power sources are wired to different terminals of the actuator and that the same side of a switch are not wired together, otherwise one would be shorting the battery. This leaves only one correct configuration that allows the actuators to move in both directions. In order to determine which direction is which a simple test can be done by depressing the rocker. If the actuator still does not function attempt to power the actuator with a different constant source eliminating the rocker switch so that you can easily tell if the actuator is working or not. This will determine if a new actuator is necessary. A last resort is to refer to the Grainger manual for additional assistance.

The most complicated component on the RevoBike is the tilt actuator. This circuit starts with a voltage regulator much like the DVD player. Therefore the first thing to check is that the regulator is outputting the correct voltage of 10.5 volts. If it is not then check the wiring to the battery from the regulator and make sure that the regulator still has everything attached correctly on the PCB board. Once this voltage has been verified go to the rocker switch that corresponds to the tilt actuator. This rocker switch has the source voltage of 10.5 volts to activate the relays in the H-bridge. Again verify the voltages on each terminal for the rocker switch to make sure the rocker switch is not broken. It is again important to make sure the polarities are opposite for the different switch directions. The rocker switch now sends its signal voltage to the H-bridge of relays. This wiring is very confusing. Each relay has four connections: two different circuits. When the signal voltage circuit is activated via the rocker switch this activates the second circuit in the relay, this is reaffirmed by a ‘clicking’ sound. A quick way to check and see if the system is fully functional up to the relays is to depress the rocker switch in each direction and see if the relays actually do ‘click’, however because two relays are clicking at once it can be difficult to hear both of the relays, but it is also possible to feel the click internally. It should be noted that in order to complete the signal voltage circuit the terminal opposite the signal voltage terminal needs to be grounded. Now comes the tricky part so keeping the circuits straight. Each signal voltage from the relay was split onto two relays for each direction of the rocker. One of each of these split relays needs to be power and one needs to be ground, but on opposite terminals of the actuator. To try making this easier to keep track of the relays have been labeled P or G for power or ground and U or D for up or down. There needs to be one of each combination. Once all of the relays are ‘clicking’ the user knows that the signal circuit is wired correctly. The other two terminals on each relay are the 12 volt source circuits. One of these terminals on each relay much go to the battery, P goes to positive terminals and G goes to the negative ground terminal. The other terminal on each relay must go to the actuator. It is important to put the U (up) power terminal with the D (down) ground terminals and they must both be connected to the actuators positive terminal. This leaves the U (up) ground and the D (down) power combined to go to the actuator negative terminal. Because it is impossible to depress the rocker switch in both directions at the same time the system will never short. Well all of the above steps have been verified and the wire connections are all good the actuator can be tested. Simply press the rocker
switch in either direction and see if the actuator moves, if not check to see if the relays ‘click’. If the relays do not click try testing each relay individually to make sure they are not broken. Replace any broken relays and make sure all of the wiring and connections are correct. Also make sure the battery connections to the relays are correct. If this is verified and the relays still ‘click’ check the terminals of the actuator to the relays and make sure they are all valid. If all of the above steps have been performed and the actuator still does no move try testing the actuator with a different source and without the H-bridge or rocker signal, just a straight twelve volt source. If the actuator works run through the steps above to ensure everything was connected correctly and that the battery is not dead as mentioned at the very beginning. It should be noted that this actuator draws a lot of current and the source needs to be able to provide twenty two amps (max of 500 #’s (226.8 kg) of resistance against the actuator). If there are still problems with the actuator consult the Grainger manual for further assistance.

The last electrical component is the inverter which is a simple circuit. The inverter is just wired to the battery with a 30 amp breaker in-between. The breaker serves the purpose of keeping the battery from being drained by something as large as a mini-fridge. The first thing that should be checked is that the switch on the inverter is powered on. Next make sure the appliance trying to power does not require more than 30 amps. After these two steps have been verified the user must check the wiring from the battery to the inverter and make sure everything has a good connection. Also make sure that the battery is not dead again. If the inverter still is not passing any power through the outlets DO NOT TRY to use the digital multimeter by inserting the probes into the outlets. Try to power the inverter without the breaker. If this does not work then try to power the inverter with an alternative power source. If the inverter is still having problem consult the Duracell manual.

The power generation component of the RevoBike is a bit more difficult to test because there needs to be two people, this because someone has to be pedaling in order for a voltage to be produced. The first thing that should be done is disconnecting the bridge kit from the battery. Once the battery is disconnected the second person should start to pedal the assembly around thus spinning the generator shaft, this should be verified visually. If the shaft is not spinning then adjustments need to be made so that it does. This could be adjusting the wheel attachment on the generator shaft. Once the generator shaft is spinning a voltage should be produced, this can be verified with the digital multimeter. Once this has been verified the user knows that the generator is functioning properly. It is important to wire the generator into the correct terminals on the full wave bridge kit, otherwise the generator isn’t allowed to pass its power to the battery, but the battery can pass it to the generator turning it into a motor, which is the reverse of the desired. Once the connections have been corrected, if necessary, wire the full wave bridge kit back to the battery and the generator should now power the battery.

For further assistance please contact one of the designers and co-founders Drew Seils or Shane Tornifoglio.