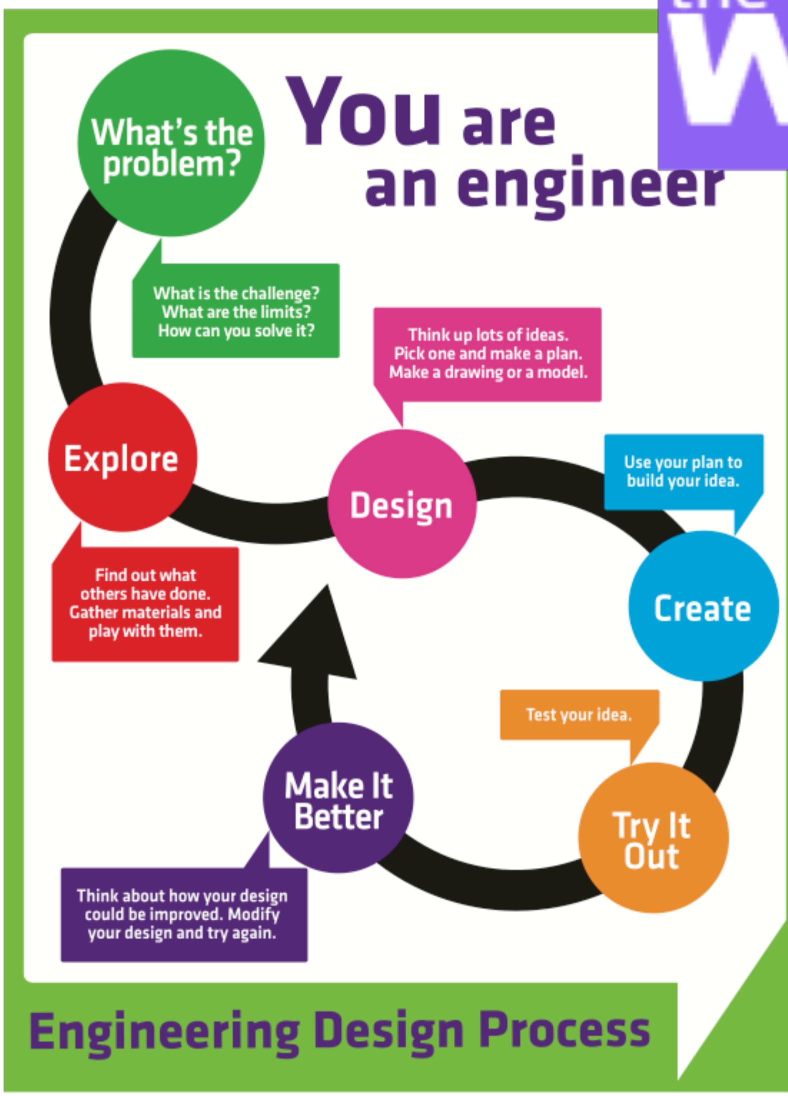
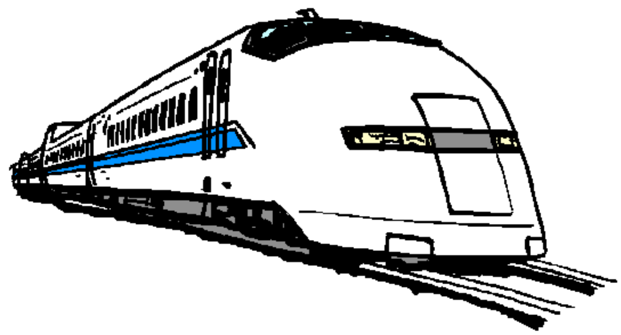
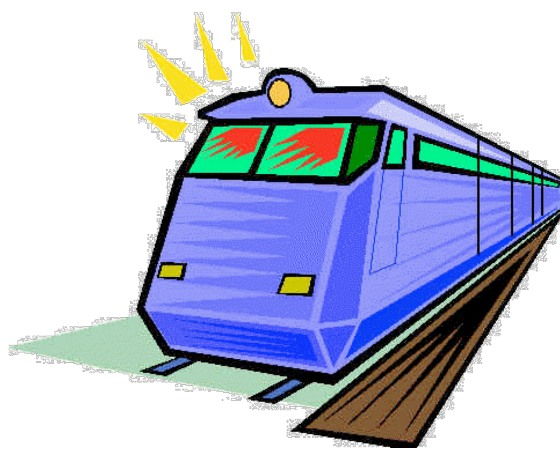
Maglev Train Project







Name: ______________________________________

Date: ____________________ Grade: _____ Section: ____

Maglev Train Project

DESIGN CHALLENGE	
>> Design and build a **mag**netically **lev**itated train that can hold twenty (20) pennies and glide down a track, without getting stuck.	
Criteria	**Constraints**
Your prototype must have... • A chassis with 4 magnets underneath • Room for 20 passengers (pennies) in such a way that they can be seen individually or easily removed for counting. They cannot be tossed inside the car • A shape that fits on the maglev track	*Your prototype must stay within these boundaries:* ▪ **Maximum length**: 20 cm (front to back) ▪ **Maximum width:** 6.5 cm (side to side) ▪ **Maximum height:** No restrictions ▪ Train suspension must be 100% magnetically levitated. ▪ The train must operate without being pushed, touched, or otherwise interfered with once in place at the starting
Approved Materia	**Key Points**
• One (1) foam block • Four (4) magnets • Cardboard • Glue • Balsa wood • Plastic ***NOTE:** **Materials will NOT be given out** until a drawing is submitted with different views and an explanation of the design choice. **Points will be lost** if replacement parts are needed.	• The higher the the vehicle levitates off the track, the better it performs. • The load (weight) should be distributed evenly. Vehicles that ride level do very well. • Magnets need to be positioned directly over the rails to make the chassis balanced. **Key Terms** • **Attraction**- pulling together of the magnet forces- unlike poles of the magnet attract • **Magnetic field** - the space around a magnet where the magnetic force is significant • **Magnetic force** - the force with which a magnet attracts or repels a metal • **Magnetic poles** - the ends of a magnet where the magnetic force is greatest (north and south • **Repulsion**- pushing away of the magnet forces- like forces repel
Class Competition	
On competition day: • The track will be elevated to a height of 1-2 m. • Each competitor will be given three attempts at racing. Vehicles stalled on the track will be disqualified for that run.	

ENGINEERING design Process

A PROCESS is a series of steps, done in order, that brings you from one place to another or from beginning to end. Engineers use and follow this process to design and build solutions that improve our way of life.

STEP 1
Identify the Need or Problem

- How can someone's quality of life be improved?
- How can we make a certain task easier?
- How can we improve upon an existing product?

STEP 2
Research the Need or Problem

- How have other people addressed the need or problem?
- What existing technologies (materials, methods, parts) can we use as part of the solution?
- What are the requirements and constraints?

STEP 3
Develop Possible Solution(s)

- Brainstorm possible solutions to the need or problem.
- Draw on mathematics and science.
- Use your imagination.
- Describe and refine the possible solutions.

STEP 4
Select the Best Possible Solution(s)

- Which solution(s) best meets the requirements and constraints?
- Is the solution realistically feasible?
- Which solution is the most marketable solution?
- Which solution(s) deserve further exploration?

STEP 5
Construct a Prototype

- Model the selected solution(s) in two and three dimensions.
- Model may be a physical model or a computer model, and may not be the same size as actual product.
- Prototype can address some or all of the features in the solution(s).

STEP 6
Test and Evaluate the Solution(s)

- Does the solution work?
- Does the solution meet the original design requirements and constraints?
- Is it safe, reliable, and durable?
- Does the solution appeal to the consumers?

STEP 7
Communicate the Solution(s)

- Make a presentation that discusses the original need/problem and how the solution best meets it.
- How would the product impact the society?
- Communicate the design to manufacturers.
- Describe the product to consumers and users.

STEP 8
Redesign

- How can the design be improved based on things you learned from test and usage?
- Redesign the solution to adapt to newly available technologies or methods.

HANDOUT 0-2

ENGINEERING design Process

DIRECTIONS: Imagine that your'e part of a engineering team that developed one of these devices: a locker organizer, cup holder, toothbrush, iPad case, three-ring binder, water bottle, clothes hanger, band-aid or other device that you're familiar with. In the diagram below, describe what you may have done during each step of the Engineering Design Process (follow the example) to make this device.

STEP 1: Identify the Need

We were asked to come up with a new design for the dashboard in next year's model of Ford's top-selling sport utility vehicle.

STEP 2: Research

We looked at dashboard designs of other sport utility vehicles from the past and present and from all different manufacturers.

STEP 3: Describe some possible solutions

We brainstormed all the different ways that we could design a dashboard and thought about the materials we could use. We made a bunch of mini, 3D drawings showing different ways it could be attached and fastened to the inside of the vehicle.

STEP 4: Describe the best possible solution

We looked at our drawings and the project criteria and chose the best idea. Next, we made a detailed, measured drawing showing different views of the dashboard from the front, back, bottom, sides and top.

STEP 5: Construct a prototype

We used our measured drawing to make an exact prototype of the dashboard.

STEP 6: Test & Evaluate the prototype

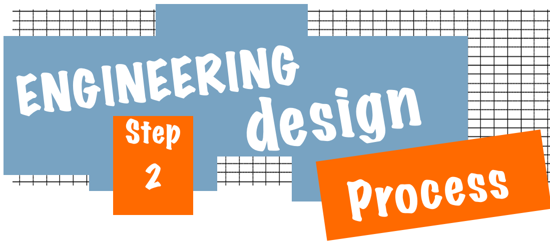
We examined the prototype for any defects and tested it to make sure it was the right size and would fit inside a sport utility vehicle.

STEP 7: Communicate the Solution

We sent the dashboard to Ford motor company and asked them if it fit their requirements, liked the way it looked and had any suggestions for improving it.

STEP 8: Redesign

We used the feedback from Ford motor company to make changes in the dashboard and drawings and were proud to see our dashboard design in thousands of sport utility vehicles the following year.



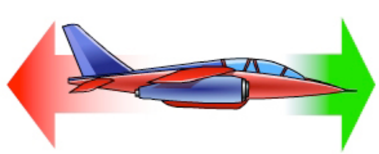
DIRECTIONS: Write an open response to this engineering situation. It will help you think about and analyze essential engineering principles contained in this project.

The diagram below shows a Formula 1 racing car. Many forces act together on the racing car so it can move safely at high speeds on a racetrack.

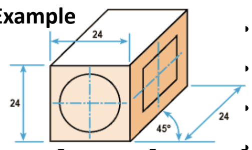
Using the copy of the diagram below, draw arrows to show how the forces of thrust, drag, and gravity act on the racing car as it moves forward on a racetrack. (It should look like the plane example at the bottom)

a) Label each arrow as thrust, drag, or gravity.

b) Describe how each force that you labeled in part (a) acts on the racing car as it moves on a racetrack.



<u>ISOMETRIC drawings are 3D drawings (show three sides).</u> In the boxes below, draw **SIX DIFFERENT ISOMETRIC** drawings (see example) of possible prototypes for this project. Try it on-line: http://connectedmath.msu.edu/CD/Grade6/Ruins/index.html

Possible Prototype #1 ⟷	Possible Prototype #1
Example 	Briefly explain this idea:

Possible Prototype #2 ⟷	Possible Prototype #2
	Briefly explain this idea:

Possible Prototype #3 ⟷	Possible Prototype #3
	Briefly explain this idea:

Possible Prototype #4	Possible Prototype #4
	Briefly explain this idea:

Possible Prototype #5	Possible Prototype #5
	Briefly explain this idea:

Possible Prototype #6	Possible Prototype #6
	Briefly explain this idea:

ENGINEERING design Process Step 4

List your top three choices from pages 7 & 8 and identify their advantages and dis-advantages. Engineers call these **TRADE-OFFS.**

Example

Advantages of this prototype

+ big wheels on the back of the car will provide more power
+ better traction with the floor
+ will look cool

Disadvantages of this prototype

-more weight which might slow it down
-it takes more energy to move bigger wheels so there will be less power to push the car

Prototype # ______
Advantages (+)
Disadvantages (-)

Prototype # ______
Advantages (+)
Disadvantages (-)

Prototype # ______
Advantages (+)
Disadvantages (-)

Identify which prototype you've chosen to build and **describe** why you think its the best solution.

Prototype # ______

ENGINEERING design Process
Step 5

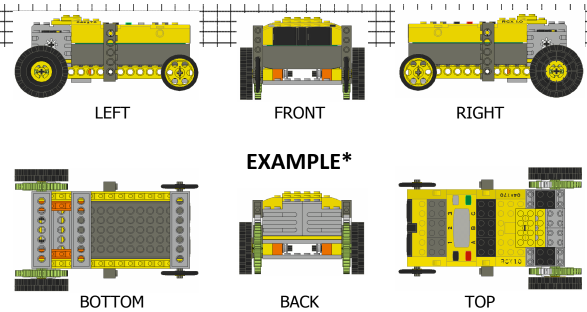
<u>ORTHOGRAPHIC drawings show six different views of an object</u>. Follow the examples below and draw your prototype from the front, back, left, right, top and bottom.

THESE DRAWINGS SHOULD NOT BE DONE FREE-HAND!

(Drawings can be computer generated [Google sketch-up] and attached to this page)

Checklist:

- ☐ **YES** I used rulers and drawing templates
- ☐ **YES** Each view is centered in the work space
- ☐ **YES** I made lines that are sharp, dark and crisp
- ☐ **YES** I erased completely any smudge marks or stray lines
- ☐ **YES I** labeled the major parts (magnets) with neat printing
- ☐ **YES** I showed where the pennies are located



FRONT VIEW	BACK VIEW

LEFT SIDE VIEW	RIGHT SIDE VIEW

BOTTOM VIEW	TOP VIEW

* Used with permission from Tufts University CEEO

ENGINEERING design Process Step 5

FASTENERS are parts that hold two or more objects together and there are many ways to do it. Complete the table below by describing how each type of fastener could be used on your prototype **OR** on a device or structure around your home.

Fastening Method	List three places on your prototype OR around your home where you could use these fasteners to hold two objects together.	What makes these fasteners good choices for holding these objects together?
Screws 	**1.** **2.** **3.**	**1.** **2.** **3.**
Nails 	**1.** **2.** **3.**	**1.** **2.** **3.**
Nuts and Bolts 	**1.** **2.** **3.**	**1.** **2.** **3.**
Screw Eyes 	**1.** **2.** **3.**	**1.** **2.** **3.**
Zipper 	**1.** **2.** **3.**	**1.** **2.** **3.**

ENGINEERING design Process

Step 5

PROPERTIES are characteristics that different materials possess. Engineers choose materials based on their properties. Think about your prototype **OR** some device at home and list a material for each property. Explain why the property is a good choice. Check out this web site for specific examples: http://www.pbs.org/wgbh/buildingbig/lab/forces.html

Properties	Identify a specific material on your prototype OR on something at home that has this property	Why is this material a good choice? (What will it do?)
Strength •Tension: can be stretched •Compression: can be squeezed •Shear: ability to resist sliding •Torsion: can be twisted	ex: wood for a chair	ex: resists compression when someone sits on on it
Elasticity The ability to stretch, flex and return to an original size and shape		
Plasticity The ability to flow into a new shape under pressure and to remain in that shape when the force is removed		
Hardness The ability to resist cuts, scratches and dents		
Toughness The ability to resist breaking		
Fatigue The ability to resist constant flexing or bending		

ENGINEERING design Process
Step 5

Follow the building guide and suggestions below, as well as your **ORTHOGRAPHIC** drawings on page 9 to build your prototype.

1. *Mark Your Magnets*

Mark one pole on all of your magnets so you later can lay them down with the same pole facing upwards:

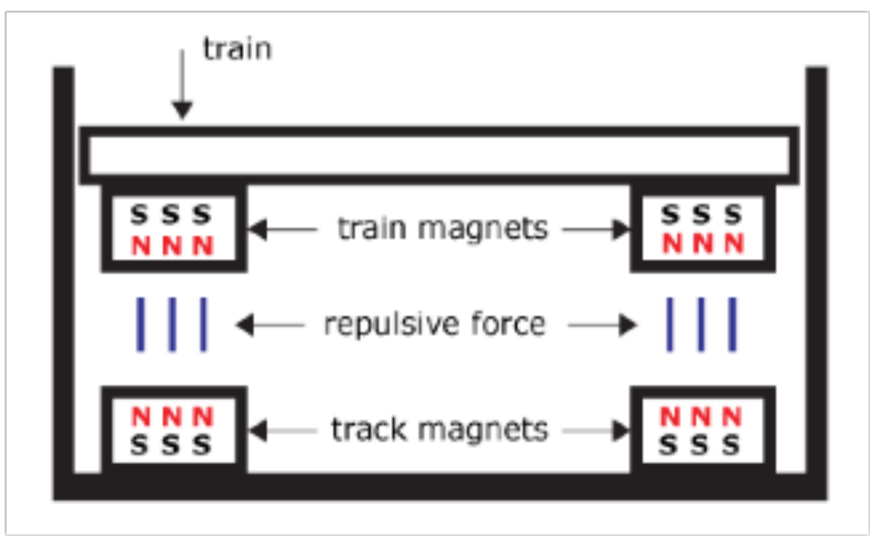
- Stick your magnets all together in one long stack.
- Use a marker to make an "X" on the flat face of one end of the stack.
- Pull the marked magnet off the stack; make an "X" on the next one, etc., until you're out of magnets.
- Be sure to mark every magnet on the

2 *Make the "Car"*

- Follow your production drawing and shape the "car" the way you want it. Don't forget to leave room for the pennies.
- DO NOT, DO NOT, DO NOT remove any foam from the sides. If you do the "car" will be too narrow and will not levitate evenly.
- Determine which side of each of the four remaining magnets repels from the magnets in the tracks, and mark it with

TROUBLESHOOTING

You might need to work at this project a little bit to get it to work. The trickiest part is aligning the magnets on the train and the magnets on the track; the alignment needs to as accurate as possible. This means magnets need to be aligned well enough to keep the train stabilized. Otherwise, your train will wobble and probably be attracted to one side of the track or the other, sticking to it rather than being repelled.



ENGINEERING design Process

Step 5

Fill out an engineering log after each building class. This is an official record of your progress and participation as well as your understanding of engineering principles.

EXAMPLE

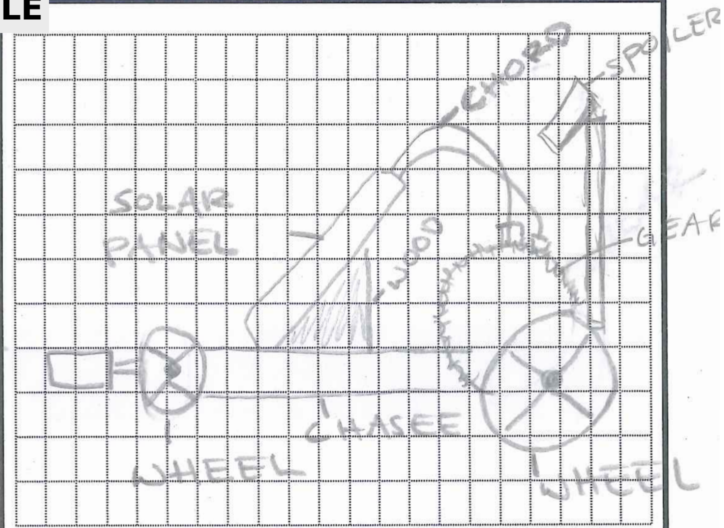
On the lines below, describe what you did. Mention any difficulties you had or any design changes you made.

LOG #5: Date: 5/3/12

Today I finished attaching the motor. I had a hard time w/ the gears because the the gear with the gray motor is so big so I changed it to a little smaller instead. I also used a velcro instead of gluing the motor on the car. Today my car is fe-

❑ **YES** I described the drawing in a clear and understandable way
❑ **YES** I used key terms and information to accurately describe my progress and drawing. I have enough information.
❑ **YES** My description is neatly written and legible.

Make a labeled sketch that shows what you did.



❑ **YES** My drawing is large enough to show all the details.
❑ **YES** My line quality is sharp and precise (no smudges)
❑ **YES** My labels are outside the drawing and accurate
❑ **YES** My drawing uses shading for highlights

Describe what you did today; tools that you used; materials that you used, parts you worked on, design changes and problems.	Make a labeled drawing (or paste a picture taken w/your phone) of your prototype or the parts you worked on.
LOG #1 Date: ____________________	
❑ **YES** I used complete sentences to describe my progress ❑ **YES** My description is neatly written and legible ❑ **YES** I described how I used specific tools and materials	❑ **YES** My drawing is large enough and centered in the space ❑ **YES** My line quality is sharp and precise (no smudges) ❑ **YES** Labels and measurements are **OUTSIDE** the drawing

Describe what you did today; tools that you used; materials that you used, parts you worked on, design changes and problems.	Make a labeled drawing (or paste a picture taken w/your phone) of your prototype or the parts you worked on.
LOG #2 Date: ____________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________	
☐ **YES** I used complete sentences to describe my progress ☐ **YES** My description is neatly written and legible ☐ **YES** I described how I used specific tools and materials	☐ **YES** My drawing is large enough and centered in the space ☐ **YES** My line quality is sharp and precise (no smudges) ☐ **YES** Labels and measurements are **OUTSIDE** the drawing

Describe what you did today; tools that you used; materials that you used, parts you worked on, design changes and problems.	Make a labeled drawing (or paste a picture taken w/your phone) of your prototype or the parts you worked on.
LOG #3 Date: ____________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________ ________________	
☐ **YES** I used complete sentences to describe my progress ☐ **YES** My description is neatly written and legible ☐ **YES** I described how I used specific tools and materials	☐ **YES** My drawing is large enough and centered in the space ☐ **YES** My line quality is sharp and precise (no smudges) ☐ **YES** Labels and measurements are **OUTSIDE** the drawing

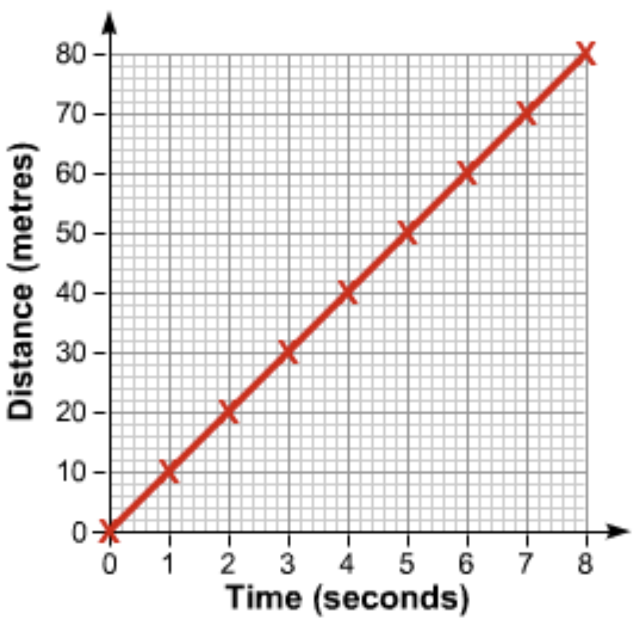
Describe what you did today; tools that you used; materials that you used, parts you worked on, design changes and problems.	Make a labeled drawing (or paste a picture taken w/your phone) of your prototype or the parts you worked on.
LOG #4 Date: ____________________ ___________________________________ ___________________________________ ___________________________________ ___________________________________ ___________________________________ ___________________________________ ___________________________________ ___________________________________ ___________________________________ ___________________________________ ___________________________________	
☐ **YES** I used complete sentences to describe my progress ☐ **YES** My description is neatly written and legible ☐ **YES** I described how I used specific tools and materials	☐ **YES** My drawing is large enough and centered in the space ☐ **YES** My line quality is sharp and precise (no smudges) ☐ **YES** Labels and measurements are **OUTSIDE** the drawing

Describe what you did today; tools that you used; materials that you used, parts you worked on, design changes and problems.	Make a labeled drawing (or paste a picture taken w/your phone) of your prototype or the parts you worked on.
LOG #5 Date: ____________________ ___________________________________ ___________________________________ ___________________________________ ___________________________________ ___________________________________ ___________________________________ ___________________________________ ___________________________________ ___________________________________ ___________________________________ ___________________________________	
☐ **YES** I used complete sentences to describe my progress ☐ **YES** My description is neatly written and legible ☐ **YES** I described how I used specific tools and materials	☐ **YES** My drawing is large enough and centered in the space ☐ **YES** My line quality is sharp and precise (no smudges) ☐ **YES** Labels and measurements are **OUTSIDE** the drawing

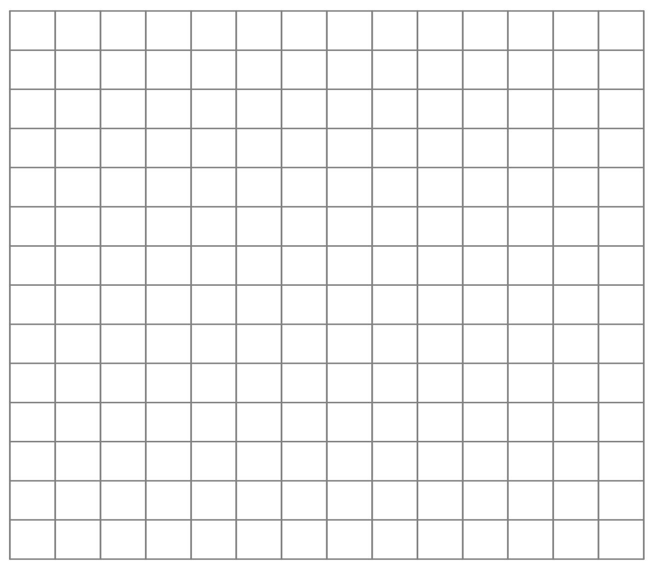
These are the official results of your prototype's performance that will help you make decisions and design changes during the project.

Maglev Distance/Time Trials

Trial	Distance (m)	Time (sec.)	# of Pennies	Moved forward and straight w/o rubbing side rails	Moved forward & rubbed side rails	Got stuck on track
1						
2						
3						
4						
5						
Avg.						



Graph your data like the example on the left



Things that I redesigned (changed)

1. ____
2. ____
3. ____

What the changes did

1. ____
2. ____
3. ____

ENGINEERING design Process — Step 7

Use the test data from the previous page to evaluate how well your prototype met the design criteria (page 2)and performed during the test trials. Just ask yourself one question; "Would **YOU** buy it?"

My prototype's performance was: (Check one)

___ **Exceptional:** it worked every time it was tested and needed no repairs

Some reasons for this are:

1. ____
2. ____
3. ____

___ **Very good**: it worked most of the time it was tested and didn't need any (or many) repairs

Some reasons for this are:

1. ____
2. ____
3. ____

___ **Good:** it worked some of the time it was tested and needed repairs

Some reasons for this are:

1. ____
2. ____
3. ____

___ **Not good:** it didn't really work

Some reasons for this are:

1. ____
2. ____
3. ____

ENGINEERING design Process — Step 8

List how you can improve the design and functioning of your prototype. What would make it better than it is?

Things I'd do differently next time	**What these might do**
1. ______________________________	1. ______________________________
2. ______________________________	2. ______________________________
3. ______________________________	3. ______________________________

ENGINEERING design Process Step 7

Engineers use something called the **Universal Systems Model** to describe how a particular prototype functions and all the resources needed to make it work. Study the diagram and examples below and use them to describe the inner workings of your prototype.

The Universal Systems Model:
Describing a skateboard

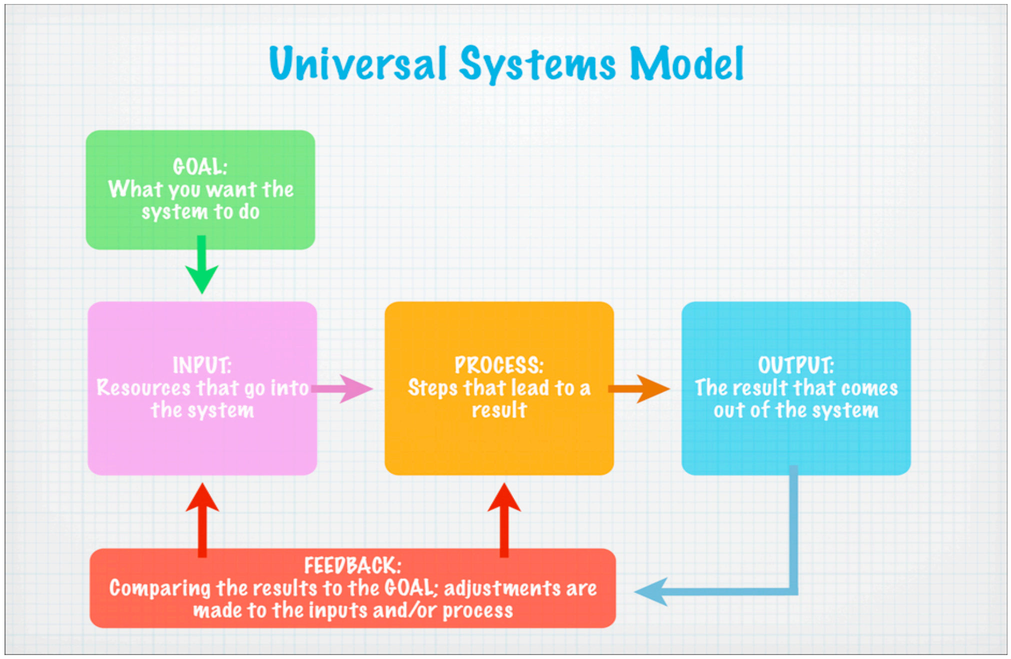
Goal: The goal is to ride the skateboard down the street

Input: Get on the board and kick off

Process: The wheels spin and the board travels down the road

Output: The board moves forward and you ride it

Feedback: Information that causes you to make adjustments. (Ex: you see a puddle and shift your weight to steer around it)



USM	Maglev Prototype
Goal:	
Input:	
Process:	
Output:	
Feedback:	

Maglev Train Scoring Sheet

Learning Target #1: Use and follow the Engineering Design process to plan and build solutions to problems.					
This is how I'll do it...					
•I'll imagine that I'm part of an engineering team and describe how the engineering design process could be used to develop a specific device or solution. (Pg.4)	0	1	2	3	4
•I'll make and explain drawings that show different ways to solve a design problem. (Pg.6-7)	0	1	2	3	4
•I'll make orthographic 3D drawings of the prototype I'm building from different views with labels and measurements that anyone could understand and follow. (Pg.9)	0	1	2	3	4
• I'll use the Universal Systems Model to describe the parts that operate my prototype (Pg.18)	0	1	2	3	4
The assignments above can be edited and re-scored while the project is on-going.	**Final Score**				

Learning Target #2: Explain and defend the reasons for using specific tools and materials when building a prototype.					
This is how I'll do it...					
• I'll list and explain how specific materials can be used on my prototype or in my home. (Pg. 10-11)	0	1	2	3	4
• I'll record my progress and describe how I used specific tools and materials to build my prototype.					
>>Engineering Log #1 (Pg.13)	0	1	2	3	4
>>Engineering Log #2 (Pg.14)	0	1	2	3	4
>>Engineering Log #3 (Pg.14)	0	1	2	3	4
>>Engineering Log #4 (Pg.15)	0	1	2	3	4
>>Engineering Log # 5 (Pg.15)	0	1	2	3	4
The assignments above can be edited and re-scored while the project is on-going.	**Final Score**				

Learning Target #3: Choose the most effective and safest way to use tools and materials when building a prototype.					
This is how I'll do it...					
•I'll describe and explain my reasons for the prototype I want to build. (Pg.8)	0	1	2	3	4
•I'll collect and display data about my prototype and use it to evaluate how well it worked. (Pg.16-17)	0	1	2	3	4
• I'll complete an open response question about technology & engineering (Pg.5)	0	1	2	3	4
The assignments above can be edited and re-scored while the project is on-going.					
•I'll follow my production drawings and build a prototype that meets the criteria below, looks like a finished product without any loose parts, damaged or rough surfaces and globs of glue, and holds together without needing repairs between multiple uses.	0	1	2	3	4
❑ Train chassis w/4 magnets that travels the entire track ❑ Room for 20 passengers (pennies) ❑ **Maximum length**: 20 cm (front to back) ❑ **Maximum width:** 6.5 cm (side to side)	**Final Score**				