Project 1_2_5: Mechanical Winch System

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Course: Honors Principles of Engineering (Period 6)

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No references because no external sources were used!	

Design Brief

Designers:
Romyr Concepcion
Sai Kolla
Shaan Mathur
Shravan Nemmara

Client: “Local Construction Company”

Problem Statement:
Carrying heavy items manually up a high distance is very tedious and difficult. Tired workers often drop materials which can also be very dangerous to others and hinder progress.

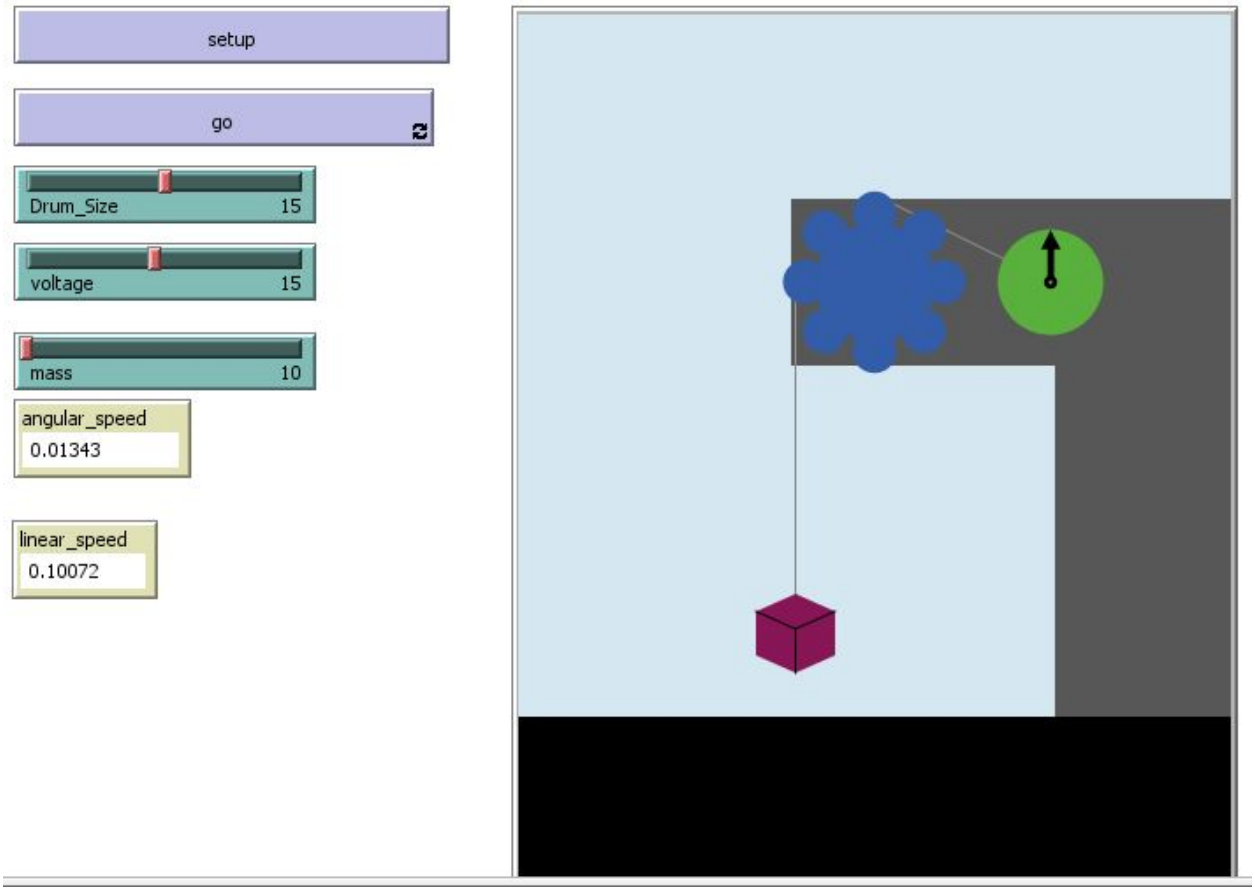
Design Statement:
Design and build a scale prototype of an electrically powered mechanical winch for “Local Construction Company.”

Constraints:
The mechanical winch must lift a weight of at least 100 grams up 3 floors (30 cm) only using materials provided by the client. The winch must be completed within seven days.

Deliverables:
Team documentation on both the document and spreadsheet
Team presentation in class
Netlogo Simulation of the winch (see the screenshots below and the code in the shared folder)
A scale prototype of the winch (built in class, pictures below)
Completed calculations and design briefs within each team members’ notes notebook

NetLogo Simulation Screenshots:

Final Simulation Interface/GUI:

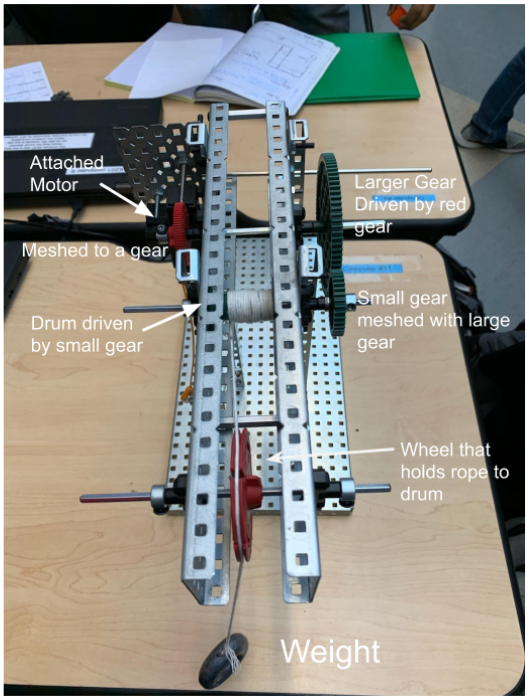
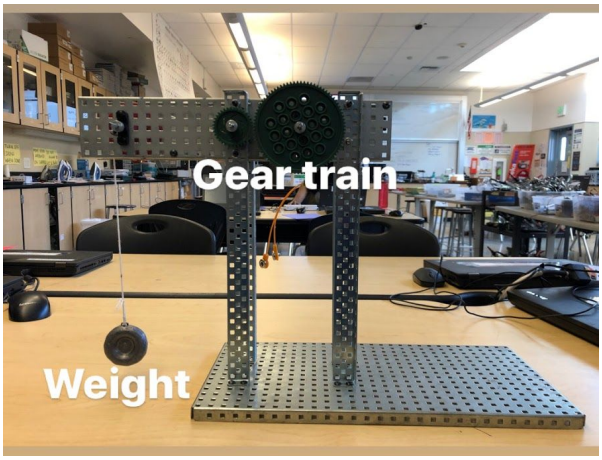


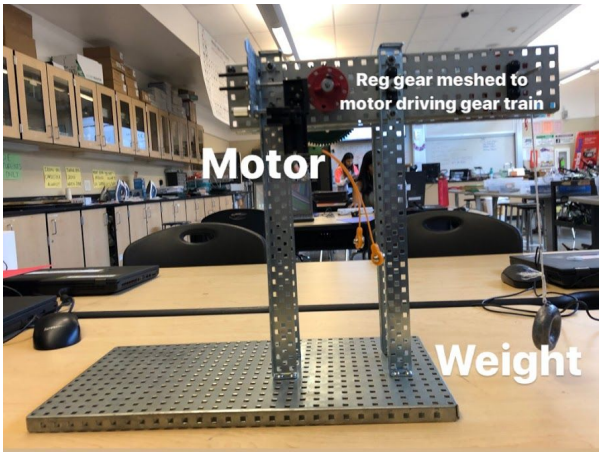
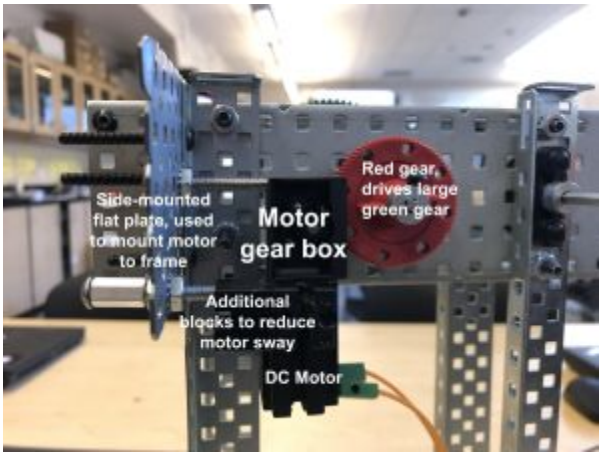
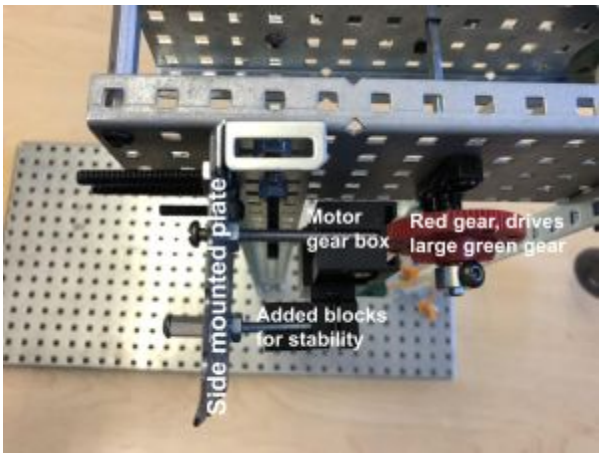
Final Code Screenshots In Order (actual NetLogo Code File is in the group folder):

```
;;World P125
;;POE 6
;;Conception, Kolla, Mathur, Nemmara

globals [
  delta_t
  drum
  weight
  edge
  omega
  current
  power
  petal
  edge2
  edge3
  linear_speed
  angular_speed
]
;;creating global variables named delta_t, drum, weight, edge, omega, current, power, petal, edge2, edge3, linear speed, angular speed

to setup
;;creates the setup function used for setup button (in interface)
  ca
  ;;clears the world
  ask patches [set pcolor 99]
  ;; making the background a light blue color
  ask patches with [pxcor > -10 and pycor < 30 and pycor > 10] [set pcolor 3]
  ;; making the base grey
  ask patches with [pxcor > 20 and pycor < 30 and pycor > min-pycor + 20] [set pcolor 3]
  ;; making the base grey
  ask patches with [pycor < min-pycor + 21] [set pcolor black];; making the ground black
  reset-ticks;;starts a counter called ticks
  set delta_t  1 / 100
  ;;sets the variable delta_t equal to 0.01 seconds (makes time step quite slow)
```

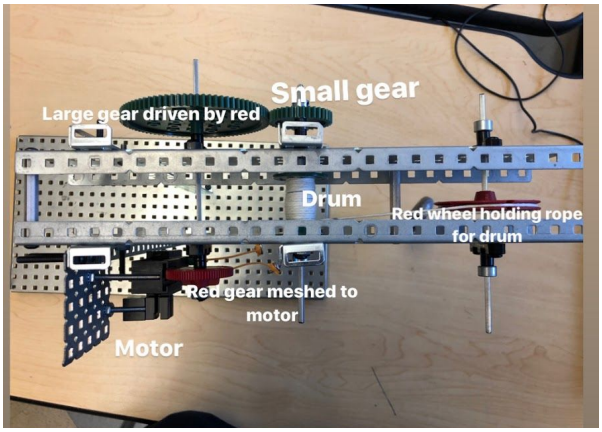
```
crt 1 [
  ;;makes a single turtle
  set shape "clock"
  ;;shaped like a clock
  setxy (20) (20)
  ;;sets xy coords of turtle
  set heading 0
  ;;headed towards zero degrees
  set color green
  ;;that is green
  set size Drum_Size
  ;;with size equal to the drum_size variable (from slider in interface)
]
crt 1 [set shape "box" set heading 0 set color 124 setxy (-9)  (min-pycor + 30) set size mass]
;; creating the box that represents the weight we are lifting. setting the color to be purple
crt 1 [set shape "dot" set heading 0.1 setxy (0) (30) set color black]
;; making a dot in the middle of the green clock shaped gear
crt 1 [set shape "petals" set heading 0 set color blue setxy (0) (20) set size (22.5)]
;; creating a blue gear
crt 1 [set shape "dot" set heading 0.1 setxy (20) (20) set color grey]
;; creating a dot in the middle of the blue gear
crt 1 [set shape "dot" set heading 0.1 setxy (-9) (20) set color blue]
;; creating a dot on the top of the box
set petal one-of turtles with [shape = "petals"]
;; making a variable for the blue gear named petal
set Drum one-of turtles with [shape = "clock"]
;;names the turtle shaped as a clock as Drum
set Weight one-of turtles with [shape = "box"]
;;names the turtle shaped as a box as weight
set Edge one-of turtles with [shape = "dot" and color = blue]
;;names the turtle shaped as a dot and has a color that is blue as edge
set Edge2 one-of turtles with [shape = "dot" and color = grey]
;;names the turtle shaped as a dot and has a color that is grey as edge
 set Edge3 one-of turtles with [shape = "dot" and color = black]
 ;;names the turtle shaped as a dot and has a color that is black as edge
 ask Weight [create-link-with edge]
 ;;creates alink with the weight and edge
 ask edge2 [create-link-with edge3]
 ;;creates alink with the weight and edge
 set power voltage / mass
 ;;sets speed as a proportion of voltage and mass
 set linear_speed ((power * delta_t * 180 / pi) * (Drum_Size / 128))
 ;; sets a variable named linear speed based on the formula for linear speed
 set angular_speed linear_speed / (drum_size / 2)
end
;;finish the setup function

to go
 ;;creates the go function used for the go button (in interface)
 ask Drum [right (voltage * delta_t * 360)/(6.28)]
 ;;makes the drum spin according to the angular distance formula shown above
 wait delta_t
 ;;have the program wait for delta_t seconds
 tick-advance delta_t
 ;;advance your tick counter by delta_t seconds
 ask Weight [fd (voltage * delta_t * 180 / pi) * Drum_Size / 128 show ycor]
 ;; asking the weight to go up by the linear speed
 if [ycor] of Weight > 20 [stop]
 ;; telling the weight to stop when it is at the same level as the gear
 if power < 0.5 [ask Drum [set color red ask patch (max-pxcor - 10) (max-pycor - 10) [set plabel "Stall!"]] stop]
 ;; calculating the correct amount of power needed for the winch to lift the weight. If there is not enough, then it will not lift the weight and display the "stall" message
end
;;finish the go function
```

Final Design Photos

Pictures with Labels and Dates:	Descriptions and Signatures
FRONT VIEW - 10/21/19 	- Shows all components of the winch - Motor attached in the back is meshed to a red gear with similar teeth - The red gear shares an axle with the large gear on the right side of the winch, which forms a simple gear train on the right side. Simple gear train increases speed - The small gear shares an axle with a drum in the center which wraps the string around itself to lift the weight - Red wheel in front of the drum to hold the string level so that the drum will be able to properly wrap the string around itself Electronic Signatures: Shravan Nemmara Sai Kolla Shaan Mathur Romyr Concepcion
RIGHT SIDE VIEW - 10/22/19 	- Shows the right view of the winch - Shows gear train on the right side which is driven by the red gear meshed to the motor on the left side - The small gear is driving the drum in the center of the winch - Weight is hanging off to the side Electronic Signatures: Shravan Nemmara Sai Kolla Shaan Mathur Romyr Concepcion

LEFT SIDE VIEW - 10/22/19  	- Shows the left view of the winch - Shows the left side which has the motor and the red gear - Motor is mounted to the side platform of the structure - Red gear is meshed to the motor and drives the gear train on the other side with a shared axle - Weight is hanging off to the side Electronic Signatures: Shravan Nemmara Sai Kolla Shaan Mathur Romyr Concepcion
DETAIL VIEWS OF MOTOR - 10/22/19   	- Closer, more detailed views of the motor - The flat plate on side of the frame allows the motor to be attached - The motor is attached with two screws that fit into the slots on the sides of FischerTech pieces - Additional blocks added to side of motor to increase stability/reduce skipping teeth - Used very long screws with nuts on both sides of the plate in order to be able to adjust the motor's distance to the red gear Electronic Signatures: Shravan Nemmara Sai Kolla Shaan Mathur Romyr Concepcion

TOP VIEW - 10/22/19



- Shows top view of the winch
- Motor attached in the back is meshed to a red gear with similar teeth
- The red gear shares an axle with the large gear on the right side of the winch, which forms a gear train with the smaller gear train right next to it
- The smaller gear shares an axle with the drum, which is used to wrap the string around itself lifting the weight
- Red wheel in front of the drum to hold the string out over the edge of the base plate and keep it moving smoothly

Electronic Signatures:
Shravan Nemmara
Sai Kolla
Shaan Mathur
Romyr Concepcion

Final Design Solution Explanation:

Our project was to build a scale prototype of an electric winch for a “Local Construction Company” because they wanted a machine to lift heavy objects at a set height of 3 floors/30 centimeters for our scale model. After we built the scale prototype, the following measurements were taken: force, work, power output, power input, and efficiency. We found force by converting our weight, 239 grams, into newtons which came out to be 2.3422 newtons. To find work we used the formula “work = force x distance”. The total work produced by the machine was 0.7 joules. To find the output power we used the formula “power output = work / time” which came to be 0.04 watts. The input power formula was “ power input = current x voltage”. Using a multimeter, our voltage was measured to be 7.5 volts and the current to be 105.8 milliamps. The calculated input power was 0.79 watts. Finally, the efficiency was calculated by taking the quotient of the power output and input, then multiplying it by 100. It was calculated to be 5.06%. With such low efficiency, there is much room for improvement in the final design, but the current prototype is definitely functional. If the prototype were to be directly converted into a real-world machine then it would still fulfill its purpose, meeting project requirements. Three specific factors that could have affected our efficiency is the voltage level, the small gear, and the drum size. If the voltage level were higher the motor could spin at a faster speed, bringing up our weight faster and increasing our efficiency. Using a large gear to drive a smaller gear increased our drum’s rotation speed, making it lift the weight faster than being directly powered by the motor, but an even smaller gear would have made the drum spin faster. Shorter lifting times means greater efficiency. Finally, if we had chosen a larger drum then we could have brought up the weight faster, reducing the time taken to lift the weight and increasing our efficiency. Overall, our prototype has met all set standards and has completed its objectives, albeit not perfectly.