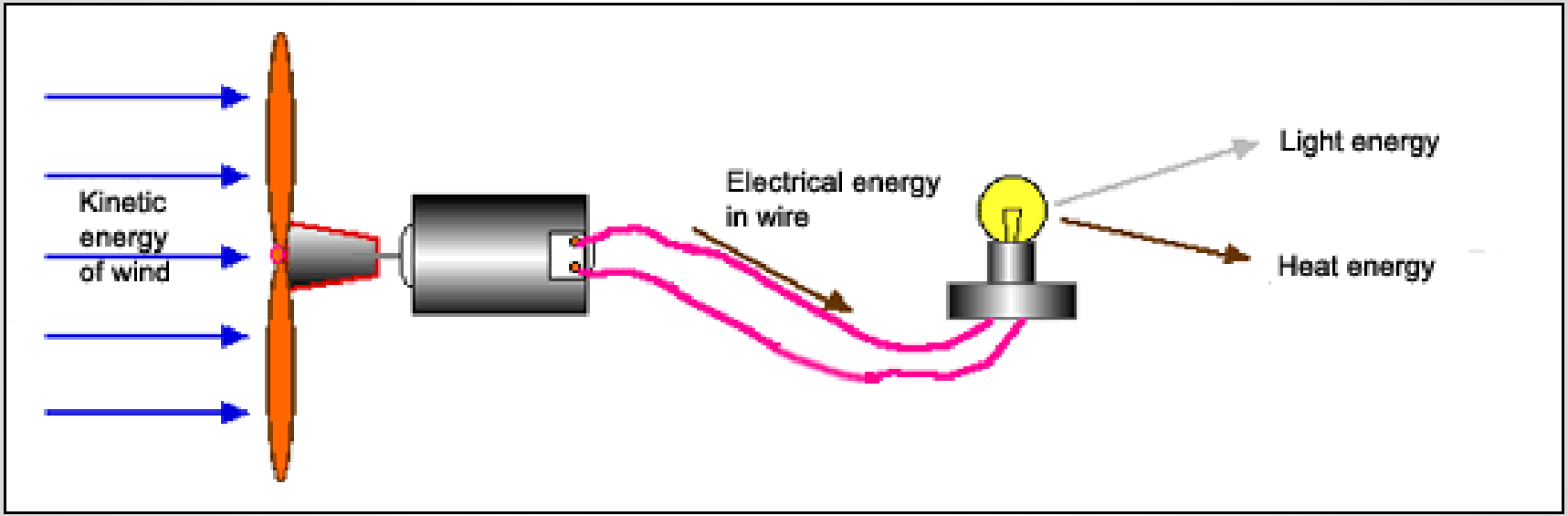
Micro-Harvesting Wind Energy

in New York City

Caitlyn Tien, Chris Mulvaney, Jeremy Uys, John Lim, Sally Ko, Terell Long

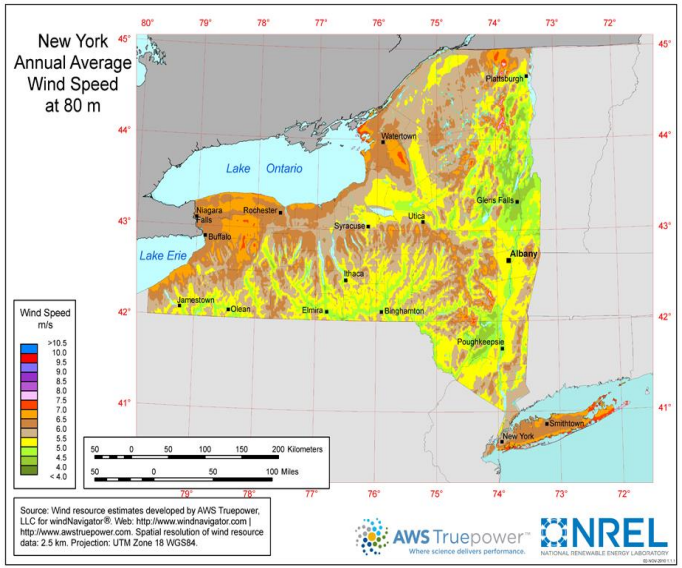
Saving the World
Nick Mitchell
Prof. Robert Dell

How Does a Wind Turbine Work?



http://www1.curriculum.edu.au/sciencepd/energy/images/energy_ill110.gif

Wind Availability in New York City



New York State Annual Average Wind Speed

13 MPH at 80 meters above sea level

New York City Annual Average Wind Speed

http://apps2.eere.energy.gov/wind/windexchange/images/windmaps/ny_80m.jpg

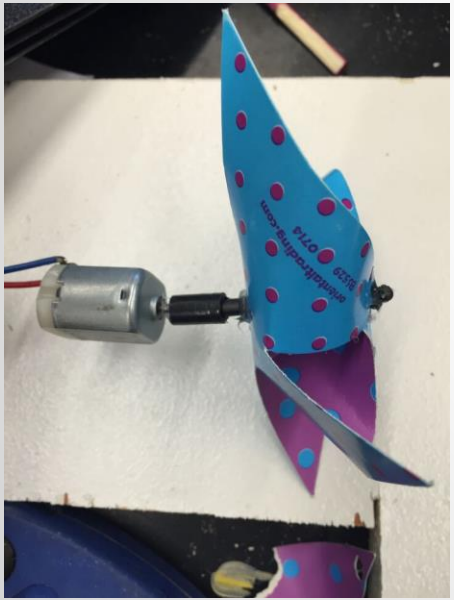
Proposed Solutions

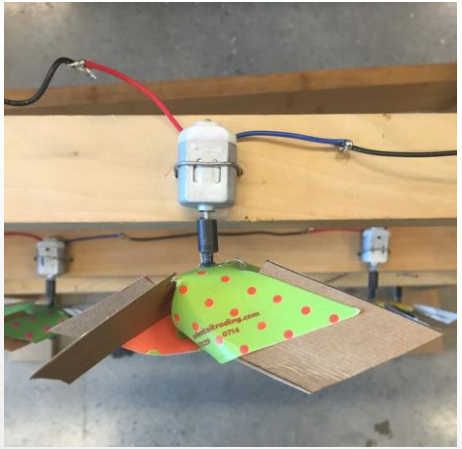
Low-cost approaches to wind energy in New York City:

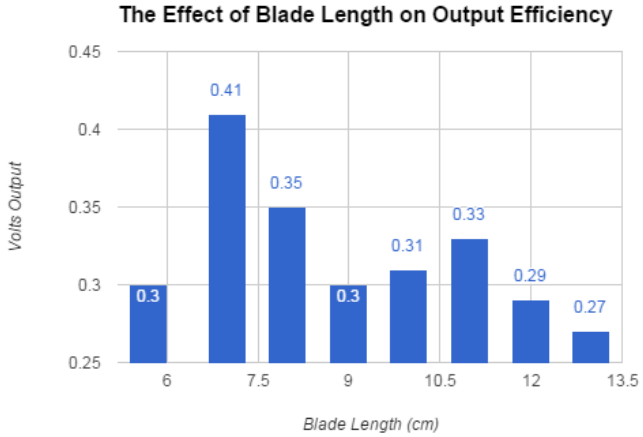
- Pinwheel structure
- Vertical-axis wind turbine

Testing the Modified Pinwheel

Final design: Pinwheel with extensions of length 7 cm. Tested at 9 MPH.

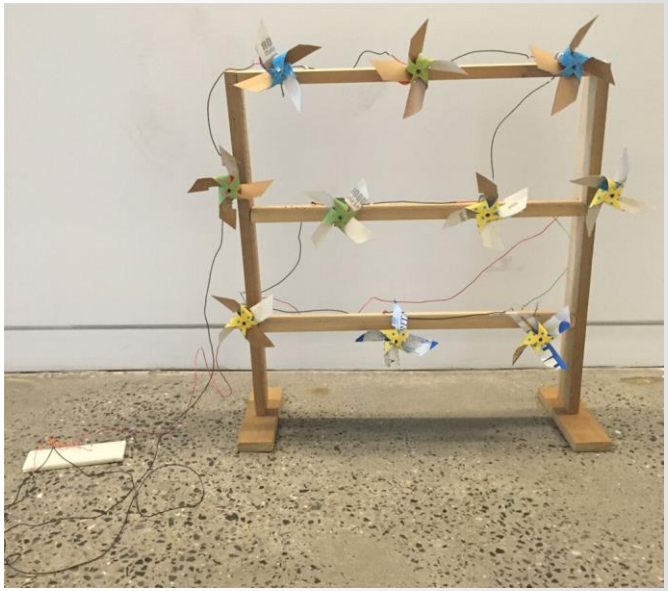






Results: Pinwheels

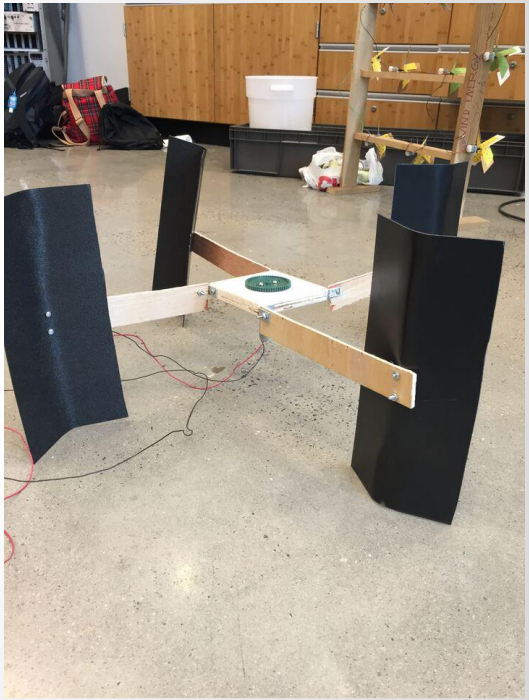
- Final setup using modified pinwheels generated average of 2.95 volts and 28 milliamps to produce a total of .0826 watts



- Peak values: 4.5 volts and 40 milliamps

Results: Vertical-Axis Wind Turbine

- 120 milliamps at 1.1 volts for a total of .132 watts



Remarks

- Pinwheels more effective at lower wind speeds
- Pinwheels generate higher voltage
- Large wind turbine more effective at higher wind speeds
- Wind Turbine generates higher current and more power
- P=IV

Questions?

http://www.johnkaye.org.au/wp-content/uploads/2013/04/130411_wind-guidelines_question-mark.jpg

https://oitblog.files.wordpress.com/2009/10/cloud-question-mark-cloud-computing.jpg?w=500

Acknowledgements

Professor Robert Dell
Professor Bill
Dean George Delagrammatikas
Nick Mitchell

SAVING THE WORLD
DESALINATION

PROFESSOR DELL
EMMY KUO

Nicolas Acosta, Aksheeta Baid, Lila Hitzig, and Dylan Sanders

Suffern High School

Eastchester High School

The Spence School

The High School of American Studies at Lehman College

PROBLEM

- 1 in 9 (750 million) people lack access to potable water
- Most of the water present in these areas is ocean water making it unusable
- Has a great impact in California and in developing countries

WHAT IS DESALINATION?

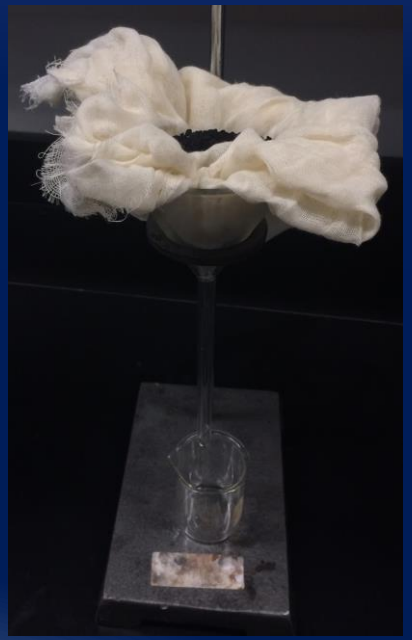
- Desalination is the removal of salt from water
- Composition of Seawater

Water	Salt	Other
96.5%	2.5%	1%

- Has existed since Ancient Greece, when sailors used distillation
- Filtration and distillation used in combination

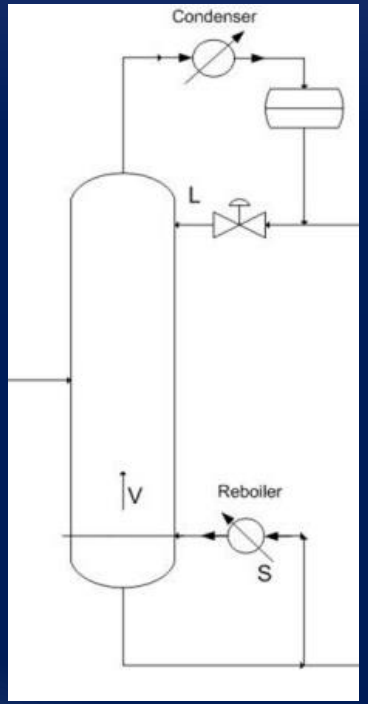
FILTRATION

- Filtration of the seawater is necessary to remove hazardous organic and inorganic materials materials
- Granular Activated Carbon used to filter the water
- Carbon processed to have low-volume holes that increase surface area for **adsorption**



DISTILLATION

- The act of separating a liquid mixture by phase creation
- Concentrated sunlight by means of a fresnel lens to generate the needed heat
- Constructed a reboiler using copper
- Separation by production of vapor that is condensed



https://controls.engin.umich.edu/wiki/index.php/DistillationModel

OUR DESIGN

RESULTS

- In 30 minutes, 10mL of water was collected
- Water was lost during the boiling phase through the top of the reboiler
- Extrapolating, our system would take 50 hours to purify 1 liter of water

ACKNOWLEDGEMENTS

- Our TA Emmy Kuo
- Professor Dell
- The Cooper Union STEM program
- Professor Bill
- Dean Delagrammatikas

Saving the World

The Integration of Hydropower into Bridges

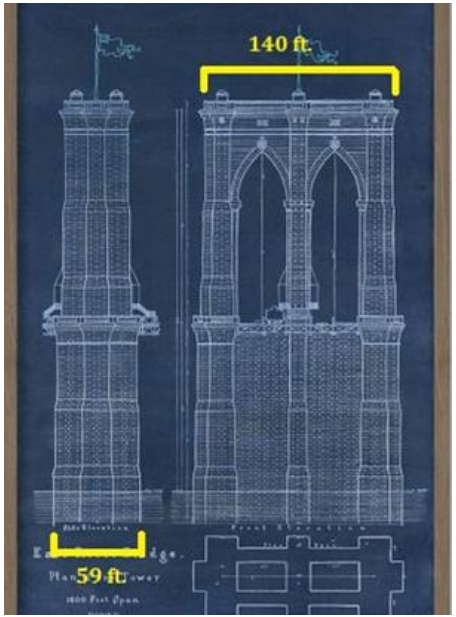
Max Miranda, Simar Sahwney, Caleb Wong, Hannah Contreras

Professor Robert Dell
Teaching Assistant Nick Mitchell

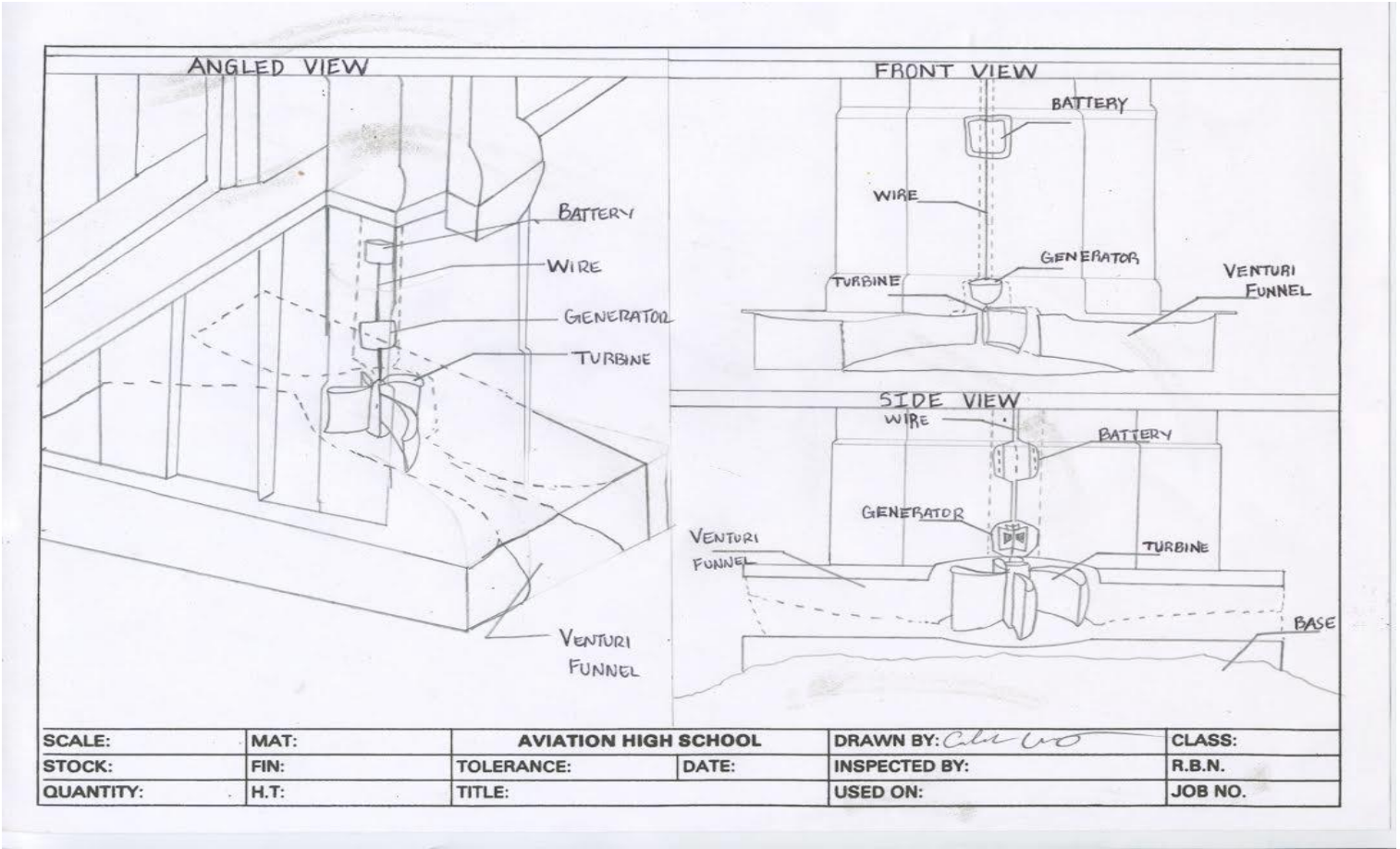
The Brooklyn Bridge on the East River

- Length of pier (parallel to river flow): 140 feet
- Width of pier (perpendicular to river's flow): 59 feet

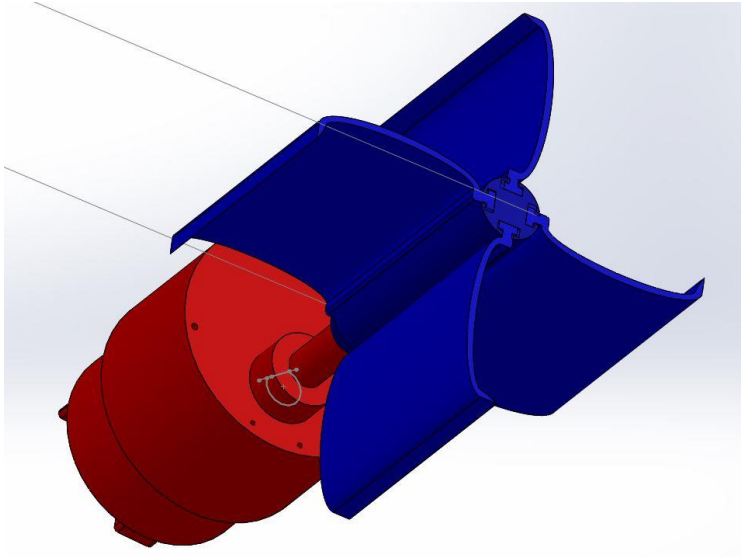
- Issues with the East River:
  - Reverses flow every six hours
  - Constant commercial traffic
  - Relatively low water flow rate (average of 4 mph)

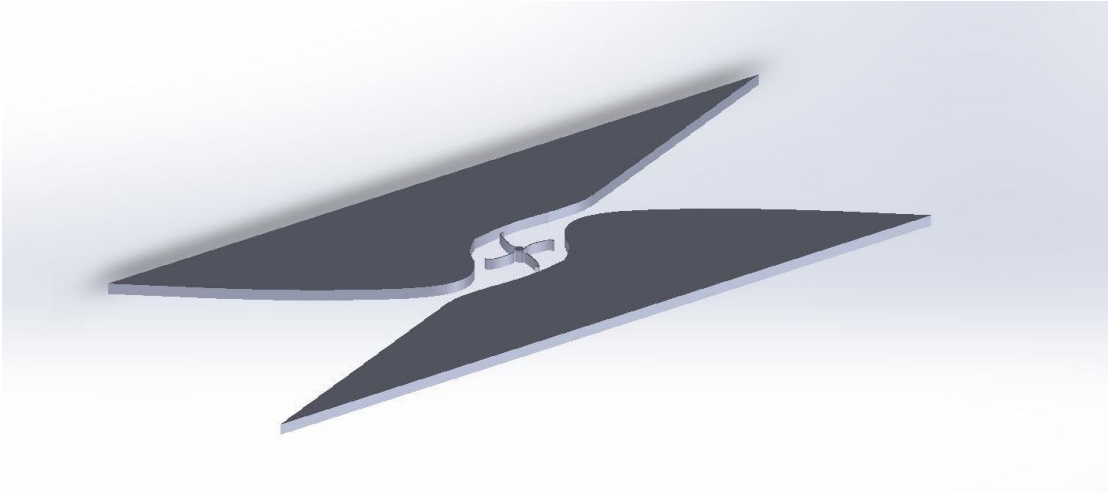


Our Turbine Concept



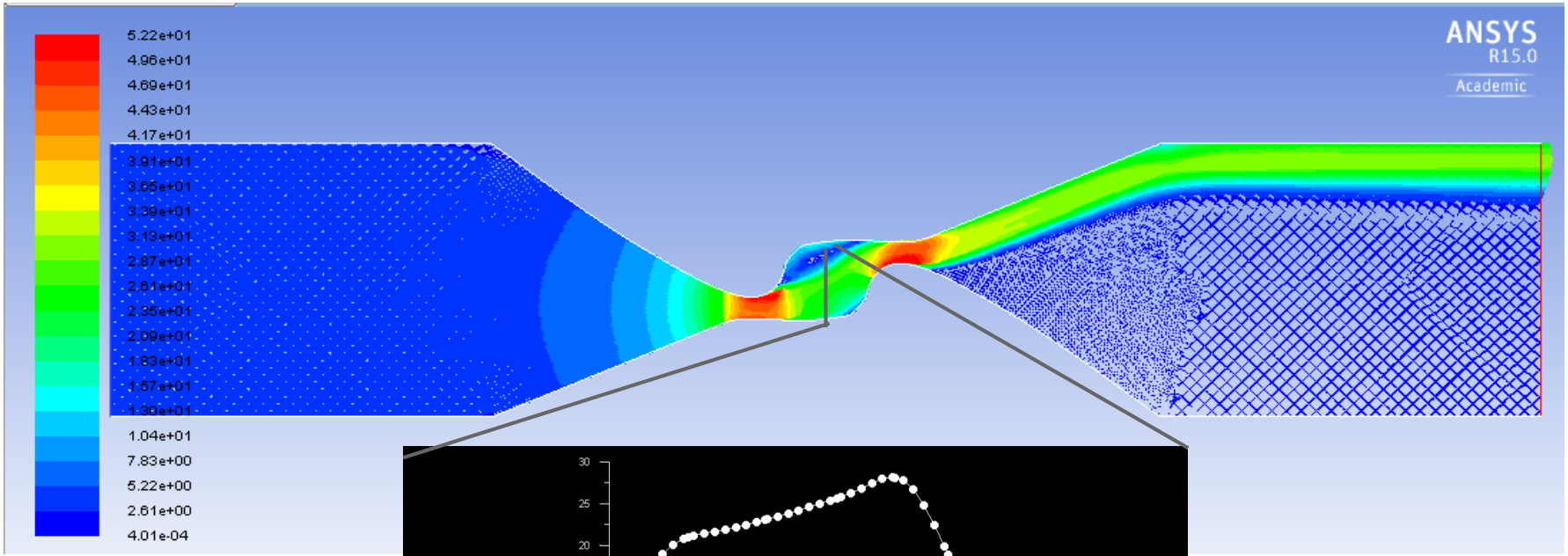
3D Modelling- SolidWorks





ANSYS Fluid Simulations Part 1

Computing the velocity of water hitting the turbine



3.7 meters per second

Computing the power of the full-scale turbine

Formula : $P = (½)\ \dot{m}\ v^2 = (½)\rho A v^3$

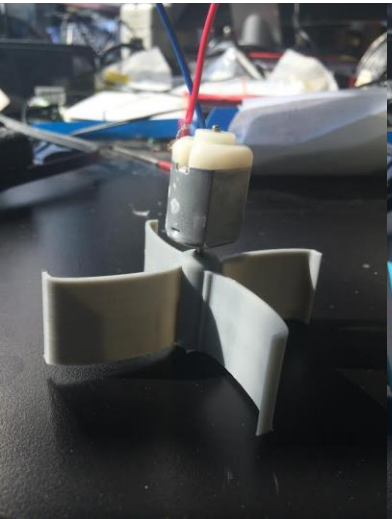
Where P = Power, ρ = Density, A = Cross-sectional Area, v = velocity, $\dot{m}$ = Mass Flow Rate

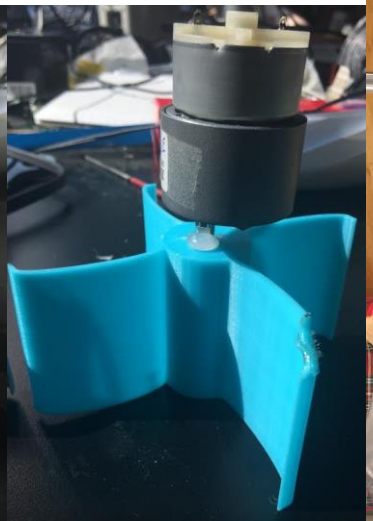
$(½)\ (1000\ kg/m^3)\ (5.66\ m^2)\ (30\ m/s)^3$

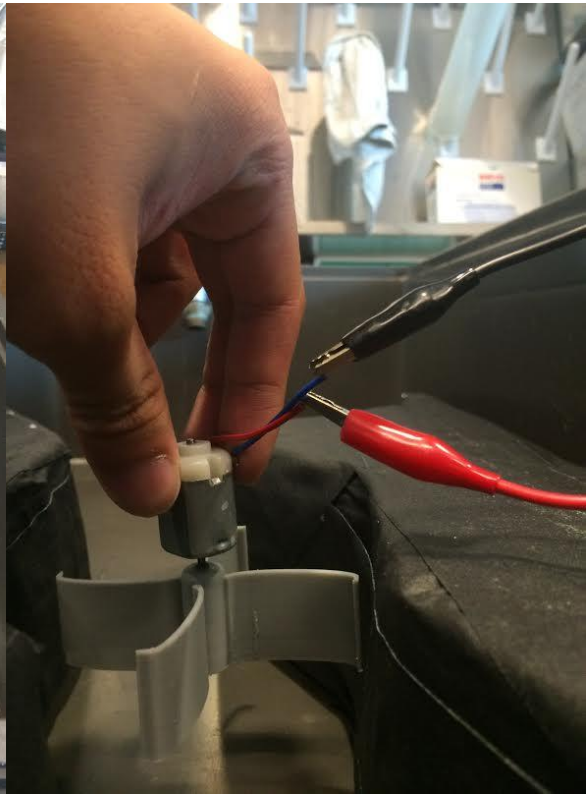
= 76.4 Megawatts

- The total power capacity of a full scale turbine we computed as 76 megawatts
- At optimal conditions the bridge turbine would produce 12.1 million kilowatt-hours per year, enough power to power 1,100 houses

Physical Models

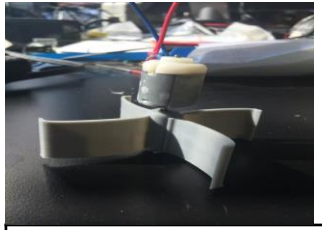




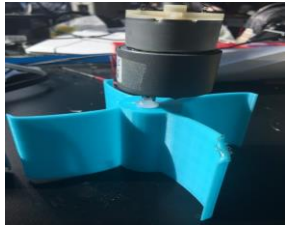


Physical Testing Part 1

Finding the optimal turbine design



We concluded the Turbine Blade with the larger surface area (Blue) Created a creator amount of watts.
The greater the height the greater Kinetic Energy found.



Turbine Blade (Shorter Blade Design)				
Distance of turbine from faucet	40 cm	30 cm	20 cm	10 cm
Average Voltage	0.455 V	0.407 V	0.323 V	0.326 V
Average Amperes	0.02 A	0.02 A	0.01 A	0.00 A
Total Miliwatts	9.10	8.14	3.23	0

Turbine Blade (Longer Blade Design)				
Distance of turbine from faucet	40 cm	30 cm	20 cm	10 cm
Average Voltage	0.463	0.416	0.385	0.365
Average Amperes	0.02	0.02	0.02	0.02
Total Miliwatts	9.26	8.23	7.7	7.3

Physical Testing Part 2

Computing the power of the turbine

$$\mathrm{Re} = \frac{\rho w d_o}{\eta}$$

Re	Reynolds number
ρ	density of the liquid
w	flow velocity of the liquid
d_o	orifice diameter,
η	viscosity

Acknowledgments

Professor Robert Dell
Nicholas Mitchell
Emmy Kuo and Alex Livermore
Professor Bill
Professor Delagrammatikas

The End

Saving The World:

Solar Powered Phone Charger

Luna Oiwa, Candy Liu,
Cassidy McAllister, Jacob Hoffman

Professor Robert Dell
Alex Livermore

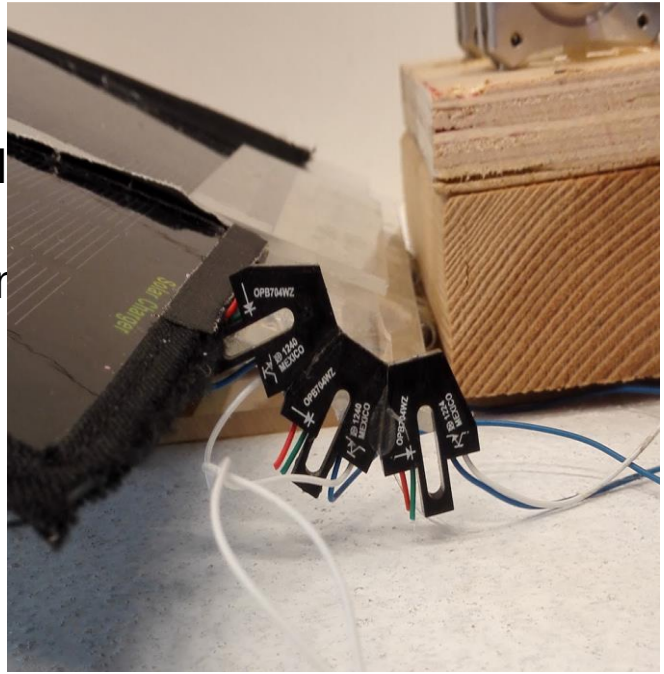
What is Solar Energy?

-Renewable Energy from the Sun
    -Nuclear fusion
    -Electromagnetic Waves
-Energy can be converted to electricity by solar panels (photovoltaic cells)
-600W/m^2 on a sunny summer day in NYC
-Provides earth with enough power every hour to power the entire planet for a year.

Our Project

Solar powered phone charger with:

- **Sun tracking tri-solar panel setup**
  - Photodiodes to detect optimal angl
  - Programmed Arduino to control motors
  - Two 12V stepper motors for motion
- **Rechargeable battery**
- **USB ports for charging**

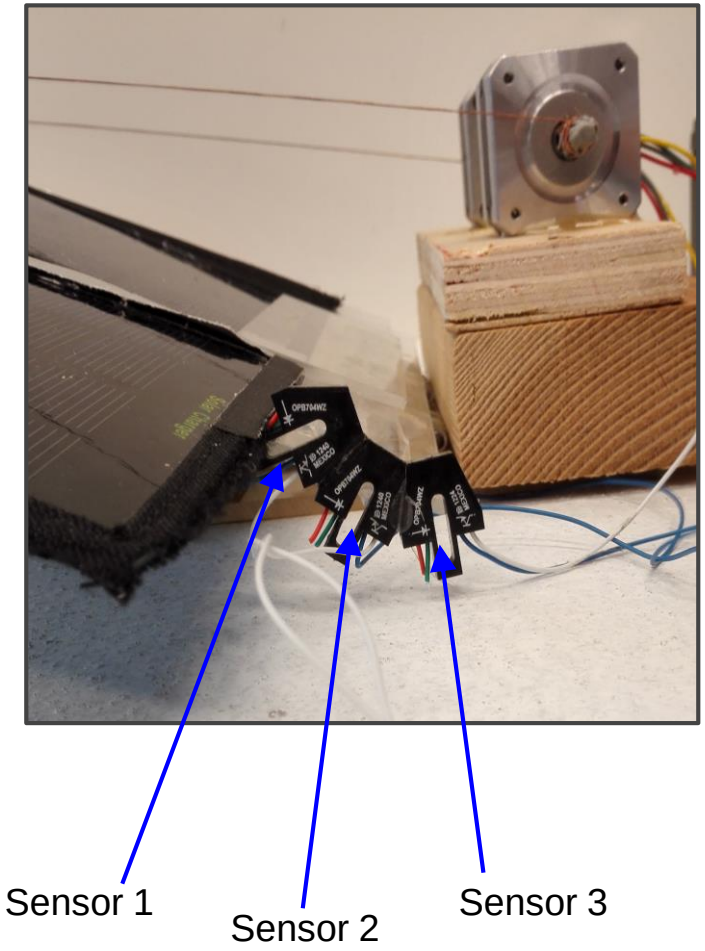


Challenges

-Maximizing efficiency of solar panels
-Making the device portable
-Generating enough torque to raise panels

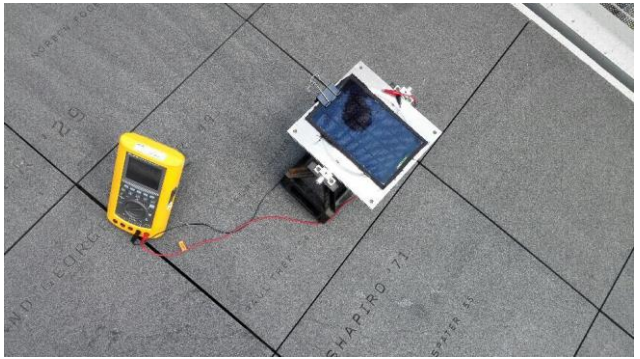
Mechanism

1. Sensors send back data on amount of sun exposure to Arduino.
1. If sensors detect a drop in sun exposure, Arduino activates motors to lower/raise panels accordingly.
1. When sensors send back data consistent with greatest exposure, motors stop.



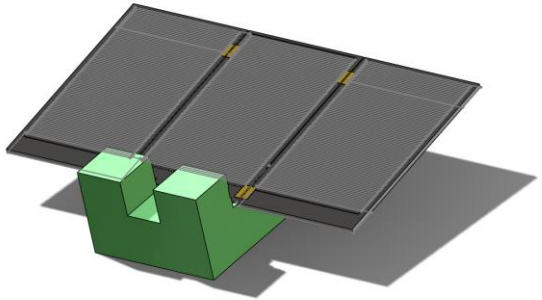
WHY

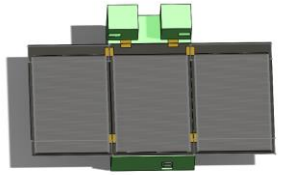
Voltage and Current Readings from Solar Panels and Power Calculations

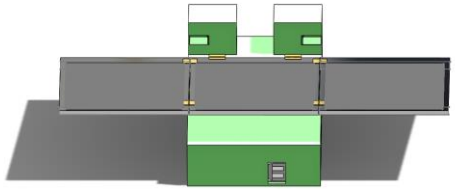


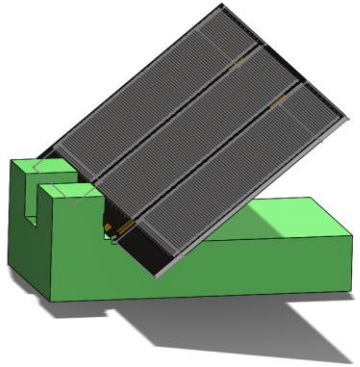
Angle to Sun	Voltage (V)	Current (A)	Power (W)	Solar Radiation (W/m^2)
90°	10.5	0.39	4.095	1009.6
60°	10.1	0.22	2.22	1015.6
45°	9.95	0.26	2.587	1003.6
30°	9.75	0.18	1.755	985.6

Designed Solidworks Model

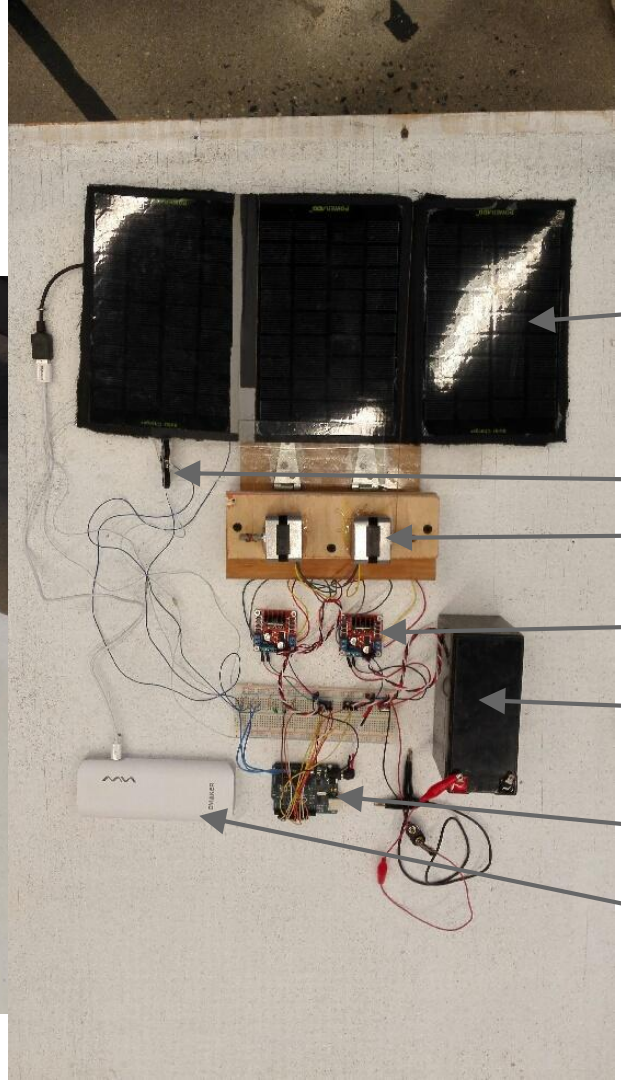




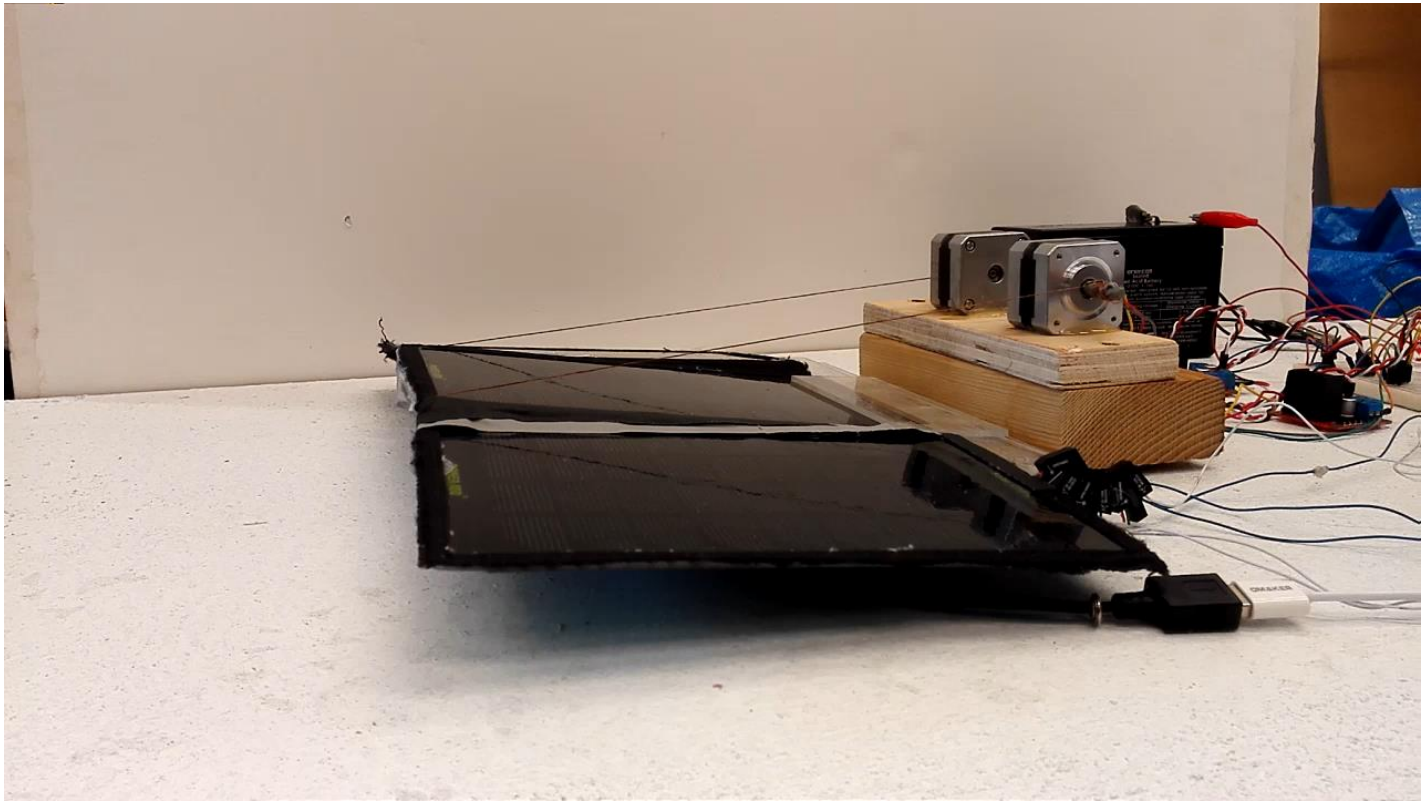




Final Product:



Video



Acknowledgements

Special thanks to:
Professor Dell
Alex Livermore
Nick Mitchell and Emmy Kuo
Professor Bill
Professor Delagrammatikas

Power Generating Tile

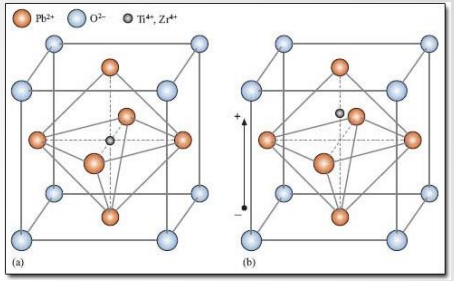
Saving the World

Professor Robert Dell
Alex Livermore

Jeahoung (David) Hong, Phillip Chen, Seokjoo Yoon, Seung Won (Sally) Na

Existing Technology

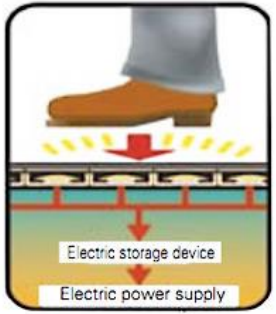
Piezoelectrics create electric potential upon compression by displacement of atoms



Experimental piezoelectric foot step tiles in Japan's train stations

- Foot steps trigger small vibrations that can be stored as energy

Demonstration experiment at Tokyo Station



Mechanism of the power generating floor

Europe's "PaveGen" - Green sidewalk

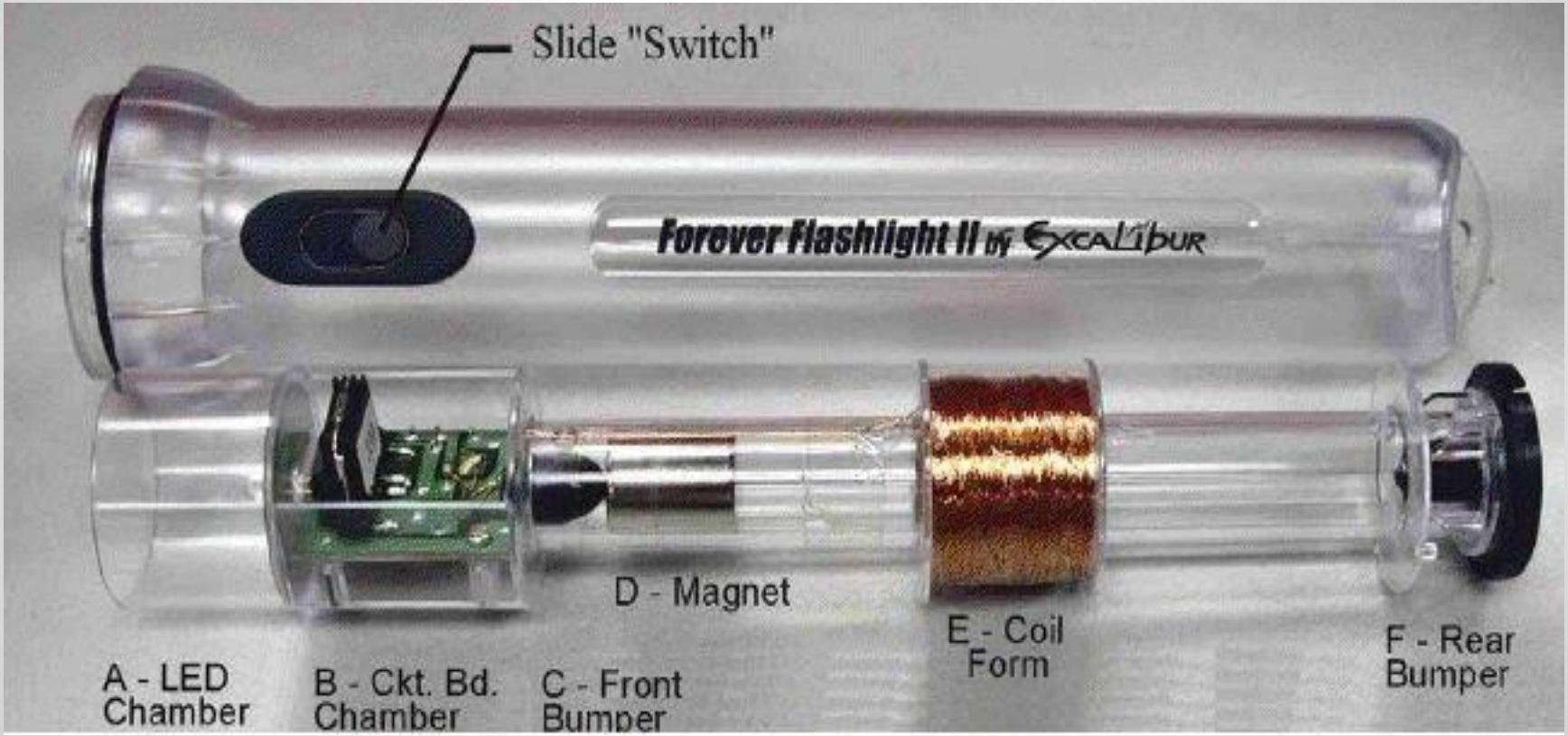
- Harvest KE and instantly delivers electricity to nearby appliances
- $4000 each (2011)

  $500 each (2014)

Our Proposal

- Electromagnetic induction will be used to generate electricity
- A solenoid and Neodymium magnet will be gathered from a shake flashlight
- The tile will compress and expand vertically in order to oscillate the magnet through the solenoid, inducing a current.

Shake Flashlight Components

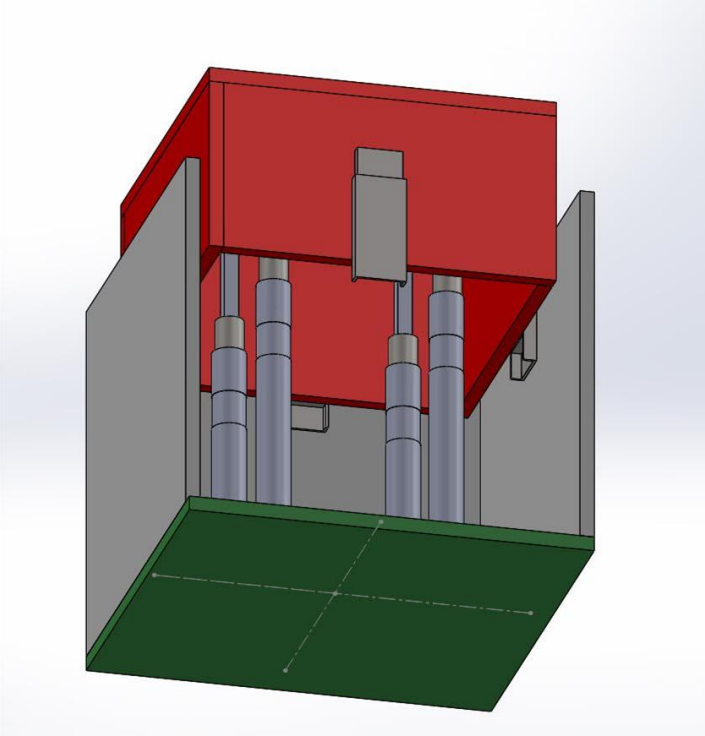


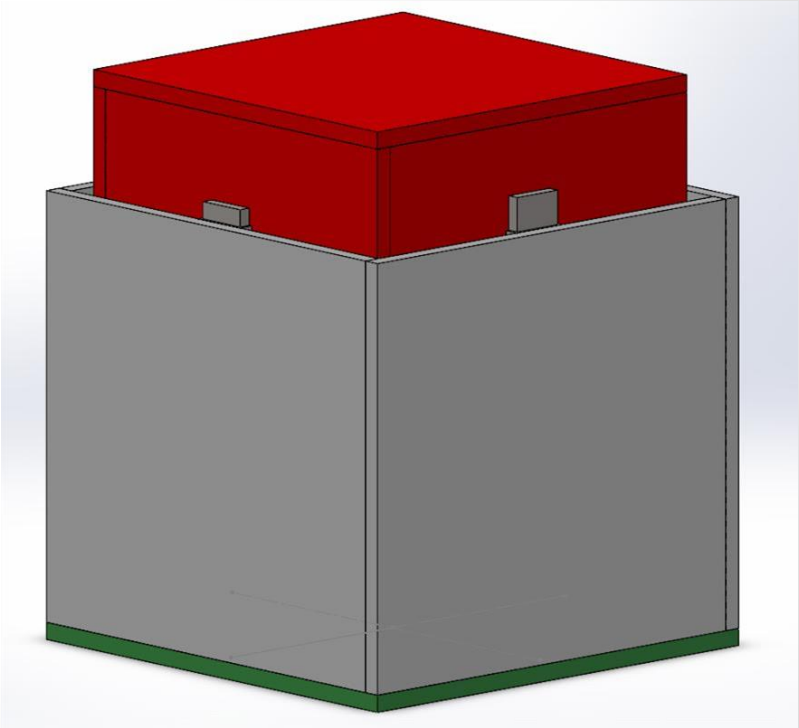
http://www.eemetric.com/product-design/makeashakeflashlight/forever-flashlight.jpg

Materials

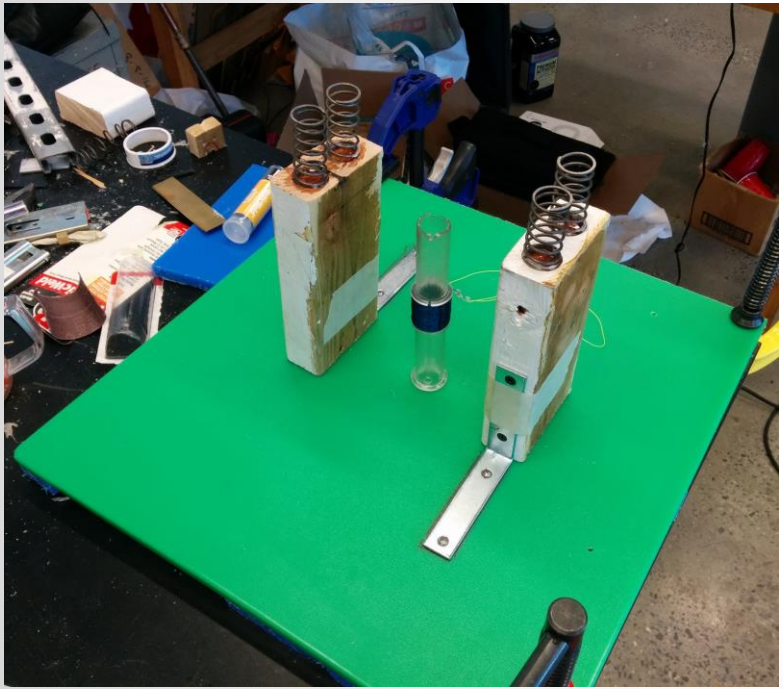
- Magnet and solenoid wire coil from flashlight
- HDPE (High Density Polyethylene) for tile, supports, and base plate
- Drawer slides
- 4 springs mounted on spacers
- 3 wood blocks

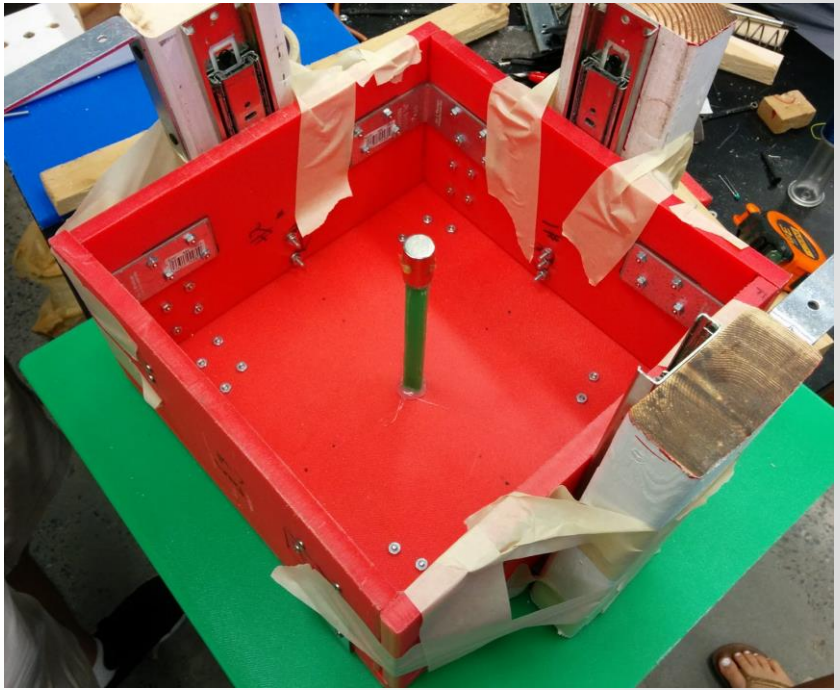
SolidWorks Conceptual Model



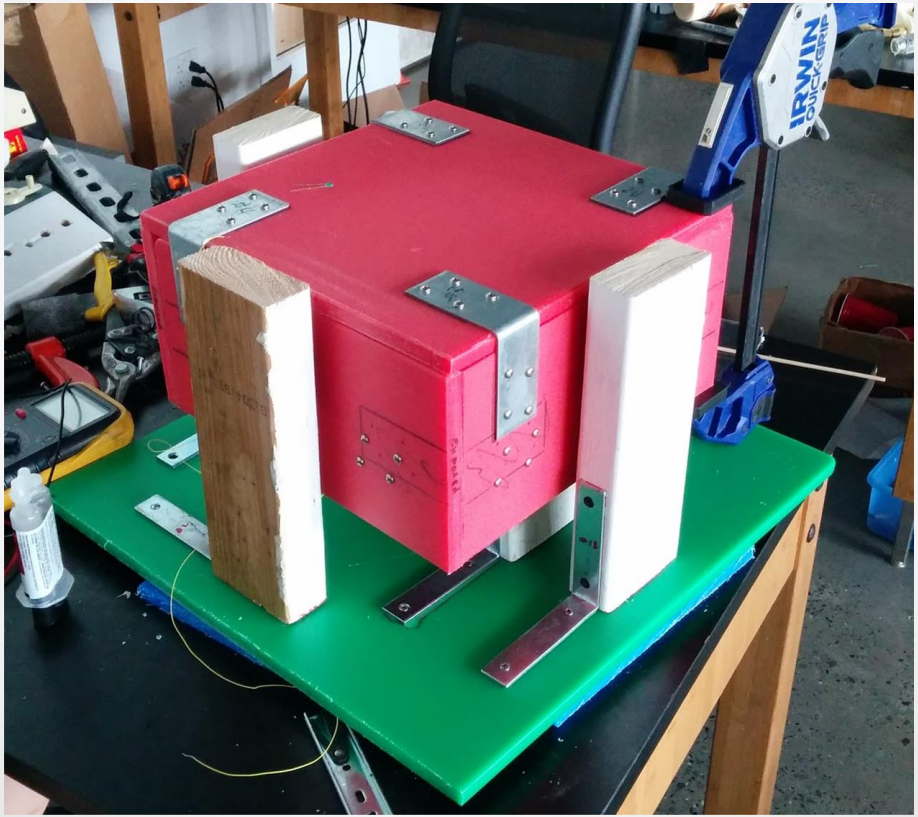


Design Process





Final Product



Final Product in Action

Results

	Frequency (steps/sec)			
Oscillation (in.)	**.5 step/sec**	**1 steps/sec**	**2 steps/sec**	**4 steps/sec**
.5 in.	.89 V	.95 V	.93 V	.98 V
1 in.	1.69 V	2.22 V	2.39 V	2.35 V
2 in.	2.2V	2.35 V	2.98 V	2.89V

- Peak performance at 2.39V and 2.98V at 2 steps/sec with oscillation of 1 inch or 2 inches
- Amount of oscillation mattered more to the voltage than the frequency of the footstep
    - Frequency affect the speed of AC current more

Benefits

- Could serve as a source of clean, renewable energy in urban areas
- Better shock absorption because the compressing mechanism of the power generating tile acts as a spring
- An alternative to other power generating floor tiles that utilize piezoelectrics

Acknowledgements

Professor Robert Dell
Alex Livermore
Professor Bill
The Cooper Union for the Advancement of Science and Art

Sources

http://www.cnn.com/2011/10/13/tech/innovation/pavegen-kinetic-pavements/
http://inhabitat.com/tokyo-subway-stations-get-piezoelectric-floors/