Aerial Tram

General

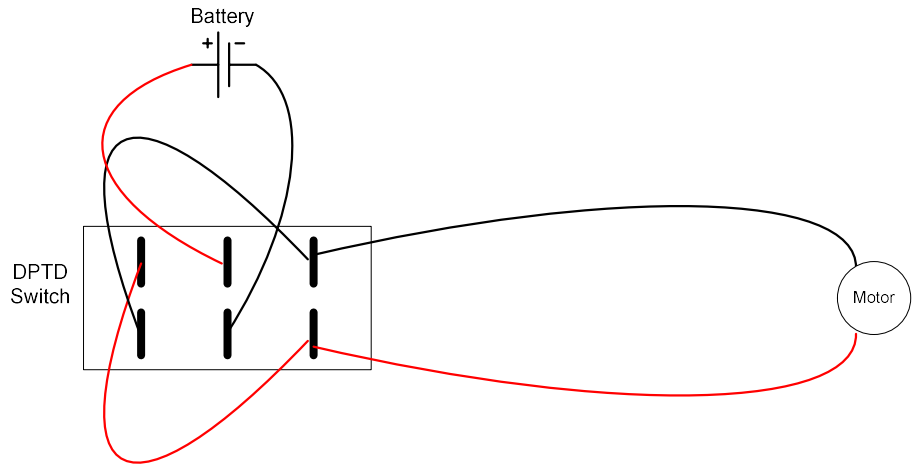
In this exercise you will build a not very pretty version of a moving part to use in your city model. This is called a Proof of Concept or POC. It gives you experience in working with the materials and connecting the electrical circuits. The version you build for your city model will look much better, but work basically the same.

All of the parts and supplies you need are in your team's brown bag or on the table. Leave scissors, needle nose pliers, tape and other supplies on the table when you leave the room. You many want to partially disassemble your moving part so it fits in your pack, or you can just carry it around. A few supplies like duct tape and masking tape may be at the front table.

The wiring harness was assembled so that the POC could be built in the time available.
Some information on aerial trams can be found at:
https://www.eco-transit.com/cable-transit/

IMPORTANT
The direction the motor turns is dependent on the polarity of the voltage supplied. This project uses a double pull double throw (DPDT) switch to reverse the polarity of the voltage supplied to the motor.
Red or Copper is the positive wire.
Black or Silver is the negative wire.
Except when the polarity to the motor is reversed.
Review the Parts List and Receipt before starting the exercise.
Take the parts out of the bag and arrange them neatly on the table.

1. **Build the switch and battery assembly**
   - 1.1. Layout the electrical harness on the base cardboard. Do not tape anything down yet. Review the diagram below carefully and observe the model if available.
   - 1.2. Connect the battery pack wires and the electrical wire harness that has two switch connections. Twist the wires together and use the grey wire nuts to hold the wires together.
   - 1.3. Connect the motor wires and the electrical harness that has four switch connections. Twist the wires together and use the grey wire nuts to hold the wires together.
   - 1.4. Connect the wires to the DPDT switch as indicated in the diagram below. Note the two switch connections from the battery pack connect to the middle two spots on the switch. Note that the motor wires cross over sides on the switch. Each of the motor wires has two switch connections and one is connected on one side of the switch and the other is connected to the opposite side and opposite end of the switch. When connecting to the wires, hold by the connectors only. Do NOT push or pull on the wires.



1.5. Insert the batteries in the battery pack.
1.6. Test the switch wiring to motor
  1.6.1. With the switch in the middle O position: The motor should not turn on
  1.6.2. With the switch in the I position: The motor should turn on, note the direction of rotation.
  1.6.3. With the switch in the II position: The motor should turn on and rotate in the opposite direction from the previous test.

2. Build the motor tower assembly and

2.1. Snap the large pully wheel on to the axle of the motor. Note the hole in the pulley wheel and the axle must be lined up exactly right for it to snap into place
2.2. Use double sided tape to attach the motor to the box or plastic container (this will be our tower) so that the pulley is hanging in the clear. NOTE: The contacts on the motor are relatively fragile, handle the motor and wires gently.
2.3. Attach the tower assembly to the larger piece of cardboard that will be the base using duct tape. The back of it should be even with the end of the cardboard so you can run the tape down the tower a few inches, then wrap it under the base. You may want to do the same on the sides if feasible.
2.4. Test the electric motor and switch to make sure no wires came loose.
2.5. Fasten (duct tape) the tower to the large piece of cardboard that will serve as the base.
2.6. Use masking tape to neatly fasten loose wires to the base and tower assembly

3. Assembly

3.1. Layout the wires in an orderly manner on the cardboard base.
3.2. Check that the motor connections using grey wire nuts are still fastened.
3.3. Test the circuit.
  3.3.1. With the switch in the middle O position the motor should not turn on
  3.3.2. With the switch in the I position note the direction of rotation.
  3.3.3. With the switch in the II position turn on and the motor should rotate in the opposite direction from the previous test.
3.4. Layout the wires, DPDT switch and battery pack on the cardboard base
3.5. Fasten the DPDT switch and battery back in place with double sided tape.
3.6. There will be excess wire to accommodate the layout in your real model city. Layout the wire neatly and fasten in place with either double sided tape or masking tape.
3.7. Repeat the test in step 3.3

4. Build tram base station

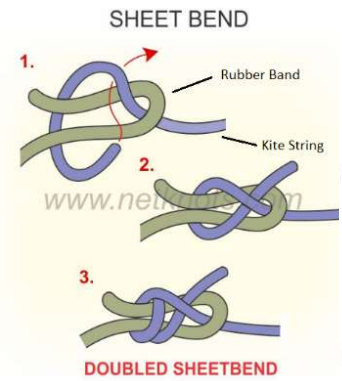
4.1. Fasten the small plastic container to the smaller cardboard piece using duct tape and follow the same procedure as for the tower.
4.2. Use two strips of double-sided tape to fasten the foam block to the top of the small plastic container. Align one smooth side so it is aligned with the edge of the container. Note: you have at least one piece of foam to use in your city model. A coping saw works well to cut the foam.
4.3. Attach a strip of double side tape to the plastic axle rod stabilizer. Cut off the excess (easiest if someone holds the tape stiff while the other team mate cuts). Peel off the back of the tape. DO NOT attach it yet
4.4. Push a 4d finish nail through tape over each of the holes in the plastic axle rod stabilizer. Roll the nail a bit to remove the glue from the edge of the hole. Attach the plastic axle rod stabilizer to the foam block in a horizontal position.
4.5. Attach the axle rod in the small pulley. You may have multiple small pulley wheels. If one is free spinning, put that on first, then put on the one that fists the axle tightly.
4.6. Insert the axle rod into one of the holes in the axle rod stabilizer, push it in in far enough that if feels stable.

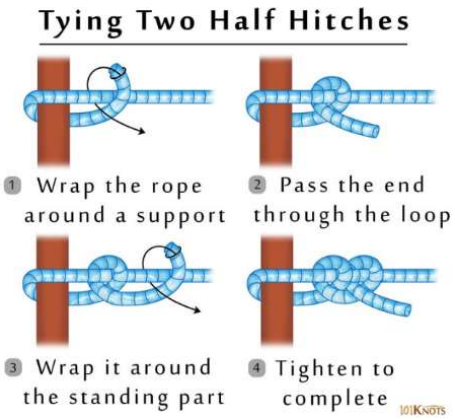
5. Set up the stations and build the cable system

5.1. Fasten the tower assembly to one end of the table **using blue masking tape only**.

5.2. Place the tram base station where you want it to be. Make sure the pulley wheels are aligned.

5.3. Loop the kite string over the both pulley wheels. Have one team member hold the base station steady. Pull the string loop it just tight enough to remove the slack then cut it so that it is about 8 inches longer.





5.4. Tie the kite string to the rubber band using a sheet bend, doubled sheet bend or two half hitches.

5.5. Arrange the kite string so that when it is tied to the rubber band, there will be some tension Tie the kite string to the other end of the rubber band. The string should have some tension on it now.

5.6. Position the tram base station assembly to the table so that the rubber band is making the string taut. Make sure the pulley wheels line up then fasten the tram base station to the table **using blue masking tape only.**

5.7. Conduct a test. Turn the motor on let it run, then reverse it. The string should move first in one direction then the other. DO NOT LET THE RUBBER BAND RUN OVER THE PULLEY WHEEL.

5.8. Optional – rearrange the string so that the rubber band is on the top and trim excess string.

6. Make the tram

6.1. The last page of the instructions has some picture of aerial trams. Cut one out along the edge of the tram pictured and attach it with tape to the bottom string so that it can go the entire length from tower to base station without the rubber band running over a pulley wheel.

7. Take your tram for ride

7.1. Run the tram back and forth a few times. Let it stop at each end to discharge passengers.

8. Things to know plus some things you can do with the tram in your city.

8.1. Obviously, make a better-looking tram. Perhaps design one and use a 3d printer to make it.

8.2. Hide the electrical wiring

8.3. The tower can be one of the city buildings or a mountain/hill in your back drop

8.4. The base station can be any building, or if you have a multi-level city, it could go below the top level to discharge/pick up passenger

8.5. You can switch which hole the axle is in on the tram base station stabilizer to keep tension on the string.

8.6. Experiment by switching pulley wheels

Parts List and Receipt for Parts

(The parts free, but you do have to claim them as an expense on your submission)

	Unit Cost	Qty	Cost
AutoEC DC Gear Motor	$3.25	1	$3.25
Steel Axle rod	$0.01	1	$0.01
Plastic pully wheels	$0.02	3	$0.06
Plastic axle rod stabilizer	$0.00	1	$0.00
Grey Wire Connectors	$0.04	6	$0.24
AAA Batteries	$0.40	2	$0.80
AMPATH Battery Holders	$0.54	1	$0.54
DPDT Switch	$1.30	1	$1.30
Electrical harness with connectors and insulating sleeves	$0.55	1	$0.55
Finish nails 4d	$0.00	2	$0.00
Rubber band	$0.00	2	$0.00
Kite string	$0.00	1	$0.00
Cardboard base	$0.00	1	$0.00
Tower material	$0.00	1	$0.00
Hard packing foam	$0.00	1	$0.00
Total			**$6.75**

Some pieces have spares included.

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