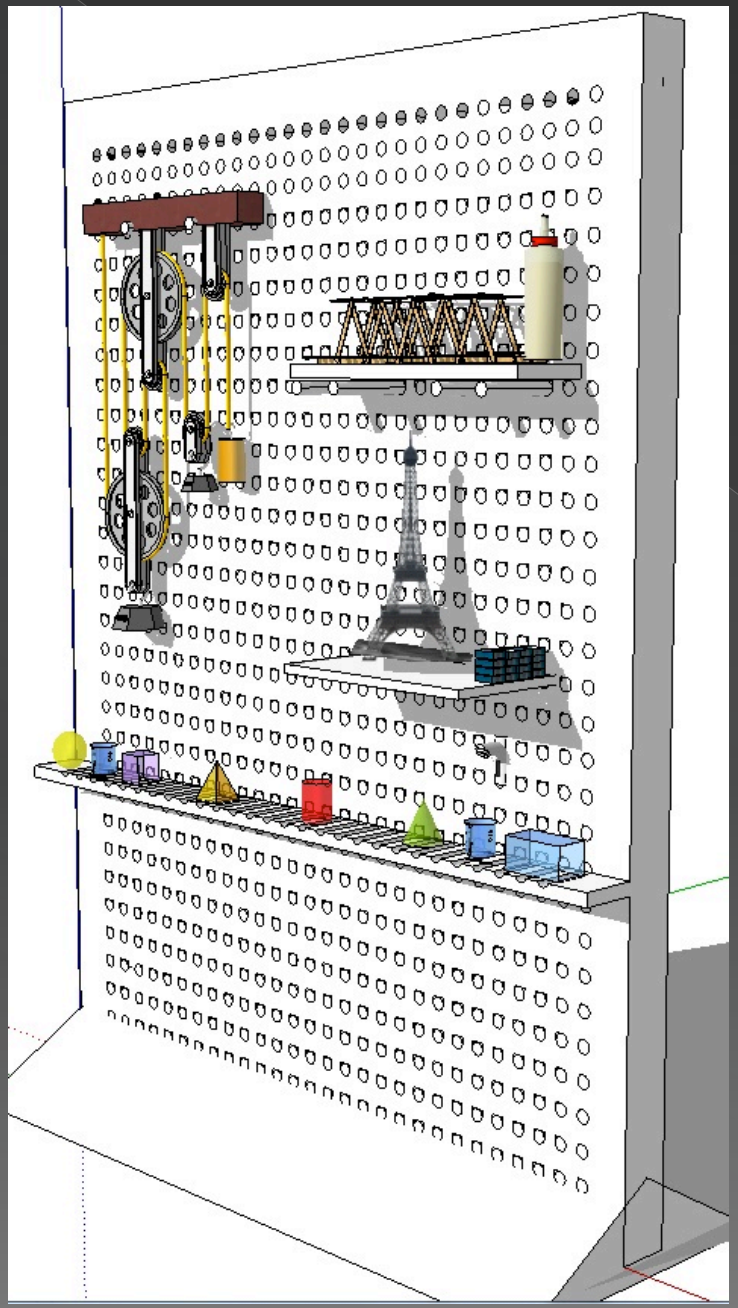

The Stem House

Structures—Team 2

Engineering Design 100 Section 17
Rámon Morales, Jim Nixon,
Andrew Nolff, Maxine Taylor
Thursday, October 17, 2013

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The Task

- Problem Statement: The United States is falling down the rankings in educating students in the science and math disciplines. Our task is to attempt to solve this problem by making a “STEM House” to excite and encourage students in the STEM disciplines.

The Task

- Mission Statement: To design and build an educational tool to be marketed and sold to middle schools in order to motivate and assist in educating students in grades 6-8 in the STEM disciplines, using structures as a subsystem while interfacing with other subsystems.

The Task

- Customer Needs:
  - Stakeholders:
    - School Board
    - Parents
    - Teachers/Principals/Staff
    - Students
  - Obtainable:
    - Parents
    - Teachers
    - Students

The Task

- Customer Needs Assessment:
  - Do you think this system is beneficial to students? How?
  - How much are you willing to spend for this program?
  - How do you think parents will respond to the idea?
  - How comfortable are you teaching these topics?
  - What type of structure would you like this facility to be?
  - How much physical space would you be willing to give up for this program?

The Task

- Specifications:
  - Virtual combined with interactive learning
  - Ability to fit into a classroom
  - Easily assembled
  - Able to be mass produced
  - Under $100
  - Must encourage and maintain at least 40 students
  - Must satisfy Pennsylvania State Educational Standards

Design Process

- Brainstorming
  - Strengthening structures
  - Bridges and towers
  - Forces and momentum
  - Volume vs. Surface area
  - Buoyancy
  - Vibrations
  - Simple machines
  - Vectors
  - Design Process

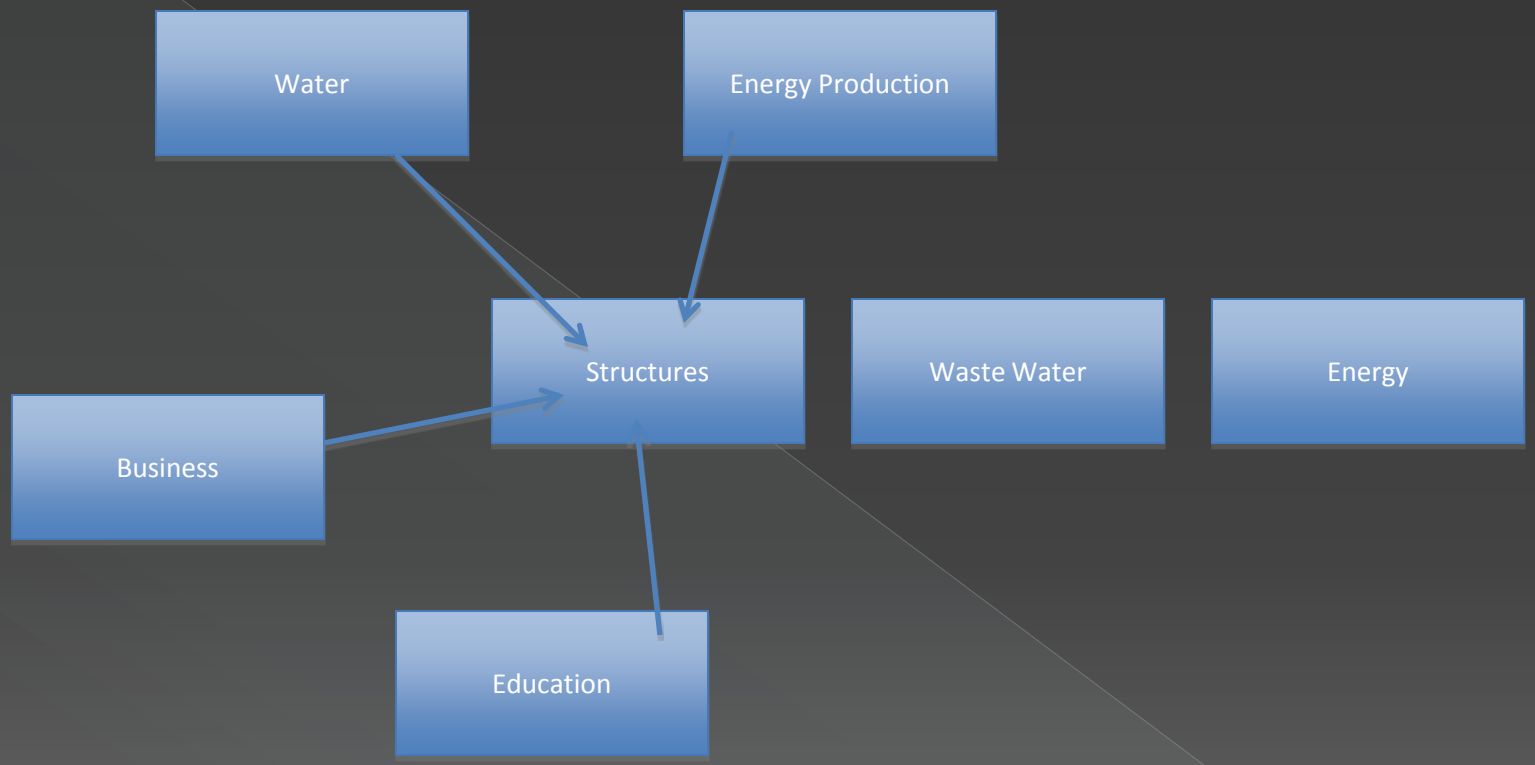

Fig. 1. Systems Diagram

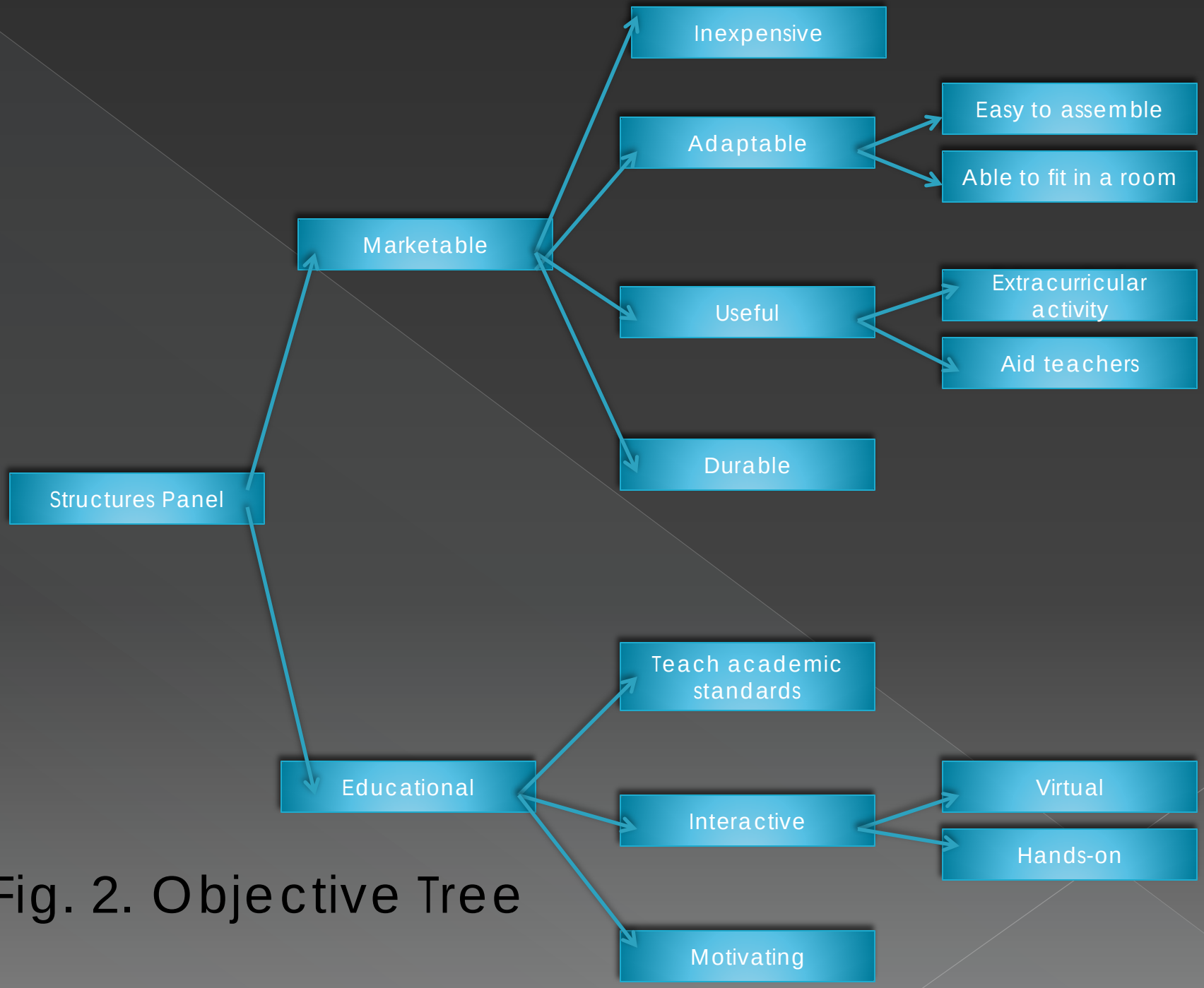

Fig. 2. Objective Tree

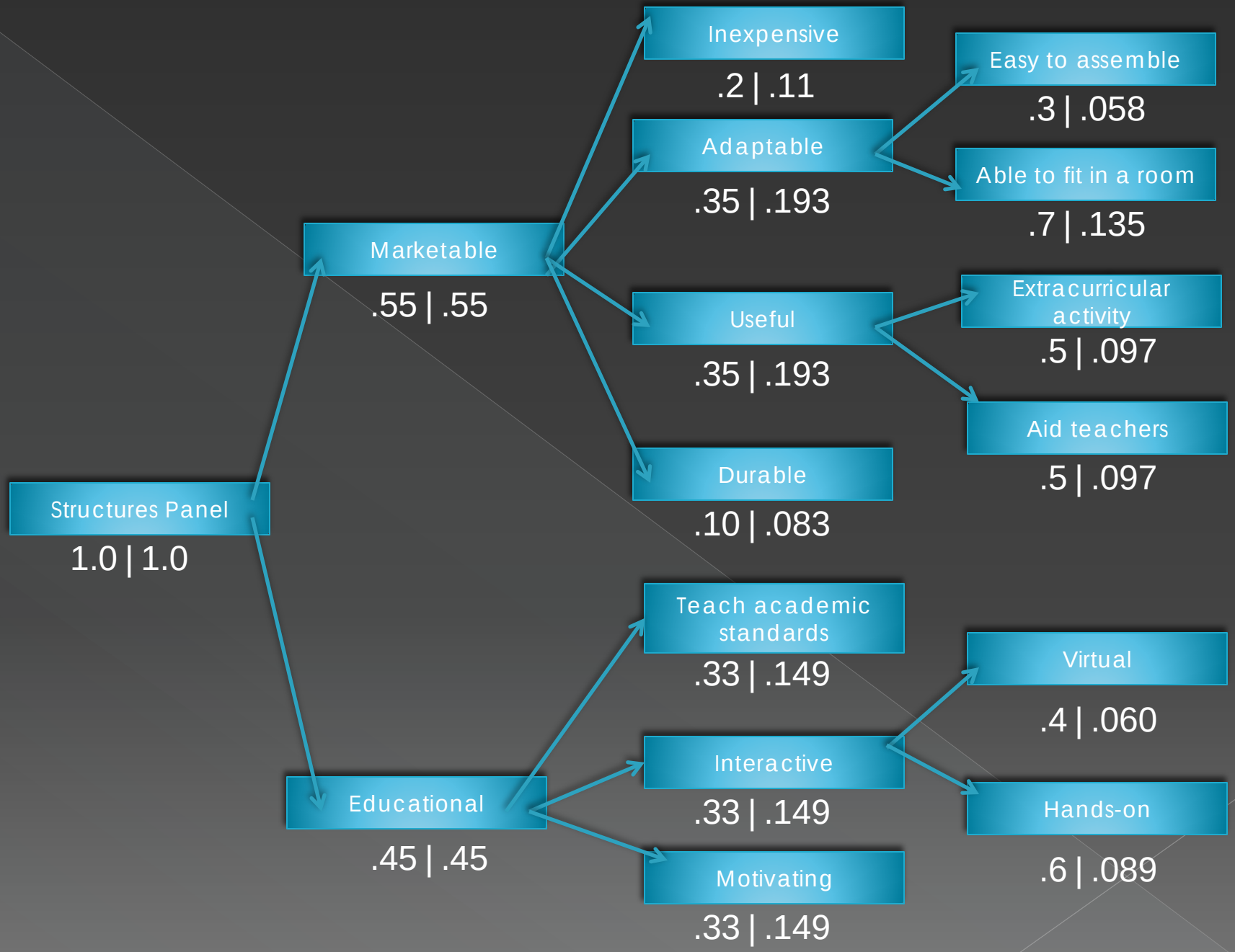

Fig. 3. Weighted Objective Tree

Evaluation

	Concept Variants					
Selection Criteria	Bridges	Tower	Spring	Volume vs. Surface area	Pulley	Buoyancy
Cost	+	+	-	0	0	0
Ease of use	0	0	-	-	0	-
Ease of assembly	+	+	0	0	+	+
Pennsylvania State Standard	+	+	-	+	+	-
Interactive	+	+	+	+	+	+
Pluses	4	4	1	2	3	2
Sames	1	1	1	2	2	1
Minuses	0	0	3	1	0	2
Net	4	4	-2	1	3	0
Rank	1	1	6	4	3	5
Continue	Yes	Yes	No	No	Yes	No

Table 1. Design Matrix

Evaluation

Pairwise Comparison							
	A	B	C	D	E	Row totals	Row total/total
A	1	2	2	2	6	13	0.3805
B	1/2	1	1	1	3	6.5	0.1902
C	1/2	1	1	1	1 1/2	5	0.1463
D	1/2	1	2	1	3	7.5	0.2195
E	1/6	1/3	1/3	1/3	1	2.167	0.0634
					Total	34.167	

A- Cost
B- Ease of Use
C- Pennsylvania State Standard
D- Ease of Understanding
E- Interactive

Table 2. Pairwise Comparison

Analysis

Cost Estimation	
Element	Cost ($)
Shapes	21.47
Toothpicks	4.00
Glue	15.30
Pulley	12.41
String	4.00
Weights	23.75
Panel	9.00
Total	89.93

Table 3. Cost Analysis

The Model

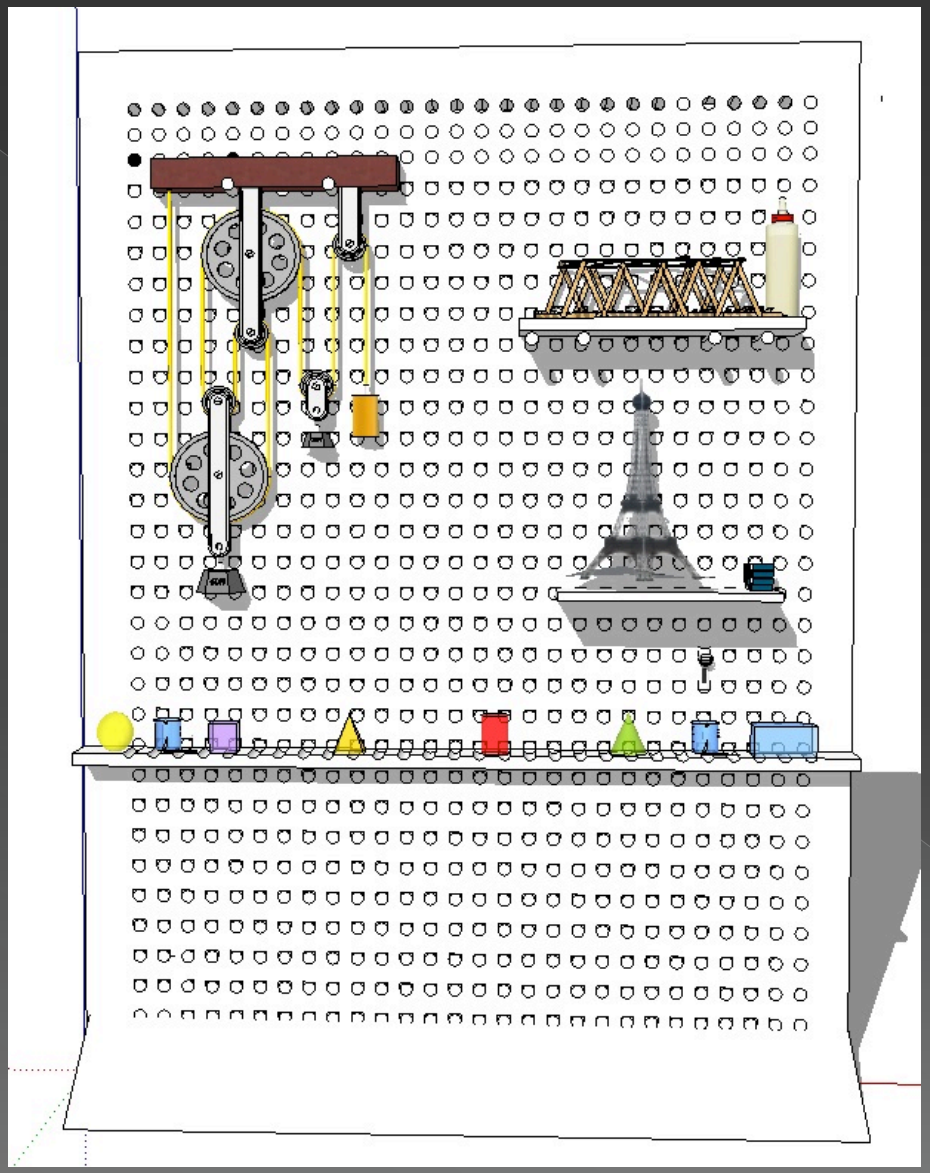

Fig. 4. Image of Prototype

The Model

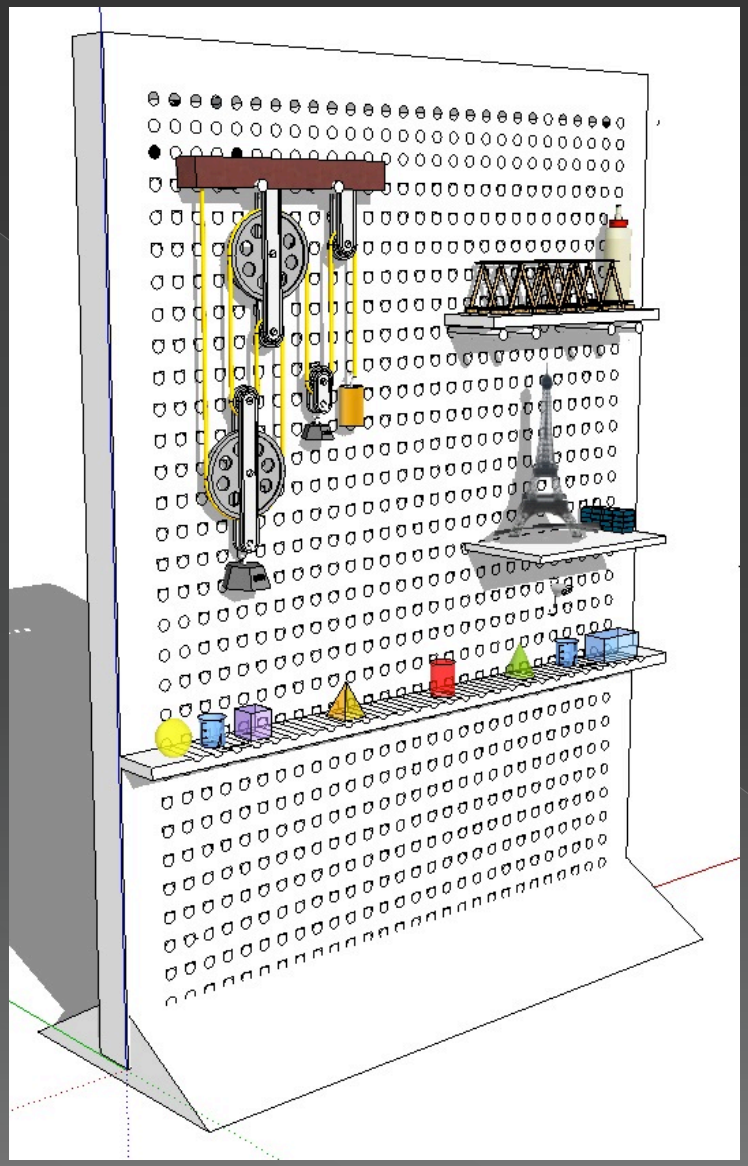

Fig. 5. Image of Prototype

The Model

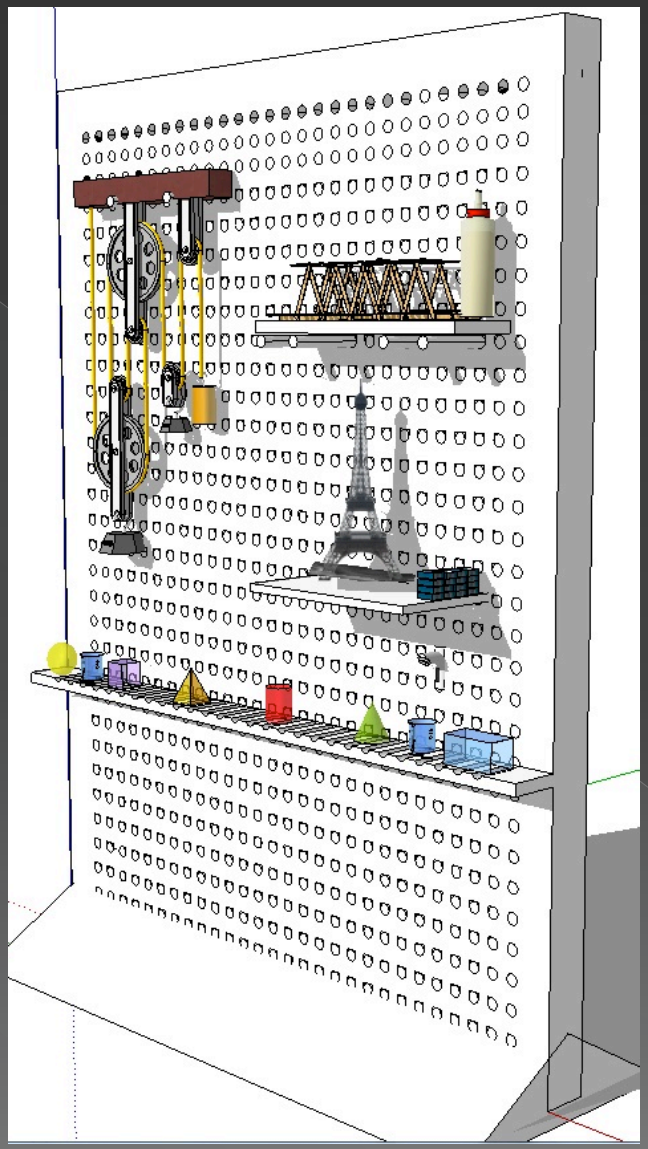

Fig. 6. Image of Prototype

Pennsylvania State Standards

Volume and Surface Area

2.3.8.B.
Develop strategies for determining areas and volumes of compound shapes and solids.

2.3.8.C.
Calculate volume, surface area, and degrees of angles; calculate circumference and area of circles.

2.9.8.A.
Name, describe and apply geometric relations for 1-dimensional shapes and 2-dimensional shapes and 3-dimensional solids.

Forces

3.2.7.B1.

Describe how unbalanced forces acting on an object change its velocity. Analyze how observations of displacement, velocity, and acceleration provide necessary and sufficient evidence for the existence of forces

3.2.6.B2.

Describe energy as a property of objects associated with heat, light, electricity, magnetism, mechanical motion, and sound. Differentiate between potential and kinetic energy.

Structures

3.4.6.E7.

Explain how the type of structure determines the way the parts are put together

Conclusions

- Using the design process, we were able to create a sophisticated teaching tool.
- To best form a project, ideas need to be taken from every stakeholder.
- Engineering is far more than just math and science. It requires far more extensive subjects in order to handle the marketing and project development aspects of every project.

Project Management

Define					
Determine the customer need	Interview users to establish requirements	Andrew	2 days	Fri 9/13/13	Mon 9/16/
	Search the literature for any regulatory requirement	Jim	2 days	Fri 9/13/13	Mon
	Find and research similar products	Ramon	2 days	Tue 9/17/13	Wed
	Identify stakeholders	Maxine	2 days	Tue 9/17/13	Wed
	Interview stakeholders	Andrew	2 days	Tue 9/17/13	Wed
	Obtain specifications	Jim	2 days	Wed 9/18/13	Thu 9
	Revise problem statement	All	3 days	Tue 9/17/13	Thu 9
Generate concepts	Brainstorm ideas	All	4 days	Tue 9/17/13	Fri 9/
	Create pairwise comparison and weighted matrix	All	2 days	Sat 9/21/13	Mon
	Select promising concept(s)	All	3 days	Sun 9/22/13	Tue 9
Begin Detailed Design	Perform detailed analyses of concepts	Andrew	4 days	Mon 9/23/13	Thu 9
	Material selction/availability	Jim	3 days	Sun 9/29/13	Tue 1
	Component selection/availability	Maxine	2 days	Tue 10/1/13	Wed
	Sketchup drawing	Andrew	5 days	Tue 10/1/13	Mon
	Cost estimation	Ramon	1 day	Tue 10/1/13	Tue 1
Documentation and Reporting	Preparation of first progress report	All	2 days	Fri 10/11/13	Mon 10/14
	Preparation of second progress report	All	1 day	Mon 10/14/1	Mon
	Preparation of final report	All	1 day	Tue 10/15/13	Tue 1
	Preparation of final presentation (powerpoint)	All	1 day	Wed 10/16/1	Wed
Refine the project as needed		All	1 day	Thu 10/17/13	Thu 10/17

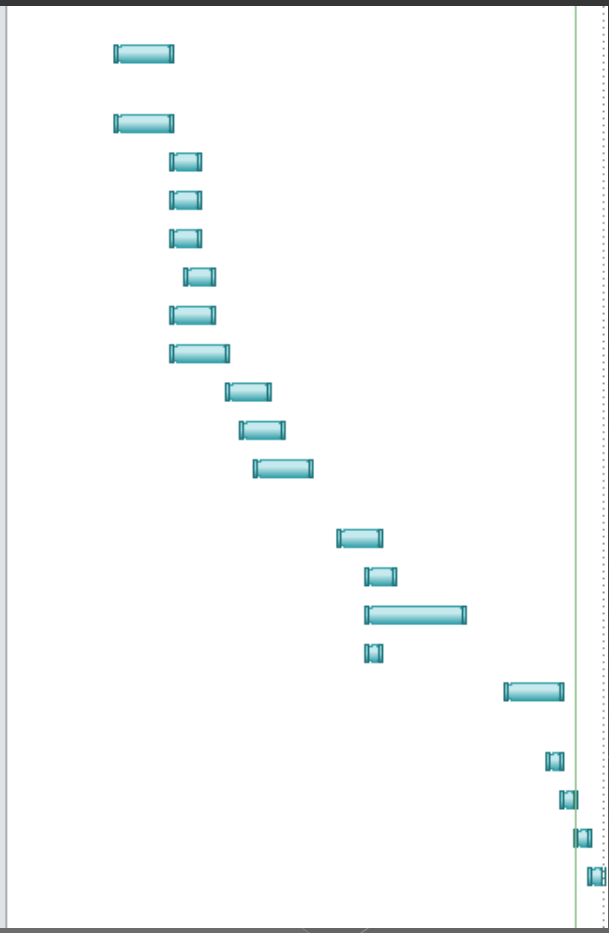

Table 4. Gantt Chart

References

- http://www.homedepot.com/c/Featured_At_Home_Depot
- David Farrell, Millburn High School
- Donald Coughlan, Board Member

Questions