To Boldly Go . . . and Return

By Brendan Carroll
Teacher - Franklin Elementary
RET Summer 2013

RET Participant: Brendan Carroll
Location: Dr. Joel Rothman’s Lab
UCSB Department of Molecular Cellular and Developmental Biology

Mentor:
Dr. Pan Young Jeong

C. elegans

Dr. Joel Rothman
C. elegans: A Model Organism for Research

Ideal subject for genetics research;

- Life span 2-3 weeks
- Adults 1mm
- Transparent
- RNAi (introduced via inoculated bacteria)
- Genome completely mapped
- Hermaphroditic

INTERESTING FACTS:

- Survives -80° C for 10 years
- Survived 2003 space shuttle Challenger disaster
- Descendants of the Challenger survivors traveled to space on the Endeavour in 2011
PCD model in *C. elegans*

Pathway to Apoptosis (programmed cell death) discovered in *C. elegans*

- Cancer
- Genetic birth disorders
- Parkinson’s disease

Diagram by Dr. Pan Young Jeong
Cell Corpse Observations
Post-Heat Shock Treatment

% Cell Corpses per Comma Cell Embryo

Total Embryos Observed: (10) (8) (9) (16) (13)
Unit Focus: Engineering

Designed for
Elementary Students
Kindergarten - Fourth Grade
The Engineering Design Process

Imagine

Plan

Create

Improve

Ask

The Goal

Flowchart from Engineering is Elementary
K-2 NGSS
Engineering Design Standards

• Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

• Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

• Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.
NGSS Grade Level Standards

Kindergarten

• Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

• Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

First Grade

• Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.

Second Grade

• Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties

• Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

• Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.
NGSS Grade Level Standards

3rd Grade

1. Make observations and/or measurements of an object’s motion to provide evidence that a pattern can be used to predict future motion.

4th Grade

1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.

2. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
<table>
<thead>
<tr>
<th>Engineering Design Process</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identifying the problem</td>
<td>Vague of understanding problem</td>
<td>Can describe one element of problem</td>
<td>Clearly articulates problem</td>
<td>Clearly articulates problem and foresees relevant issues that might also arise</td>
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<tr>
<td>Identify the engineering criteria (goals) and design constraints</td>
<td>Only identifies one goal or one design constraint</td>
<td>Identifies just the goals or just the constraints</td>
<td>Identifies all the goals and constraints</td>
<td>Identifies all goals and constraints and suggests new goals / considerations in resolving the problem</td>
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<tr>
<td>Imagine possible solutions</td>
<td>Unable to think of a solution or copies someone else's idea</td>
<td>Thinks of one solution</td>
<td>Thinks of more than one solution</td>
<td>Thinks of more than one solution and articulates the benefits or trade-offs of each solution, including those of others</td>
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<tr>
<td>Make a plan for a possible solution</td>
<td>Draws a solution</td>
<td>Uses a labeled diagram</td>
<td>Uses a labeled diagram and can explain their plan</td>
<td>Uses a labeled diagram, can clearly explain plan and rationale for their design choices</td>
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<tr>
<td>Test ideas and improve design based on results</td>
<td>Narrowly focuses on one solution and makes no adjustments based on results</td>
<td>Tests ideas, but makes improvements based on subjective opinion rather than data</td>
<td>Tests ideas and makes appropriate improvements based on results</td>
<td>Tests ideas and is able to narrow variables in order to more precisely identify areas for design improvement</td>
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<tr>
<td>Engineer(s)</td>
<td>DATE</td>
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<tr>
<td>Project Title</td>
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<tr>
<td>Engineering Goal</td>
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<tr>
<td>Design Constraints (Limitations)</td>
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</table>

**Draw your Best Ideas for Solving this Engineering Challenge**
Label the parts of your invention and the materials being used.
How will you test your ideas?

Draw the Solutions that worked Best at meeting the Engineering Goal for this project

What did you discover after testing your ideas?
What did you change to make it work better?
Vehicle Designs

- Launch
- Re-Entry
- Emergency Rescue
Launch Vehicles

**Antacid Rockets**
Compare effects of . . .
Varying amounts of Water

**Rocket Balloons**
Compare effects of . . .
Fishing Line vs. Cotton String
Fins and Stabilizers
Antacid Rockets
Balloon Rockets
Rocket Balloons
Re-Entry Vehicles

**Wind Tube**
Open-ended
Flight Experimentation

**Parachute**
Parachute Designs
Canopy Materials

**Giders**
Paper Airplane Designs
Parachutes
Wind Tube

Engineering Criteria: Make something that flies!

Design Limitations: Materials

Concept developed by San Francisco Exploratorium
Wind Tube Flying Designs
Testing Helicopter Designs
Emergency Rescue Vehicle

**Engineering Criteria:** Make a buoyant craft that supports the weight of astronauts when they land in water.

**Design Limitations:** Materials
Lifeboat Engineering Teams
Lifeboat Capacity Tests
Acknowledgments

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