Building the 3D Printed Motion Kinetic Art Sculpture

Printed parts

All parts were printed in 0.2mm PETG or PLA. Where special consideration was made for support or modified printing I have indicated below. All parts were printed in their current orientation.

- Base
  - motion-art-base-platform.stl
  - motion-art-base-bowl.stl
  - motion-art-base-top.stl
- Tower
  - motion-art-tower-top.stl
  - motion-art-tower-bottom.stl
- Ring
  - 14 x motion-art-ring-arm-bearing.stl
  - 28 x motion-art-ring-arm-blade.stl (Used PETG and increased perimeter to 4 to give flexibility and strength)
  - 13 x motion-art-ring-segment.stl (print with support)
  - motion-art-tower-ring-right.stl (print with support)
  - motion-art-tower-ring-left.stl (print with support)
- Ring blade spheres
  - 28 x motion-art-spheres-1.stl
  - 28 x motion-art-spheres-2.stl
  - 28 x motion-art-spheres-3.stl
  - 28 x motion-art-spheres-4.stl
  - 28 x motion-art-spheres-5.stl
  - 28 x motion-art-spheres-6.stl
  - 28 x motion-art-spheres-7.stl
  - 28 x motion-art-spheres-8.stl
- Gears
  - motion-art-gear-single-shaft.stl
  - motion-art-gear-dual-shaft.stl
  - motion-art-gear-ring-right.stl
  - motion-art-gear-ring-left.stl
  - 2 x motion-art-gear-tower.stl
  - motion-art-gear-base.stl
  - motion-art-gear-motor.stl

Non-Printed parts

- 19in Macramé ring
  - You need some rigid ring to hold the structure. This worked really well.
  - https://www.createforless.com/PAEssentialsBrassRings19in/pid933.aspx
- 608 Bearings – Need 14 for ring, 2 for the ring gears, and 3 for tower gear axis
  - https://www.amazon.com/gp/product/B07C6FL8TW/
- 12v Gear Reduced Motor
  - https://www.amazon.com/gp/product/B0771JLC2N/
- 12v Motor Voltage Speed Controller
  - https://www.amazon.com/gp/product/B00N30UK2M/
- 12v Power Supply
  - https://www.amazon.com/gp/product/B01GD4ZQRS/
- DPDT Switch
  - https://www.amazon.com/gp/product/B008DFYNX4/
- Metal wire for ring guides
  - I found this brass welding wire, that was perfect. Good color, stiff and the right diameter.
  - https://www.amazon.com/gp/product/B00N2TSW10/
- M3x8 screws (4 to mount motor, 2 for switch, 2 to hold gears)
- Electrical Wire, 2 conductor 20awg
- Glue
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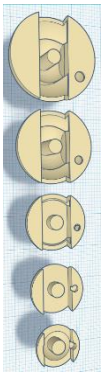
Assembly Instructions

- Base
  - The base was designed in three parts ease of assembly ease and to keep the total print time down per printed object.
  - The bowl can be attached to the platform before anything else except it makes it harder to reach the screws to mount the motor. You can do it with a small hex wrench, but it is easier before attaching the bowl.
  - The bowl snaps in place. I glued the parts together since I didn't see a need to remove it in the future.
  - There is a vertical hole running through the four pillars that connect to the top. In early prints I managed to snap off the tip of one of the pillars in the top, so I created the holes to glue a piece of wire in it to give it strength. You don't really need it if the top fit isn't very tight, but it can't hurt.
- Tower
  - The tower was designed in two parts for assembly ease and to keep the printed object down.
  - You will want to glue the tower bottom to the top.
  - I didn't need to glue the tower to the base top because the fit was tight. If you decide glue it, don't do it until after the gears are in place on the tower.
  - I would advise against gluing the tower to base top because you will need to glue the tower to the ring, and the sculpture starts getting pretty large at that point.
- Ring
  - The ridged brass ring will need to be split. I cut it along the weld joint.
  - Push the 608 bearing in to the motion-art-ring-arm-bearing part.
    - The fit is tight. I found it easy to put them on a hard floor and push down with my heel ;-)
  - You will slide one segment and then the bearing part onto the ring 14 times.
    - Make sure the bearings are all aligned facing the same way.
    - You need to have the small double holes on the bearing edge face the single hole on the opposite piece.
      - These holes are where the guide wires are placed.
    - Each segment force fits in to the next segment with the bearing in between and free to turn.
  - The tower ring right and left are then slid onto the ring on each end.
  - Attaching ring guide wires
    - The guide wires are the connection from one arm-bearing to the next. As they move around the from outside to inside the ring, the spacing is contracted towards the inside and expands again as it moves to the outside. They need to move smoothly and stay in contact
    - You will need 14 100mm length single wires and 14 200mm bent in half—so 100mm long wires.
      - Make sure the bent loop in the wire end isn't so narrow that the single wire can't slide back and forth between the bent wire.
    - I used superglue to glue these wires to the motion-art-ring-arm-bearing piece.
      - A single wire goes on the side with one hole and the loop on the side with the double holes.
    - The single wire should end in the middle of the double wire.
    - After you attach the wires, you should be able to turn the center arm bearing and the other bearings should all follow the same movement.
      - You might need to bend the wires some to make sure it works properly.
  - Once I trial fit the segment and bearings to be even across the ring, I went back and used a little contact cement to make sure they didn't slide around. You shouldn't need this.

- Gears
  - A 608 bearing needs to be pressed into the two motion-art-gear-rings (left and right).
    - Once again, this is a tight fit.
  - Slide the bearing gears on to each side of the ring next to the smaller tower ring segments.
    - Note that the gears have the same single and double holes.
    - Make sure that the single gear hole faces the double holes on the edge of the opposite bearing piece and the double holes face a single hole.
  - On the tower you will insert 3 608 bearings into the obvious holes.
    - If this fit is loose, you might want to put a little glue in the hole to hold the bearings in place
  - Insert and center the motion-art-gear-dual-shaft through the upper bearings on the tower.
  - Insert into the hole the motion-art-gear-single-shaft in to the lower bearing so that the half circle portion of the shaft sticks far enough out to be able to place the gear on it.
  - Place the 2 identical motion-art-gear-tower gears on each side of the tower.
    - I designed these with M3 screw holes so that they maintained their alignment. If your fit is tight, then you won't need the set screws.

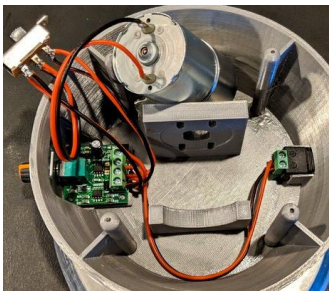
- Please the motion-art-gear-base part on the lower single shaft. This is the gear that will protrude through the top of the base to connect to the motor shaft.

- Ring blade spheres
  - This is the most time-consuming aspect of the printing and assembly part of this project.
    - In an early version of this I designed disc instead of two-sided balls which were a lot easier to deal with, but I didn't like the look as well as the balls.
    - Remember you are printing 28 x 8 x 2 = 448 pieces :-(
    - Since you are printing many of these pieces, some of the design choices made were to ensure adhesion without a brim and successful printing without supports.
  - The two halves of the balls are not the same and to make it easier to not mix them up, I placed a hole on the bottom of the sphere that goes on the inside curve of the motion-art-ring-arm-blade
  - The best way to assemble these for me was to use contact cement. Put on some glue, wait a minute or two, and then press sphere halves together on the arm blade.
    - You'll think you're gluing your fingers by the time you get to the smaller spheres :-)



- Connecting the Ring to the Tower
  - The two sides of the metal ring should fit in through the holes in the top of tower and the tower-ring-segment pieces should force fit together in the holes.
    - If your printing dimensions are off a little on the segments you may have a little too much ring exposed that doesn't allow for a tight fit. Cut off the little extra piece of ring so that you can have a good force fit.
  - You need to glue the ring to the tower!
    - I used a two-part epoxy and you need to make sure the entire structure is vertically aligned.
      - The best way I found to do this is to hang the top of the ring from somewhere and let the tower dangle below via gravity. Stand sideways to the ring and sight from the top of the ring to the bottom of the tower to make sure it is a straight path. Leave hanging until the glue dries.

- Electrical
  - The circuitry basically is a geared down motor whose speed is further controlled by a variable voltage controller with a switch to change the polarity of the motor and the therefore the direction of the sculptures motion.
  - Wiring Connections:
    - The 12-volt supply is wired up to the voltage controller to the power + and power – terminals.
    - The motor + and – output is made with two sets of wires.
      - One set is connected to one side of the DPDT switch
      - The other set is connected to the other side of the DPDT switch but with the + and – sides opposite for what was done for the first wire. This allows the switch to supply + and – or then – or +.
    - The center terminals of the DPDT switch connect to the motor's + and – terminals. It doesn't make a difference which one goes to which since the switch is creating both combinations.



- Final assembly and operation
  - Please the small motor gear on the shaft of the motor and align so than when you place the top on the base, the tower-base gear is aligned with it.
  - Realign all the gears so they are centered on each other. They don't have to be perfect.
  - Place the ring/tower on the base top. This fit should be snug, but you can also glue it if it wobbles.
  - Please the ring/tower/top on the base bowl. It should easily fit over the pillars.
    - I specifically designed it so it should only fit on one way.
  - Place all 28 motion-art-ring-arm-blades on the 14 motion-art-ring-bearing pieces. Two blades per bearing.
    - These pieces should easily slide in and stay in place without glue
      - I don't glue them in because I take the blade arms off when I want to transport the sculpture.
    - The orientation of the blade arms is so that the end of the arm is notched out, so it sits flush with the bearing piece.
  - You are ready to rumble!
    - Make sure the voltage controller is turned off.
    - Plug in your 12 volts and connect to the base.
    - Slower turn on the voltage controller and enjoy the show.
    - Want to change directions:
      - Turn off the voltage controller
      - Slide the switch to the other side
      - Turn back on the voltage controller.