instructables

Giant Tide Clock

by rabbitcreek

Whittier is a wonderful town located about an hours drive from downtown Anchorage, Alaska. Many people pass through on their Alaska cruise and are confused by its tiny charms. It does not have the jewelry shops--owned in part by the cruise ship companies--nor the odd t-shirt shops and sorry eateries of other beach towns. It's located under a incredible landscape of melting glaciers and waterfalls that cascade through the streets. Seabird rookeries and sparkling blue seas of glacial silt surround this WWII outpost with limited space to screw up its inherent beauty. I have been lucky enough to spend many pleasant hours in this rain forest outpost under grey skies filled with Ravens and Bald eagles. What it really needed was a huge tide clock!

Lazy Otter Charters has operated tours of Prince William Sound for about 30 years. The owners, Kelly and Mike Bender are the people you call in the middle of the night in January when you find that the only evidence of your boat that was previously floating in your slip is a frozen rope now stretched to its limit into the dark sea. I thought they would appreciate a gigantic tide clock that kept track of the highs and lows of the tide which are enormous here as well as the radical day light cycles that make this place so neat! This clock is 4 feet in diameter and has two micro controllers one for the tides to operate the hands and the other that calculates the shortening and lengthening days and appropriately sets the background lighting for a cascade of lighting effects from sunup to sundown. Plus a memory full of easter-egg date events to celebrate.

Step 1: Gather Your Materials

This clock is big. So most of the work is not in the microcontrollers and circuitry--rather building a watertight case for the clock.

1. 4 X 4 1/2 inch maple plywood--or as big a clock as you want. $20

2. 4 X 4 polycarbonate sheet (Lexan) 3/8 inch -- specialty plastics $150.00 -- you can compromise with Acrylic which is much cheaper...big box stores have 3 foot by 8 foot sections

3, Bendy Board -- 8 inch strip-- available at many wood specialty stores. $20

4. Epoxy with Fiberglass cloth $20

5. Thickened epoxy -- West Marine $20

6. E6000 glue, various paints, Silicon GE for water usage -- West Marine

7. Old Kayak Paddle

8. TM-785HB Servo Gearbox $120 -- this is the heart of the unit -- it allows high torque multi turn control of the very large arm -- its expensive but you get to deal with **Servocity** one of the nicest companies

9. Arduino Nano -- generic about $4 X 2

10. RTC 3231 with backup battery $4 X 2

11. Generic Small OLED screen i2C X 1 about $4

12. PCBway to get circuit boards made or just bug wire them $5

13. Letters wooden -- Craft Store $40

14. Numbers metal -- Big Box $40

15 . Neopixels 4 meters -- $60

16. Power Supply 10 A 5 volts $25 **Adafruit** 5V 10A switching power supply

17. Aluminum flashing $15

18. Plexiglass support rods $ 20 -- Amazon RuoFeng Stainless Steel Wall Mount Glass Standoff Holder Screw Nails Advertising Nails

19. Open source picture of cute Otter printed on fade resistant metal $75 FedX printing service

20. Various 3D printed parts and shell -- essentially free


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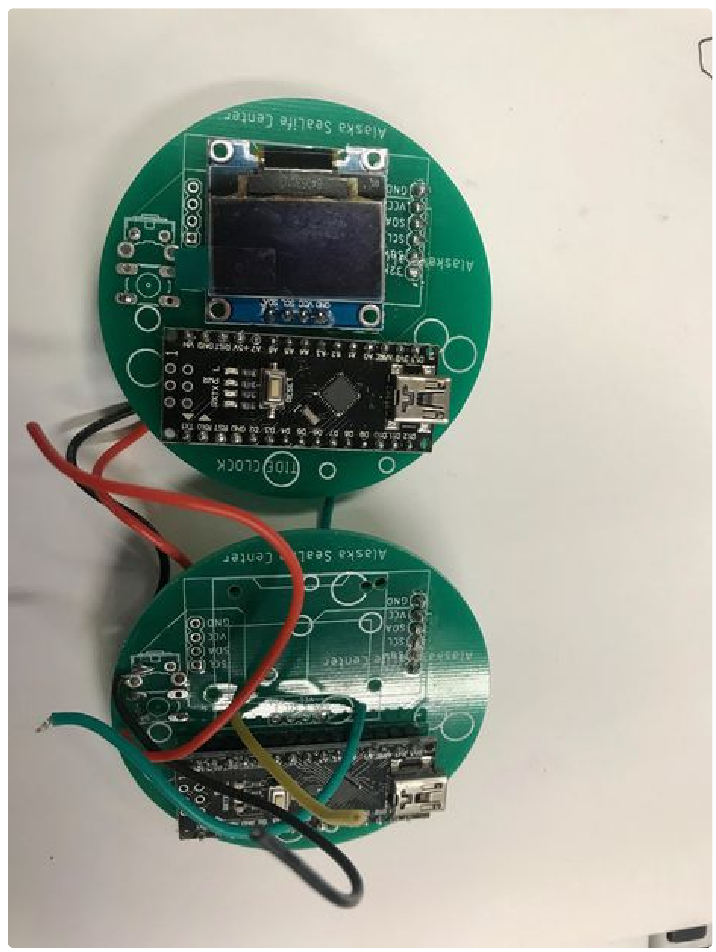

Alaska SeaLife Center
TIDE CLOCK

Step 2: Build It # 1

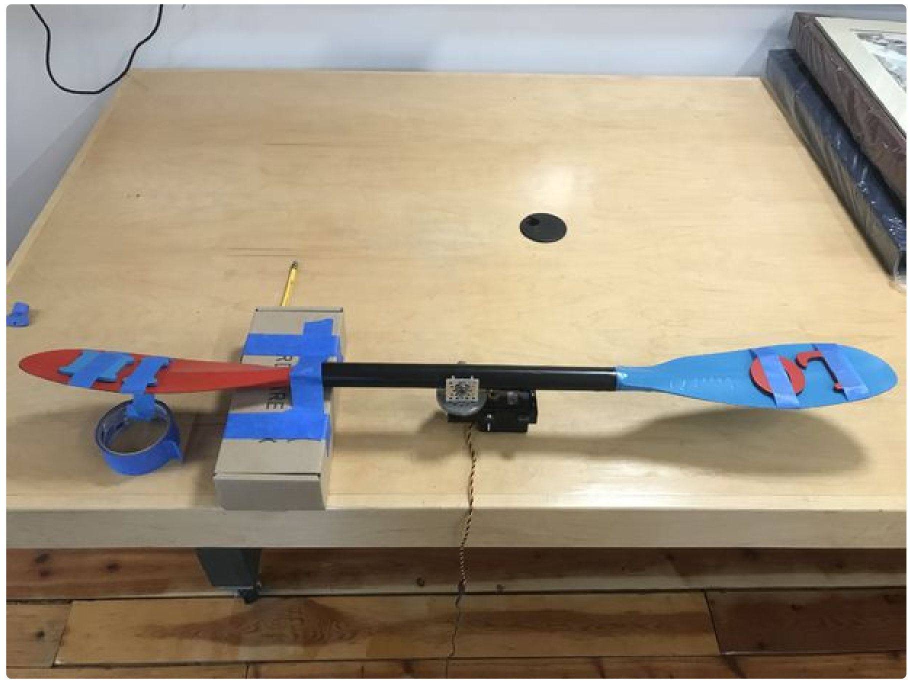
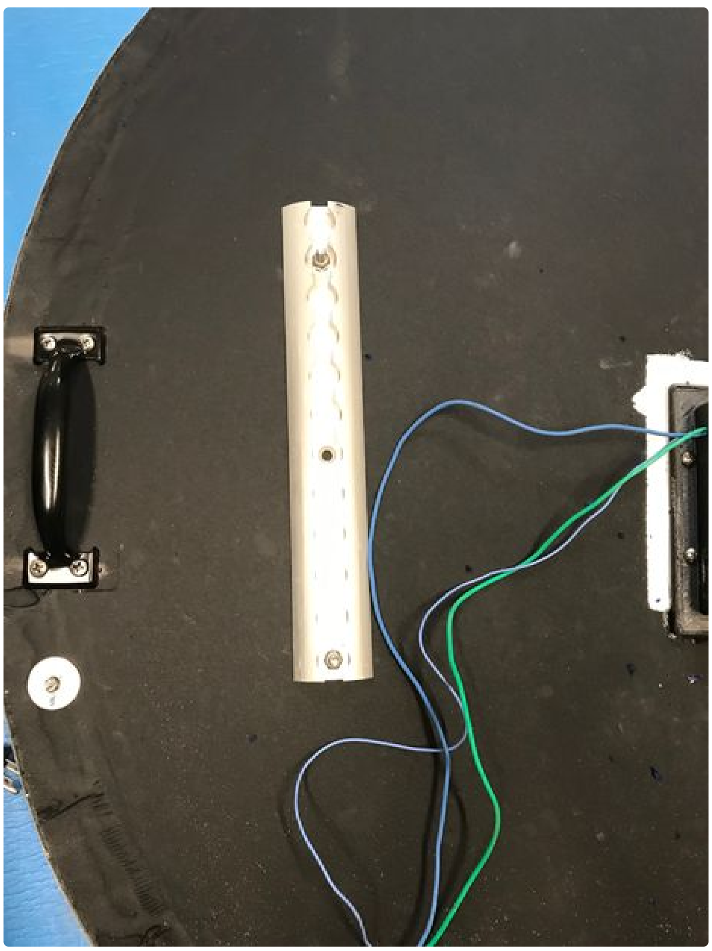
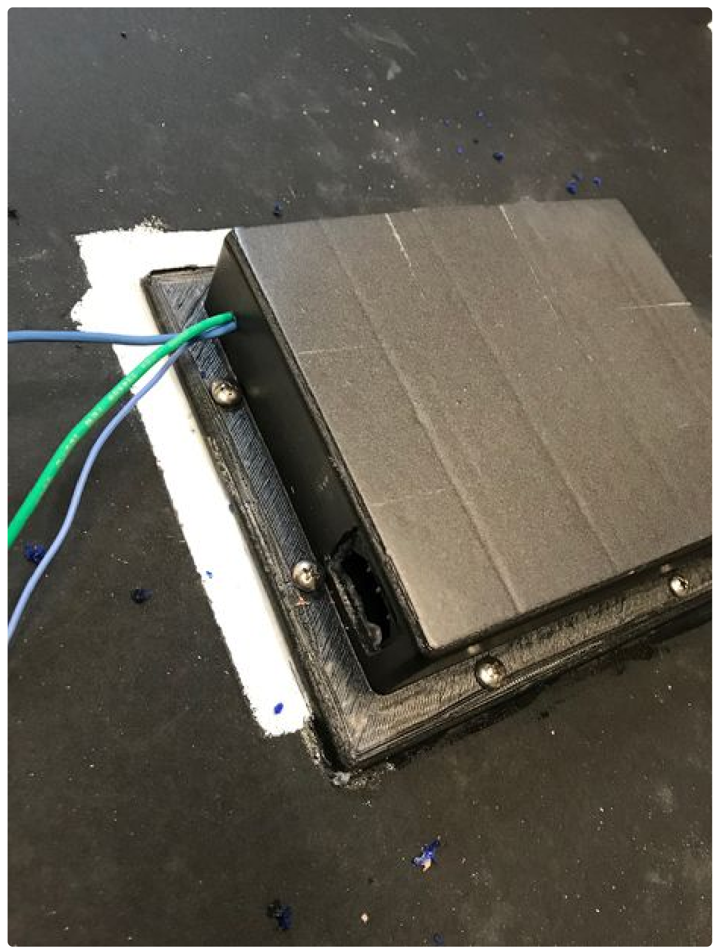
First decide how big you want this -- about 4 feet felt reasonable and was easy for raw materials. The servo can operate much longer arms with its gear box and well supported bearing design as long as the arm is carefully balanced. The basic design consists of a circle cut in plywood. The clock body is made by attaching bendy board plywood to the periphery of the 1/2 plywood circle -- you can make this any depth depending on the light and arm depth dependencies in your design. Hold the periphery in place with pneumatic nails and apply wood glue to the interface. It easily bends to this circumstance. Take a redimix tube of westMarine thickened epoxy and do a bead along the inside edge to form a fillet.

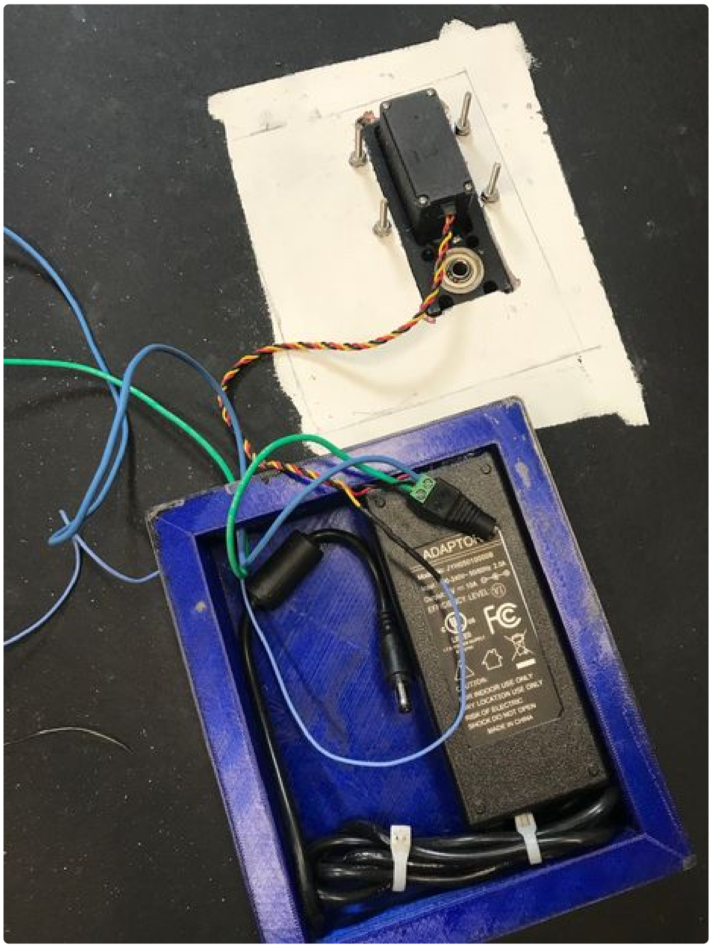
The monohull design of the clock is completed by applying an initial layer of epoxy to the outside of the frame followed by a layer of fiberglass cloth which is attached with additional epoxy. Carefully smooth this layer with a plastic spatula to remove any bubbles. The inside of the clock is then given a layer of epoxy. When dry carefully sand both inside and out and prime it with sanding primer. The inside of the clock is sprayed with a flat white paint to provide good light diffusion from the LED's. The outside rim is than covered with a layer of Aluminum flashing that's held in place with construction adhesive. The backside is sprayed with truck bed liner paint. This leaves you with a waterproof structurally sound support system for your clock. Modifications in shape and size are easily done during this phase.

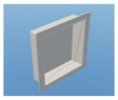



Step 3: Build It #2

The kayak paddle is made out of an old paddle that was shortened in the middle and modified at the ends to fit inside the clock on a band saw. The paddle was then reconstructed with thickened epoxy and painted with added raised graphics for HI and LOW. The TM-785HB Servo Gearbox is put together -- I used the 3.8 ratio small gear to give a least 4 turns of the hands with software timing modification. This well-made and strong gear box has support in the bearings for the paddle in all positions. It is important that when mounting the paddle you center the weight right at the bearing so the paddle won't drift when power is detached. I used some standard mounting hardware from ServoCity for attaching it to the servo. An outline was cut to accommodate the mounting of the servo in the central position and held with bolts. The Otter graphic done on composite Aluminum was mounted in position. The numbers and letters were glued into position with E6000. The power supply is a beefy 10 A unit from Adafruit that is certified by UL. I enclosed it and the servo box together on the back of the unit so the power unit could keep the servo and bearings warm during the cold dark months where it regularly freezes. A 3D printed enclosure sealed with a silicon bead with openings for the power wires and the 110v power cord are at the bottom. These are sealed with silicon too. The two mounts for attaching the clock to a wall are the aluminum rail systems that are sold for attachment points for truck beds. These were through-bolted into the clock. Four handles were also attached to the back to provide setback to protect the flat elevated power enclosure and for easy handling. The stainless steel mounting rods for plexiglass were then bolted to the case. Five of these were used and placed in a position where they would not interfere with clock movement but be far enough away from the rim to prevent cracking of the Lexan faceplate from drill holes. The Lexan faceplate was then cut giving about 1/2 inch of expansion room around the rim for the anticipated heat in the summer.





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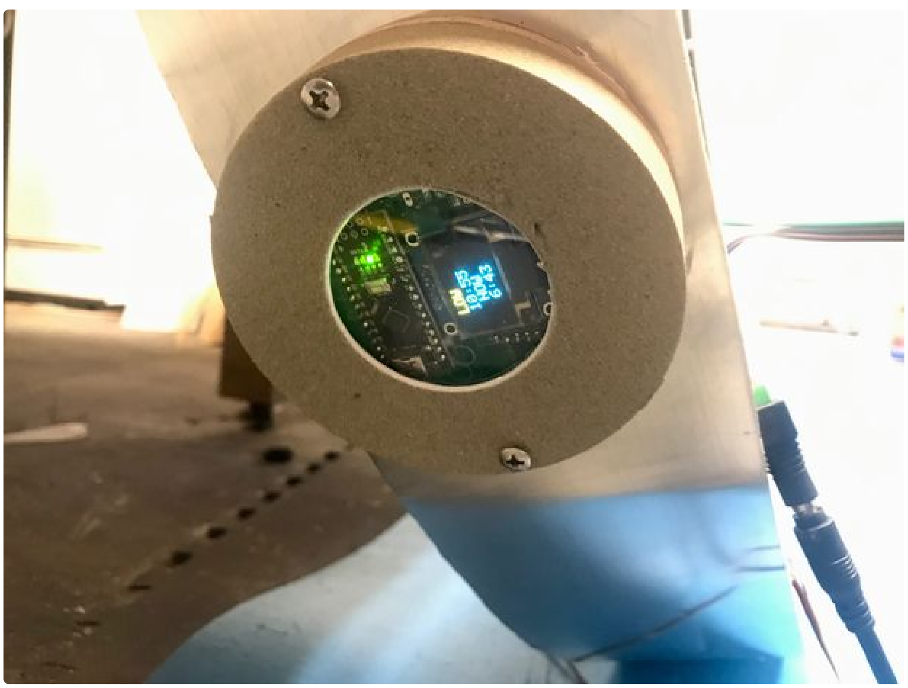
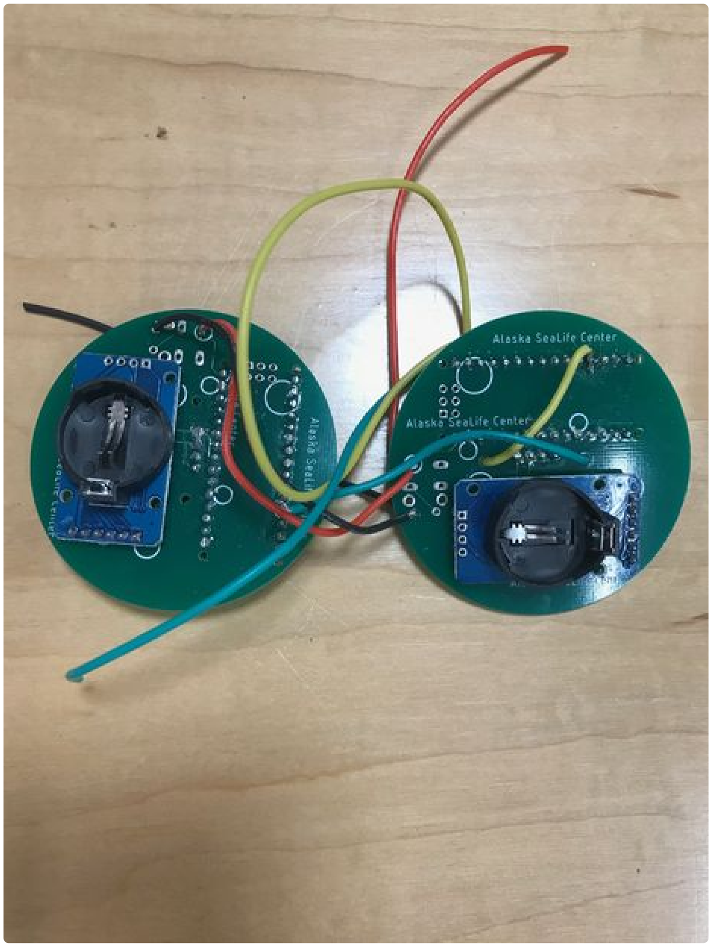
Step 4: Build It #3

The computer case was designed to provide feedback on what the clock was doing, access to the computers and RTC's for battery replacement and programming and not interfere with the movement of the arms which takes most of the space in the case. It also had to be waterproof for the electronics. Two Arduino nanos mounted on PCB's used in the moon clock **https://www.instructables.com/id/Tiny-Moon-Tide-Clock**/ along with two RTC's were used to run the machine. Servos and Neopixels are a notoriously bad combination thus the need for two clocks and two separate computers. The two control units were stacked and placed in the 3D printed enclosure with a Lexan window this was though-bolted to nuts on the inside of the clock that were epoxied into position. The power wires and the control wires (one for the neopixel data line and one for the servo data) were placed on snap connectors and led out of the baseplate and into the clock interior. The 4 meters of Neopixels were cemented into the clock periphery with E6000. The heavy gauge power wires were fed through the back of the clock from the power supply and connected with a large capacitor to both sides of the neopixel chain. A resistor was placed adjacent to the data line to the neopixels. A rubber peripheral bumper was glued into position for the window to seat against. The holes were carefully made in the Lexan over the post supports slightly oversized for expansion. Silicon GE for underwater use was then used to seal the periphery of the front glass after securing it with bolts to the support rods. All bolts were further secured with blue bolt locker and the large washers were sealed with silicon. A further rim of rubber trim was applied at the rim with E6000. All STL files are included along with the 3D printed shell to conceal the kayak mount and servo head.

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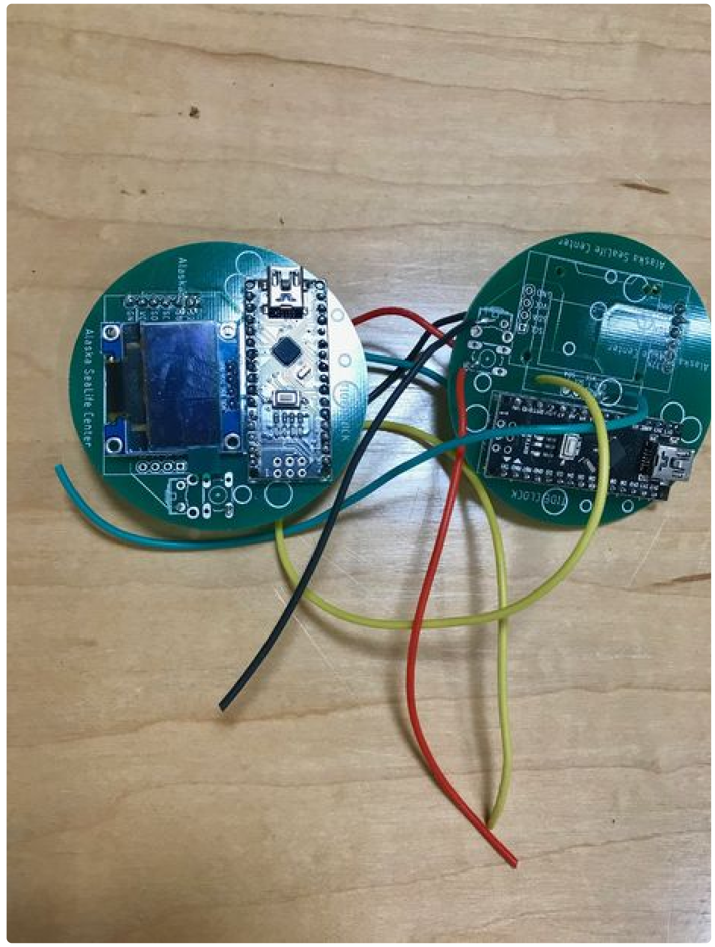
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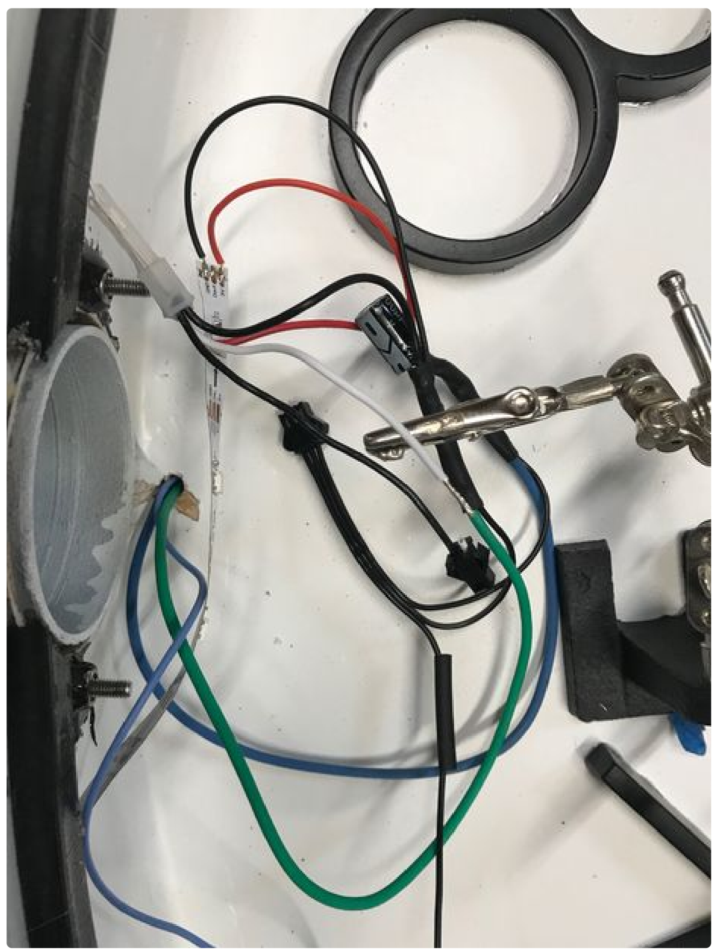

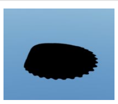
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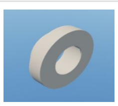
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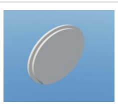
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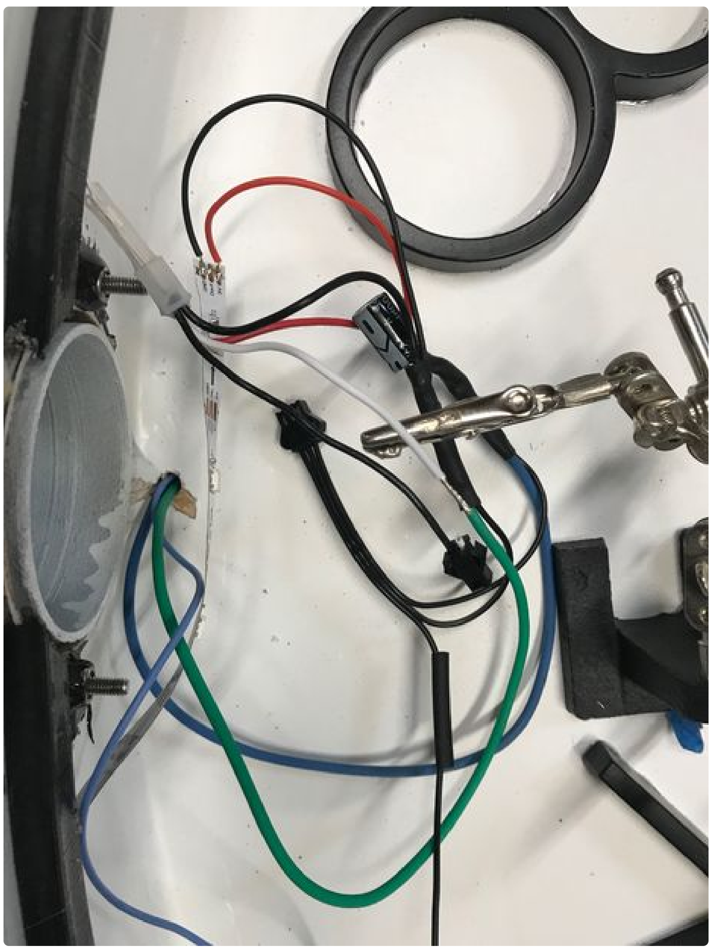
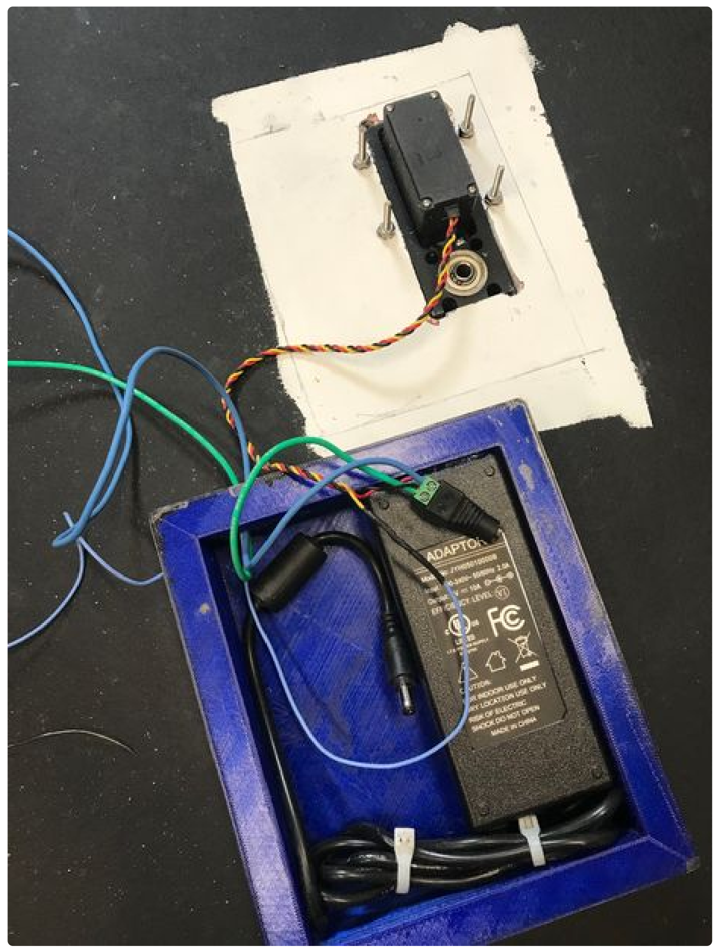
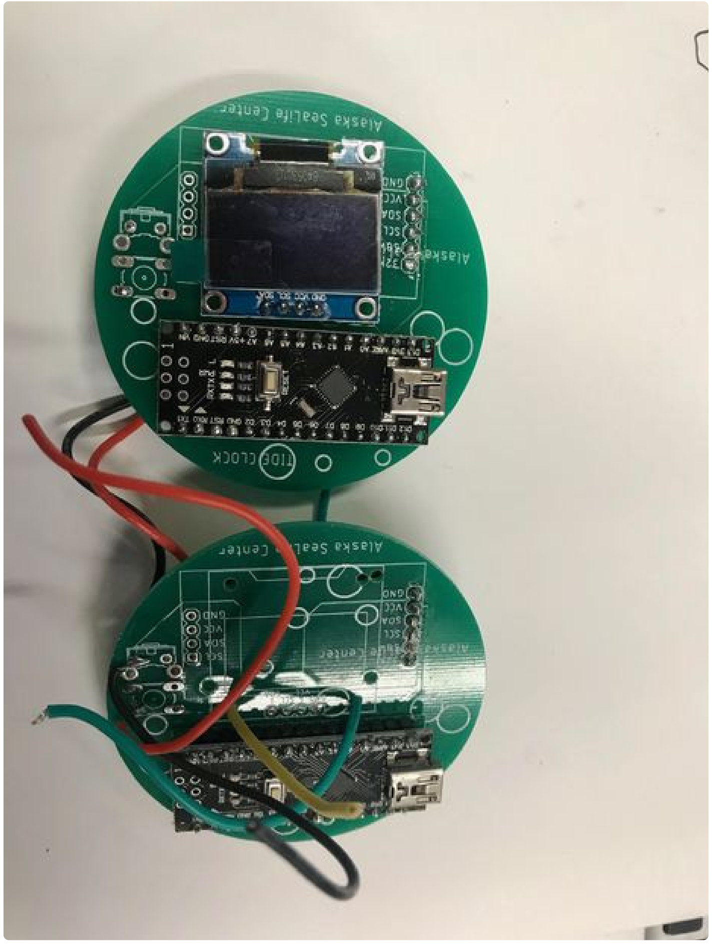
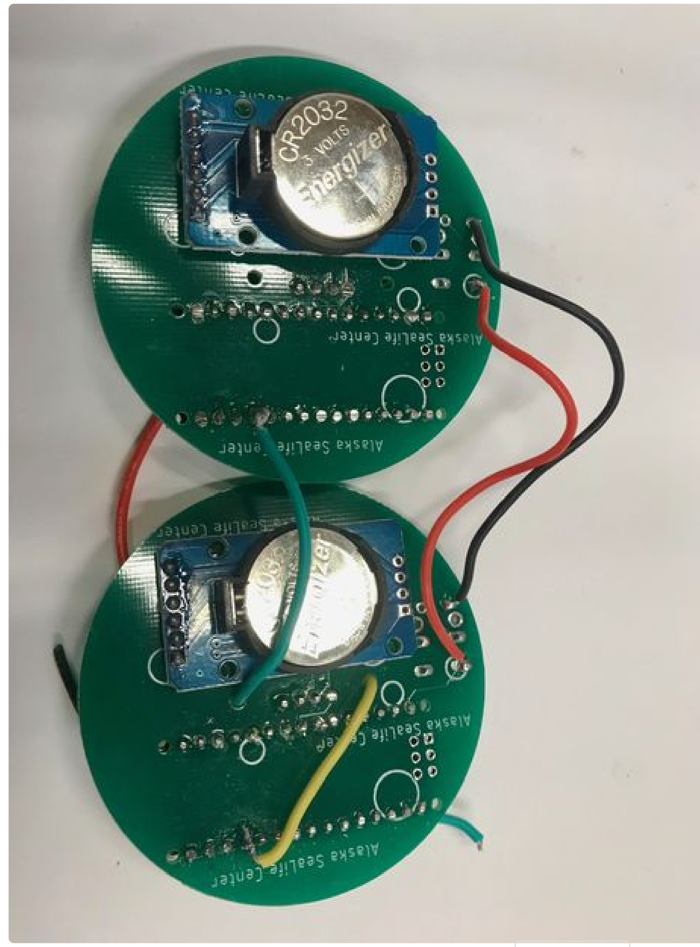
Step 5: Wiring It

The PCB board from the tiny moon clock made wiring very easy. But if you don't want to do it that way the computers are two cheap nanos off the web that are connected to separate RTC 3231's through I2C interfaces. So just power and two separate wires for SCL and SDA. Everything runs on 5 volts so you don't have to level shift for the neopixels. The only change to the board is directly adding power -- no pushbutton-- and taking a data lead off of one nano for the neopixel and one off of the other nano for servo control. The only one OLED screen is used on the servo control computer so you can always see the current time and the next HI/LOW tide. The tiny OLED screen is also I2C interfaced so just two wires and power and ground. A large 10A power supply is used because as you realize quite a bit of power is used by the 120 LED's when turned on white all day. The Servo computer just runs the servo for HI/LO and the screen output. The lighting computer runs the lighting controls and calculations for dates and background lighting. Sixteen gauge wire was used to bring the power from backside box to lights. Remember to add a capacitor to the light power and a resistor to the control data line. Both ends of the neopixel strand are connected to power to prevent the end--brown--out syndrome.









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Step 6: Programming It

Two separate arduino programs are necessary for the two nanos. The control of the servo is based on **Luke Millers** wonderful work: **http://github.com/millerlp/Tide_calculator** that allows the small nano to calculate the complex tide results. The working of this software is carefully explained on his site and my previous renditions of this instrument: **https://www.instructables.com/id/Tiny-Moon-Tide-Cl...**and here**: https://www.instructables.com/id/Solar-Tide-Clock/** Changes in this software are made for the limited output to the OLED screen -- only the next HI/LO and the current time to let people know what is going on with the tide computer in case the paddle goes nuts. Tinkering with the servo control output must be done in the form: writeMicroseconds. This servo is great for being able to do 4 turns around the dial with good software control but you must find the values that direct the servo into the 12:00 position and provide the range to swing it 360 degrees. This is done with trial and error because its initial mounting and position of the arm on the servo gear all effect this position. Do not use the servosweep software that is the usual first step with a new servo -- move the servo only with the writeMicroseconds command and be careful of the limits that you send to this function (no lower than 600 and no higher than 2400) This took some playing and you will probably readjust the map and constrain functions further when you see the arm move. The RTC time is set in the software for your compile time and then reset with the set time turned off so that when the computer reboots it doesn't go back to the time the original compiling was done. Correction for daylight savings in Alaska is in the software as well as the tide table for Whittier so these will have to be changed if you're living in Hawaii where they don't do foolish things with the clocks in the spring and fall. The calculations are done about once a minute and when the current time matches the "next" HI/LO the future "next" HI/LO is calculated and the arm is moved to it.

The nano for the lighting is kind of fun. I wanted to to have a light gradient for the day as a background with an orange sunrise, progressing through pink and violet and then whiter through the day descending into indigo and night blue. To perform these on really long and really short days --- in the winter here the day only lasts 4 hours!--you must calculate sunrise and sunset times and calculate the length of the day and then shoehorn the color changes into this time period. The software for this second arduino does this. It also presents the current time around the outside periphery as a red dot of three neopixels that helps you read the clock. Also on the hour and half hour a animation of green and red meteor lights shoots around the dial. And the clock also features an array of dates that are celebrated by a red/white/blue cascade at intervals throughout the day. Currently it set for Halloween, Christmass, New Years and Fourth of July--these can of course be changed in the dateArray. I used the FastLed library and the Timelord libraries for the sunset and sunrise calculations.
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Step 7: Using It

This clock took about a month to build and ended up weighing about 40 #'s--thus the need for fairly robust mounting hardware. The worries regarding construction are the severe winters -- freezing rain, endless winds and snow and very low temps. The case should be pretty sealed against water influx but only time will tell how it holds up. I placed a small vent in the lower section of the rim to provide air-circulation and to try to stop condensation. The computer module also has small vents. A few small drain holes are located at the 6:00 position. The neopixels do not have a silicon sleeve as they are nearly impossible to glue well even with E6000. We have recently had rather unusual warming in the arctic presenting a worry of overheating -- like the rest of the planet the tide clock might be at risk.

HOW TO READ THE CLOCK

Clockwise from the current time the next Hi or Low tide will be indicated by the position of the paddle.

EXAMPLE

Say it's 4:00 in the afternoon and you notice that the otter has his LO paddle on 12:00 and his HI paddle on 6:00 it would mean that the next HI tide should be expected at 6:00. When the current time reaches HI tide at 6:00 the otter will adjust his LO paddle to show you the next LO tide position. HI and LO tides are generally 6 hours apart.

DISCLAIMER

NEVER TAKE NAVIGATIONAL ADVICE FROM AN OTTER