

# H<sub>2</sub>Go: The Untapped Power Source

ASME Student Design Competition

ORB Engineering

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# The Challenge

- Design a device for rain energy conversion
  - Convert the potential energy of one liter of water falling from one meter height
- Use the converted energy to propel a model car as far as possible in a straight line
- Contain all the water within the device



# The Rules

- The only power source to be used is the 1 L of water
- The device must have an easily removable and drainable water storage container capable of storing at least 1.1 L of water
- The device must fit, fully assembled and ready to operate, within a box measuring, on the inside, 370 x 165 x 165 mm
- Each team will provide their own car which must:
  - Have a mass of 10 - 90 gram
  - Be 25 mm to 45 mm wide
  - Be 65 mm to 100 mm long
  - Not be used as a projectile

# The Design

- Capture water in a bucket suspended in the tower which is connected to the vehicle via a Kevlar line wrapped around the axle
- As the bucket falls, the Kevlar line unwinds on the vehicle generating a rotating motion
- The bucket falls and contacts the release mechanism rolling the vehicle forward
- The vehicle touches the ground and rolls down the course



# Water Flow Characteristics

- Designed for the optimum transfer of potential energy from falling water
- Possible designs
  - Straight fall from the funnel
  - A single nozzle
  - A single hose
  - Multiple hoses with no nozzles
  - Multiple hoses with nozzles



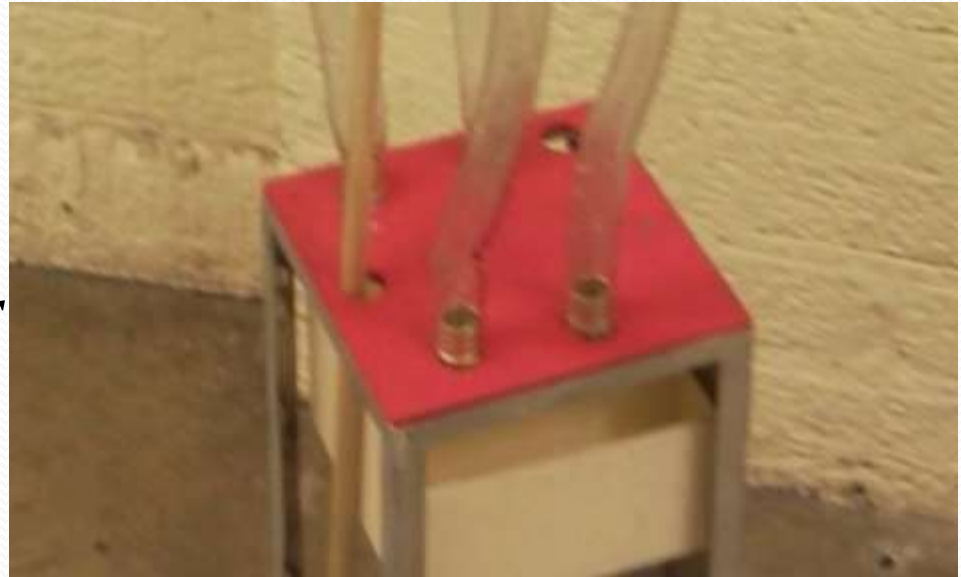
# Water Flow Characteristics

- Flow directionality control necessary to limit water losses
- Free falling water too dispersed to control flow
- Use of multiple inlets of hoses and nozzles to manage flowrate and direction



# Nozzle Design

- Flow into the bucket provided energy conversion from falling water
- Nozzle allowed for directional control of water flow into the bucket
- Multiple nozzles used to achieve proper flowrate



# Energy Transfer

- System needed to transfer energy from falling bucket to the vehicle
- Possible designs
  - Gear train
  - Belt system
  - Pulley system





# Pulley System

- Pulley system connects the bucket to the vehicle via a Kevlar line
- The amount of additional stored energy after the device operates is equal to the initial stored energy
  - Counterweight added to balance initial and final energy



# The Vehicle

- Designed to maximize the distance traveled and minimize the rolling resistance
- Possible designs:
  - 4 wheels
  - 3 wheels
  - Sphere
  - Spool shape



# Vehicle Design Model

- Parameters examined include mass moment of inertia, mass, velocity, and rolling friction

Mass moment of inertia: 
$$I = \frac{1}{12} m_{shaft} L_{shaft}^2 + 5 \left( \frac{1}{3} m_{spoke} L_{spoke}^2 \right) + 2(m_{rim} r_o^2)$$

Rolling friction and energy dissipation: 
$$f_r = \mu_r \left( 1 + \frac{v}{100} \right) \quad (\text{Gillespie 110-122})$$

$$F_f = f_r m_{vehicle} g$$

$$\dot{E} = -v F_f \quad (\text{Poschel, Brilliantov 169-174})$$

Deceleration (Newton's 2<sup>nd</sup> Law):

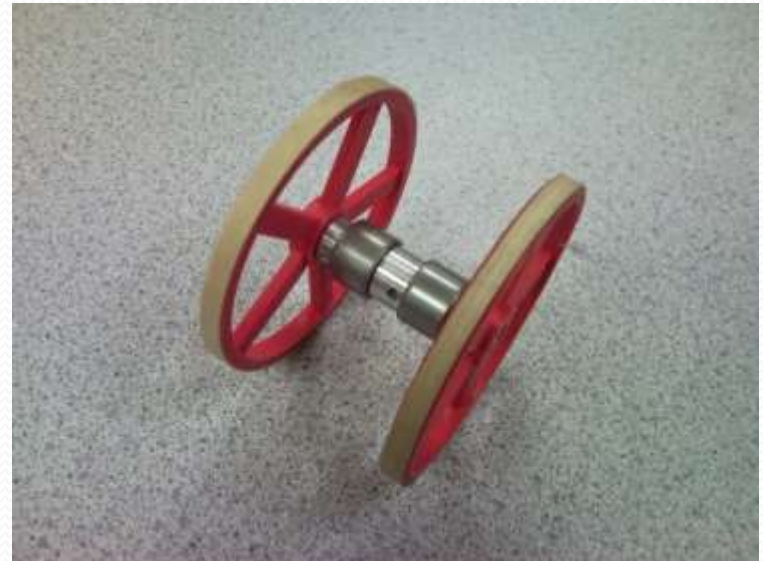
$$\alpha = -\frac{m_{vehicle} g d_p}{m_{vehicle} r_o^2 + I}$$

Total distance traveled:

$$s = \left[ -\frac{1}{2} \left( \frac{m_{vehicle} g d_p}{m_{vehicle} r_o^2 + I} \right) \left( \frac{E}{-v \mu_r \left( 1 + \frac{v}{100} \right) m_{vehicle} g} \right)^2 + \sqrt{\frac{2E}{I} \left( \frac{E}{-v \mu_r \left( 1 + \frac{v}{100} \right) m_{vehicle} g} \right)} \right] r_o$$

# Vehicle Design

- Distance maximum when:
  - Small mass
  - Small mass moment of inertia
  - Small wheel radius
  - Minimal friction force
- Spool shape chosen
  - Aluminum axle
  - Plastic wheels- 65 mm diameter
  - Overall width of 45 mm



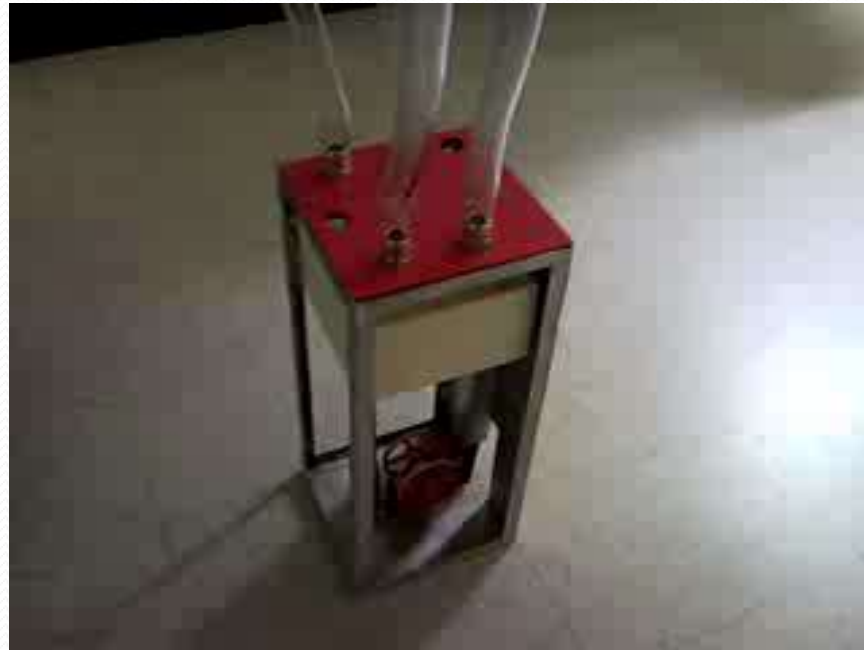
# Vehicle Release Mechanism

- Suspend vehicle off ground to allow rotation
  - Hold vehicle in place
- Release vehicle when bucket hits device floor
- Align vehicle path to travel in a straight line



# Demonstration

- The device in operation



- Vehicle traveled 18ft 8in

# Thank You

We will now answer any questions

