Ohio's Sitting Machine- Design Challenge

Skills/Knowledge: the design process, prototyping/scale modeling, measuring and mathematics, forces, material science, safely using tools, group processing at the beginning and end of the project.

Questions to consider: What makes some cardboard structures stronger than others? Why do other designs support more weight? What's the best way to orient, combine, and join the cardboard for maximum strength? What's the best way to hold the different parts of the sitting machine together? How do you keep the sitting machine from wobbling and twisting when you sit on it? How is my sitting machine similar to other structures?

Process: Design is really about discovering and getting rid of the ideas that won't work. With that in mind, you should follow two stages of development, **INVENTION AND DOCUMENTATION**. **INVENTION phase**: Forget about what you currently know as a "sitting machine," and free yourself up to invent something using what you learn about the materials and the forces acting on your design. Once you have discovered how to best overcome the forces acting on your design and understand the materials you are working with you will better understand the requirement definition for the sitting machine. **DOCUMENTATION phase**: It is here where you will document you solution to the sitting machine design challenge. Quality documentation allows for others to repeat what you have done using your written, graphical, model and finished sitting machine. This documentation tells the "story" of what you discovered/learned and how you used that information in your design and construction.

Outcome: The design of the "sitting machine" and the design submission must meet the following general requirements: The sitting machine must elevate a variety of users off of the ground comfortably for an **undetermined length of time**. Sitting machine can be designed as a portable or non-portable submission. See specifications for design/construction criteria. The sitting machine should be designed using basic ergonomic principles. The competitors are to explain about their process in detail both inside their engineering notebook and on the display board. Size of the user your sitting machine was designed for (resource must be noted), how the five forces that affect engineered structures were considered when designing and building their sitting machine (graphic or text) must be documented. **The five forces which must be considered are: compression, tension, bending, shear, and torsion**. When the sitting machine is to be tested (sat on), how will your design keep the sitting machine from twisting (torsion)? How would the sitting machine keep from pulling apart (tension)? What would keep the parts of the sitting machine from sagging or tearing (bending and shear)? What would keep it from collapsing when a user sat on it (compression)?

Materials: The sitting machine must be built from no more than **30 square feet** of **1/8" thickness Single Wall Corrugated Board** (the medium is between two sheets of linerboard, also known as **Double Face**). Material must be recycled or reused corrugated board (encourages green, re-use). No mechanical fasteners may be used, **ONLY Elmer's or wood glue**. **You cannot use** duct tape, hardware (washer, nut and bolt) or any other material not listed above. Do not paint or cover the sitting machine with any covering.

Portable sitting machine: Sitting machine must be collapsible and stored easily to fit in a 9" x 14" x 22" space to meet the criteria for the portable category.

Individual/Team Entry Forms to be affixed to the submitted sitting machine.

PLEASE PRINT Student Name(S):_____ School Name/District: _____ Current Grade Level: _____ Teacher: _____ Category (circle): Stationary Portable	PLEASE PRINT Student Name: _____ School Name/District: _____ Current Grade Level: _____ Teacher: _____ Category (circle): Stationary Portable

Deliverables: Each competitor or team (2 person) is required to submit the following items:

1. A Scale model (with scale of model noted) of idea(s) must be approved by your instructor before moving to construction of your final solution to the sitting machine design problem.
2. Completed and functional sitting machine.
3. Display/Presentation board of one or two 11" x 17"design boards with the following (minimal):
    a. Engineering drawings of sitting machine (can include sketches of ideas and details of construction)
    b. Photo or graphic of sitting machine in use.
    c. Write up for display board must include: Abstract description; Design description; Process- start to finish; Engineering principles of design; Materials used and overall dimensions of sitting machine.

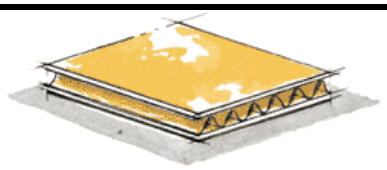
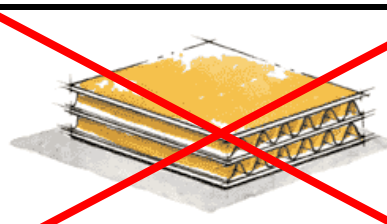
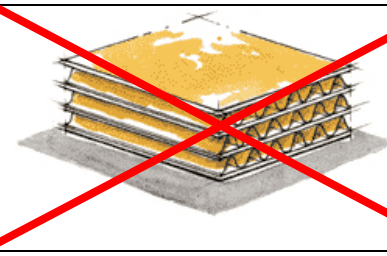
* http://www.aias.org/chairaffair/ offers examples of well documented display boards.

- **Evaluation Criteria:** In addressing the specific issues of the design challenge, submissions must clearly demonstrate the design solution's response to the following requirements:
    - Clear and easily comprehendible design (communicated on display board).
    - Originality of design and construction.
    - Ergonomically comfortable.
    - Aesthetically pleasing.
    - Cleverness of craft and details (innovative construction techniques).
    - Identification card affixed to sitting machine on bottom (out of sight).
    - Relationship of design progression: idea, model and finished product.

RESOURCES

Here are some web resources that might help to spur the imagination:
www.aias.org/chairaffair
www.careersincorrugated.org
www.fibrebox.org/Info/WhatIsCorrugated.aspx
www.andrewsenior.com/gallery/design/chair.html
www.gcbr.com/tips.html
www.rd.se/home.php
www.thesittingmachinemovie.com

Information from: **http://www.fibrebox.org/Info/WhatIsCorrugated.aspx**

Single Wall: The medium is between two sheets of linerboard. Also known as Double Face.		**Acceptable** material to use for sitting machine construction.
Double Wall: Three sheets of linerboard with two mediums in between.		**NOT ACCEPTABLE** Material!
Triple Wall: Four sheets of linerboard with three mediums in between.		**NOT ACCEPTABLE** Material!

Lesson Planning:

Before you let your students jump into designing a sitting machine, let them discover some useful information about the materials and the forces involved with such a project. STEM activities are best when there is prior learning/discovery about the project(s) requirement definition. In the case of the sitting machine learners should be exposed to the structural elements of the materials to be used (corrugated cardboard and glue), construction/structural principles, force translation, tools that are available for use (varies based on campus), design/problem definition and a controlled process from innovation/invention to finished product.

Material resources:

What is Corrugated? http://www.fibrebox.org/Info/WhatIsCorrugated.aspx
Corrugated Basics http://www.corrugated.org/Basics/Default.aspx
All about boxes http://www.argrov.com/cgi-bin/about_boxes.cgi
Benefits of reusing cardboard http://www.ct.gov/dep/cwp/view.asp?a=2714&q=324858&depNav_GID=1645
Corrugated Cardboard Furniture (Google Search)

STEM resources and suggestions:

Forces: If possible get the physical science resources from your campus (textbook, web sites, handouts they use). See the cross curricular ties? Divide into small groups and give each 2-3 person team a force to learn about and test using the cardboard material. Make each group report back to the entire class on what they found out about how cardboard reacts to the type of stress they were assigned. Give them guidelines to discover ways of overcoming that stress on the material through design/shape.

Math: Again use the resources from your campus if possible (Geometry & Algebra).

Technology/Design:

Free design/modeling software:

Google Sketch Up .

PTC Pro Engineer (training is required to get the software, but it is well worth the effort).