

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 may 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. Up to Four (4) students may work on this moving part. Two (2) students can work on Step 1 (Electrical) while up to two (2) students work on Step 2 (Structural / Mechanical). Students will come together for Steps 3-6.

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 is the positive wire.

Black is the negative wire.

Except when the polarity to the motor is reversed.

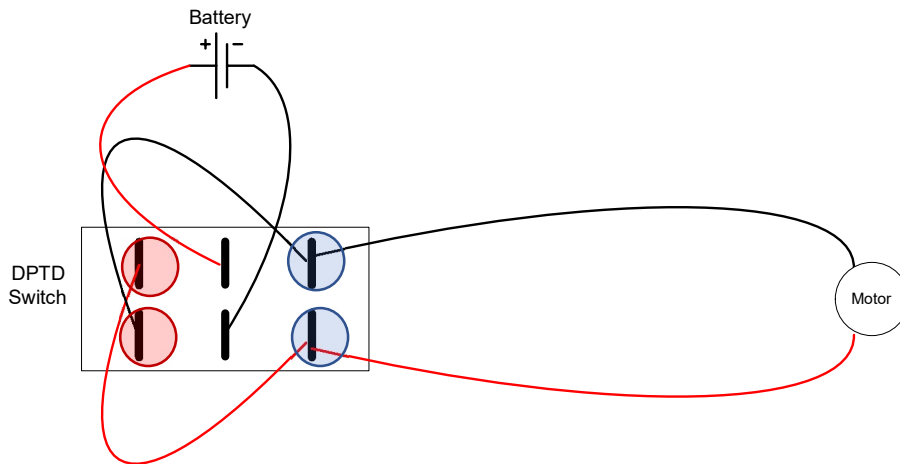
*** Review the Parts List and Receipt before starting the exercise. ***

*** 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 components 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 only 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. NOTE: The contacts on the motor are relatively fragile, handle the motor and wires gently.
- 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. Be very careful with all with connections and avoid over-handling.

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- 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 tower assembly

- 2.1. Snap the larger pulley wheel onto the axle piece. Note the hole in the pulley wheel and the axle must be lined up exactly right for it to snap into place. Connection will be tight.
- 2.2. Thread the remaining pulley wheels over the finish nail (Larger first) then push the nail into one end of the cork. The larger pulley wheel should be able to spin freely.
- 2.3. Attach the plastic cups (towers) to each end of the larger piece of cardboard (base) using tape. The back of the cups should be even with the end of the cardboard so you can run the tape down the tower a few inches, then wrap it around the base.
- 2.4. Use tape (double sided or other) to attach the cork to one of the plastic cups so that the pulley is hanging in the clear from the cup.
- 2.5. 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 long middle of string. Optionally you may also use the piece of white plastic.

3. Assembly (Confirm That Both Steps 1 & 2 Are Complete Before Proceeding)

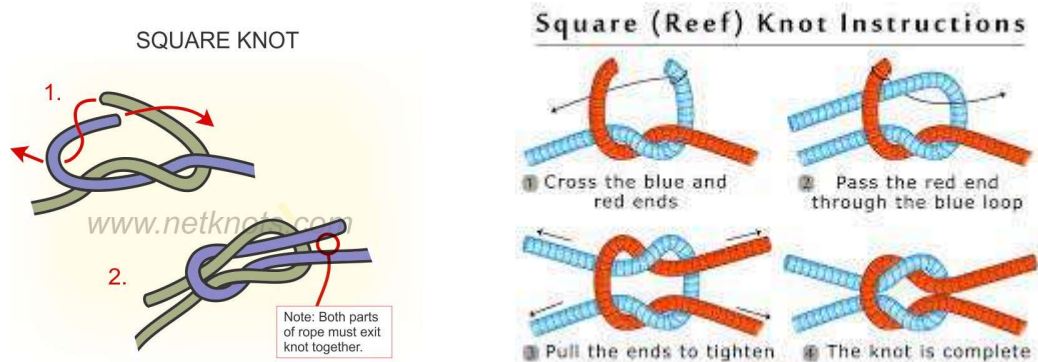
- 3.1. Insert the large pulley wheel and axle assembly from step 2.1 into one of the motor drives.
- 3.2. Use tape (double sided or other) to attach the motor to one of the plastic cups so that the pulley is hanging clear of the cup. The motor drives must be able to spin without interference. The pulley should be aligned with the pulley (attached to cork) on the opposite tower. NOTE: The contacts on the motor are relatively fragile, handle the motor and wires gently.
- 3.3. Layout the wires, switch and battery pack in an orderly manner on the cardboard base between the towers.
- 3.4. Check that the motor connections using grey wire nuts are still fastened.
- 3.5. Test the circuit again.
 - 3.5.1. With the switch in the middle O position the motor should not turn on
 - 3.5.2. With the switch in the I position note the direction of rotation.
 - 3.5.3. With the switch in the II position turn on and the motor should rotate in the opposite direction from the previous test.

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- 3.6. Fasten the DPDT switch and battery back in place with double sided tape.
- 3.7. Layout the wire neatly and fasten in place to cardboard base with either double sided tape or masking tape.
- 3.8. Repeat the test in step 3.5

4. Build the cable system

- 4.1. Loop the elastic string over the both pulley wheels. Have one team member hold the base steady. Masking tape (**BLUE TAPE ONLY**) may also be used to fix base to table. Pull the string loop tight enough to remove the slack and so that you feel some stretch in the string. Do not pull so tight that you are adding unnecessary stress on pulley wheels.
- 4.2. Tie one end of the elastic sting to the other end using a square knot. See below



- 4.3. If you are having trouble with the knot you may take the string off the pulley assembly. Be careful to note the length of string needed to make the full loop and have some stretch. Once tied, you may restring the loop over the pulleys.
- 4.4. Conduct a test. Turn the motor on let it run, then reverse it. The string should move first in one direction then the other.

5. Take your tram for ride

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

6. Things to know and next steps!

- 6.1. You can make a better-looking tram for your FC model. Perhaps design one, make one out of clay, or use a 3d printer to make it.
- 6.2. Hide the electrical wiring
- 6.3. The tower can be one of the city buildings or a mountain/hill in your back drop
- 6.4. 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
- 6.5. You can switch which hole the axle is in on the tram base station stabilizer to keep tension on the string.
- 6.6. Experiment by switching pulley wheel sizes

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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 nail	\$0.00	1	\$0.00
Elastic Bracelet String	\$0.00	1	\$0.00
Cardboard base	\$0.00	1	\$0.00
Cork	\$0.00	1	\$0.00
Tower material (Cups)	\$0.00	1	\$0.00
Total			\$6.75

Some pieces have spares included.

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