How can STEM fit into the After school program?

A love for children and openness to change are the starting points. With these, anything is possible. .. *Reggio Emilia*

Introduction

- Bill Wolfson, BSEE, MS
  billw@engineeringlens.org
- What do YOU want to get out of this Presentation?
- Review, Reflection, Next Steps

What are the goals and objectives of the after-school program?

Program Development

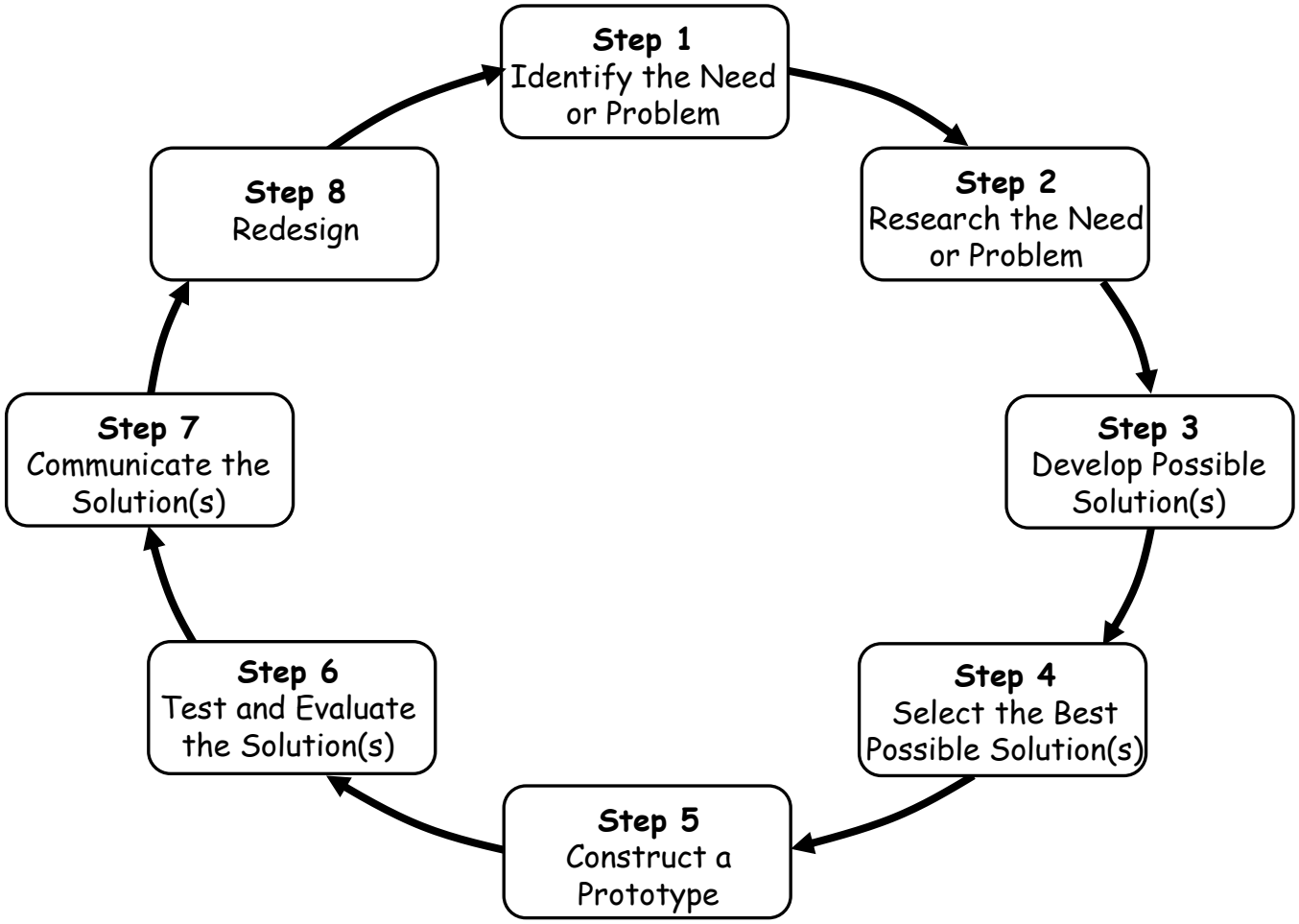
- Based on principle's for the NSF book… “Learning Science in Informal Setting”
- Connection to the Common Core
- Experience with communities in MA (Millis, North Attleboro, Boston)

Common Core

Common Core versus Design Process:

ELA common core	**Design / Problem Solving Professional development**
Reading Standards for Literature K–5 (RL), Key ideas, Structure, ideas,	Reading the story, understanding who the characters are, What's the problem you are solving
Foundational Skills (RF) reading for understanding	Reading sections of the story as part of the collaborative groups
Writing Standards (W)	Writing extension stories, drawing sketches and diagrams of their artifacts, Creating presentation of their inventions to others, writing operating manuals
Speaking and Listening Standards (SL)	Being part of collaborating teams, making presentations to other teams, parents, teachers.
Language Standard (L)	Part of creating documents, grammar and usage of words

MA Framework: Strand 4 Engineering & Technology



Framework Oct. 2006

Learners in informal environments

Strand 1: Experience excitement, interest, and motivation to learn about phenomena in the natural and physical world.

Strand 2: Come to generate, understand, remember, and use concepts, explanations, arguments, models, and facts related to science.

Strand 3: Manipulate, test, explore, predict, question, observe, and make sense of the natural and physical world.

Strand 4: Reflect on science as a way of knowing; on processes, concepts, and institutions of science; and on their own process of learning about phenomena.

Strand 5: Participate in scientific activities and learning practices with others, using scientific language and tools.

Strand 6: Think about themselves as science learners and develop an identity as someone who knows about, uses, and sometimes contributes to science.

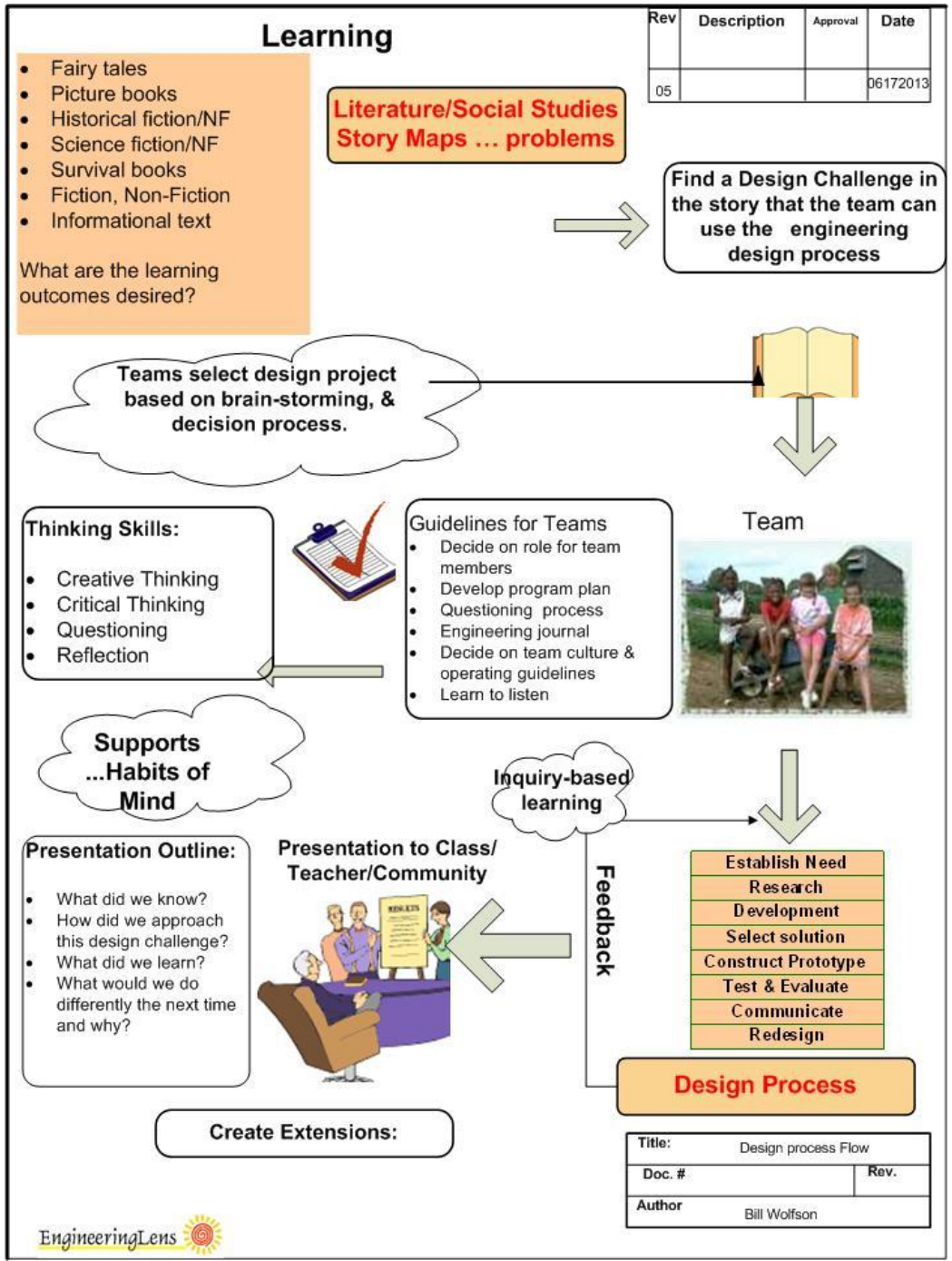
Tell me and I'll forget.
Show me and I'll remember.
Involve me and I'll understand

- Confucius

Inquire-based learning using Design Challenges

Opportunities

- Problem Solving in different context situations
- Meta-cognitive reflection
- Students own their design
- Collaboration
- Using thinking skills and habits of mind attributes
- Persistence, Managing Impulsivity, Empathy, Accuracy, humor, Questioning, etc.
- Teacher as “researcher” to understand the thinking of each child… Reggio Emilia



Possible Engagements

Using the following:

Problem Solving

Innovation/ entrepreneurship

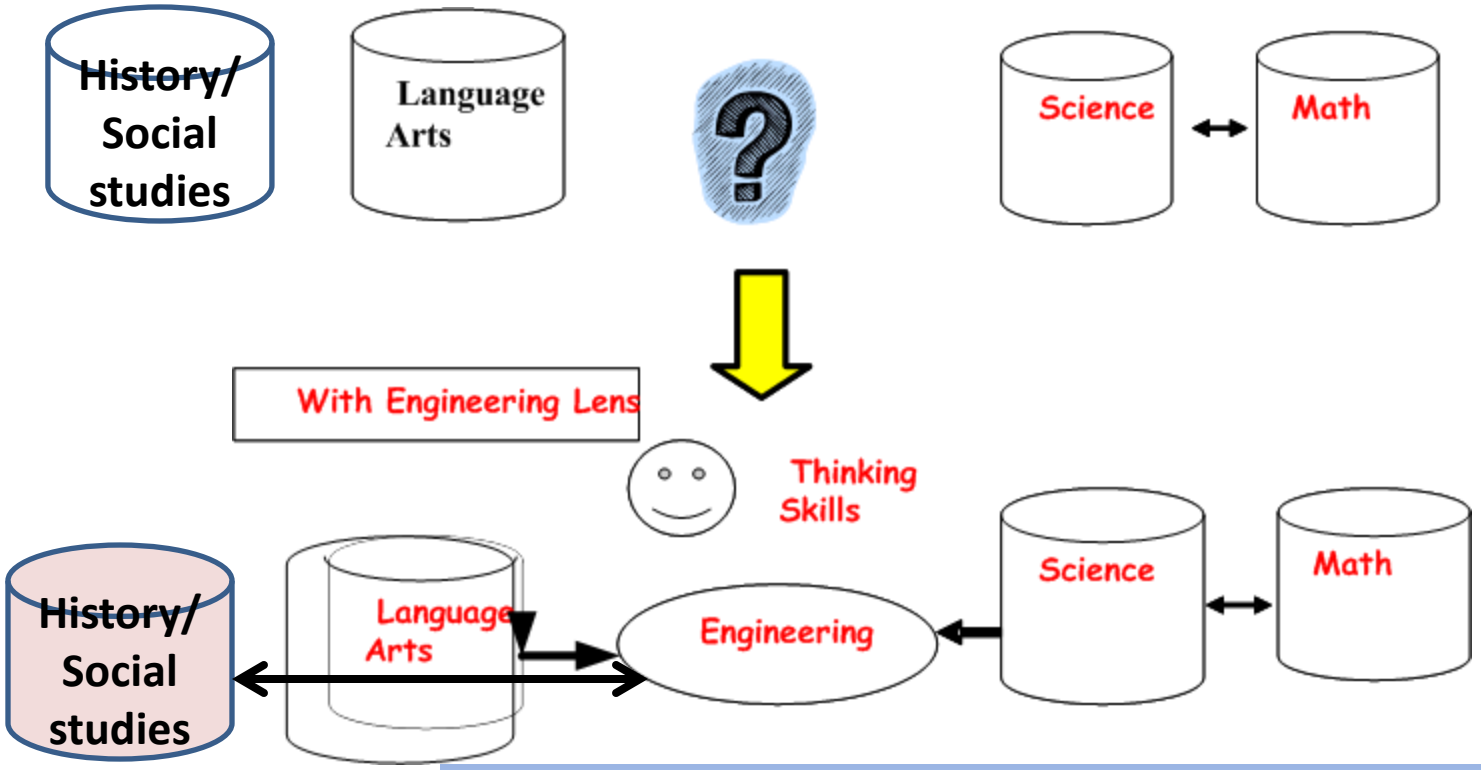
Stories

Finding the Gap

World issues (WPI)

What are we about

National Academies of Engineering report, Engineering in K-12 Education (2009), highlights the need to avoid a “silo” approach to engineering by integrating with other subjects



Interdisciplinary Learning

Gap / Bug Design

The difference between what we need and what we have.

Sense gap. Design begins with a perception of a gap in the user experience. Without a gap, there is no motive for design. The gap may be perceived by users themselves or by observers

Basic Outline

Sessions	Activity
Bugs	Intro … Bugs recording
	Brain Plasticity
	Bugs sharing
	Design … Tinkering
	What do Engineers, Scientist and Mathematicians do?
	Gathering materials
	Design and redesign
	Reflection and writing
	Sharing and display
	Innovation & Entrepreneurship
Stories	Design challenges within the story
World view	Feed the World, Power the World, Heal the World

Elements of Design

- Making … active role construction plays in learning
- Tinkering … is a mindset- a playful way to approach and solve problems through direct experience, experimentation, and discovery
- Engineering … extracts principles from direct experience. It builds relationships between intuition and science to explain, measure and predict the world around us.

The hands are the instruments of man's intelligence… Maria Montessori

Problem Solving

- What's the problem … Framing
- Creating lots of options … creative thinking
- Narrowing the choices … critical thinking
- Sketching, building, and testing
- Review and reflections
- Presenting results

Benefits

- Meets all the learning principles of the Massachusetts Science Framework
- Promotes higher-order thinking skills using design learning.
- Invites the incorporation of instructional technology into the curriculum.
- Engineering is differentiated: offers an "in" for learners of all types.
- Rich cross-curricular possibilities.
- Integration with science and math is an important way to show students how and why both are relevant and useful in the world.
- Directly connected with improvement of living conditions/safety/health and welfare of people.
- Engages both students and teachers in an exciting learning process.

Diana Mason, Missy Taft,

STANFORD
TECHNOLOGY
VENTURES PROGRAM

Tina Seelig

Executive Director,
Stanford Technology Ventures Program

May 27, 2009

The top four skills needed to get a good job as:

- critical thinking and problem solving,
- collaboration and leadership,
- agility and adaptability,
- initiative and entrepreneurialism

Most faculty understand the need to help students develop these abilities, but feel that they are being pushed into coming up with short-term strategies (such as grading rubrics) to improve student performance in the classroom at the expense of developing sustainable, higher order thinking skills.

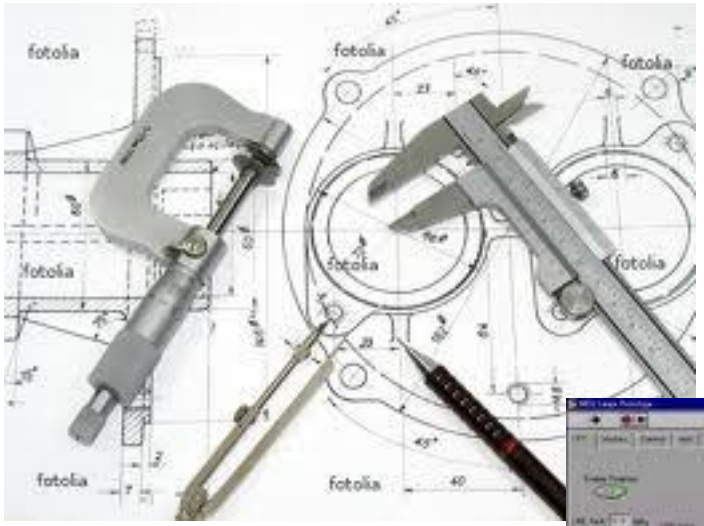
The Global Achievement Gap, Tony Wagner, co-director of the Change Leadership Group, Harvard School of Education

We start with the definition of an engineer:

… Designs useful product and processes for society based on all disciplines but mainly Science and Math.

Science: Finding the patterns in nature

Mathematics: The language to describe the patterns and the engineering design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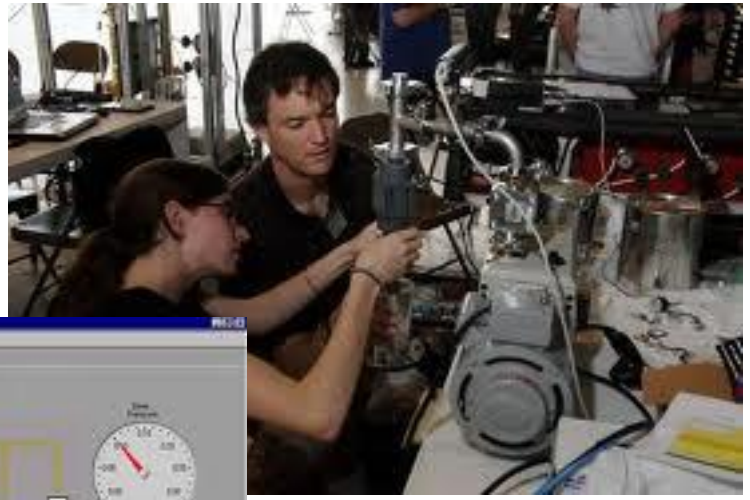
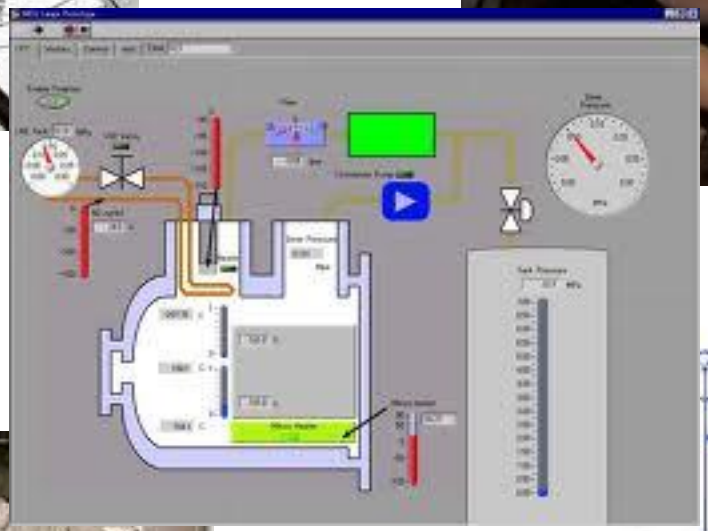
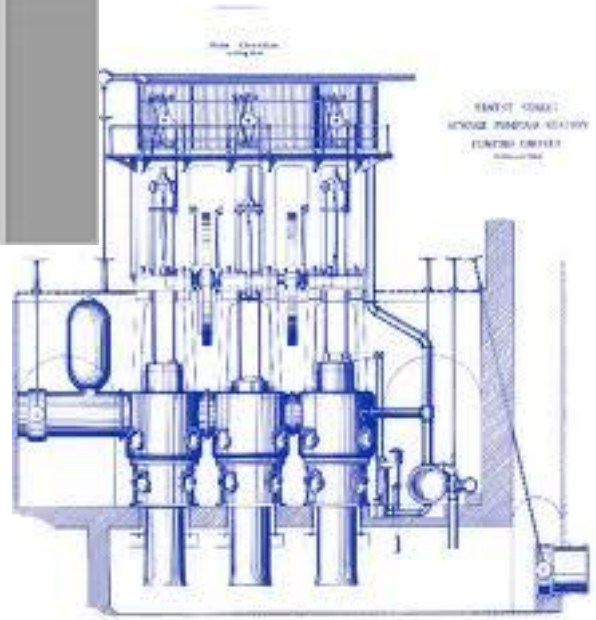






Two Options?

- Do A Story over a series of afternoons
- Find a BUG and design an artifact for it.

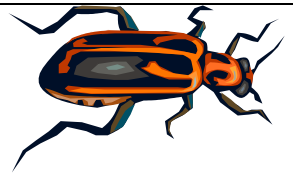
Common elements

- Frame the problem, gap
- Lots of ideas
- Shaping
- Convergent
- Sketching
- Testing
- Presenting

After school activity

Creative Exercise

Bug List Exercise



Purchase a small notepad, and carry it with you throughout the next few weeks.

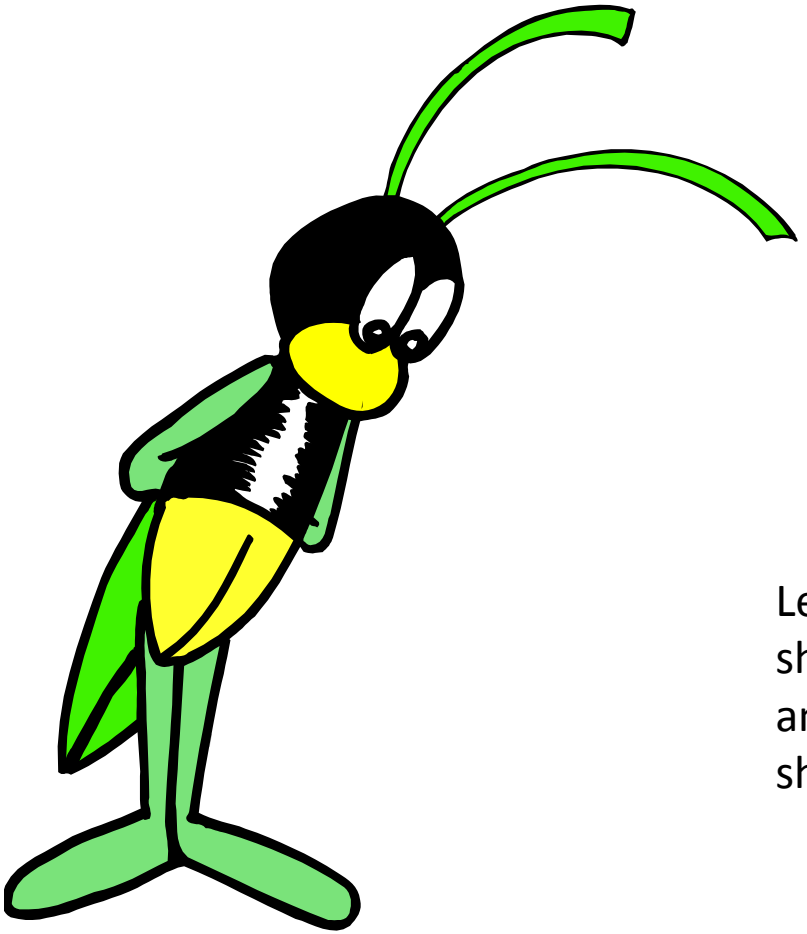
Every time you observe something that "bugs you" – something that doesn't work right, or that you think could be improved – jot it down in your notepad. You don't need to limit this to technological artifacts.

For example, you might jot down "I never know if my alarm clock is actually set", but you might also jot down "My son never tells me when he is coming home", or "Wet newspaper this morning!".

Your objective here is to become more conscious of the things around you that could be improved.

Take the "Bug" and use it as the problem to solve or fix

Lets start with a bug



Does the word BUG have two meaning?

YES… We talk about a bug as an insect or a problem I have.

Lets discuss with your partner (do a pair-share) exercise and discuss what Bugs you and as a team decide on what one you will share with the class.

Why do I want to do this project?

- Its fun
- Make lots of money
- See if I can do it

What are some BUGS you experience?

Examples of Bugs I might have

- When we come up with a good game and there are not enough friends present to play it.
- They lock the playground when we want to play
- Can’t get the batteries out of my game to change them
- I can’t open my water bottle when I want too.
- I can’t see the ball when somebody throws it to me.
- My shoe lace (Velcro) comes untied when I am running
- My pants slip down when playing.
- How do I get this water bottle to shoot up in the air?
- I can’t carry a heavy item very far
- I can’t build a good kite
- My father gives me a peanut butter sandwich every day.
-

Example

"It bugs me when my coffee gets cold."

- Needs

Divergent (**Lots**): Generate raw ideas

Use solar power!

Only drink Tea!

Convergent **(narrow)**: Define requirements

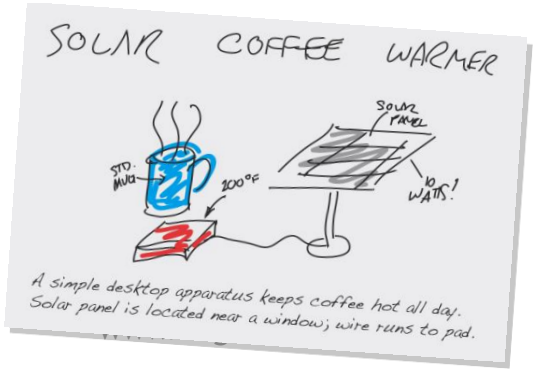
Food Warmer
REQUIREMENTS

The design should...
Be no larger than...
Cost no more than...
Keep Food at...

- Requirements

Divergent: Generate alternatives

Convergent: Select an approach



- Specification

Why Interdisciplinary Learning

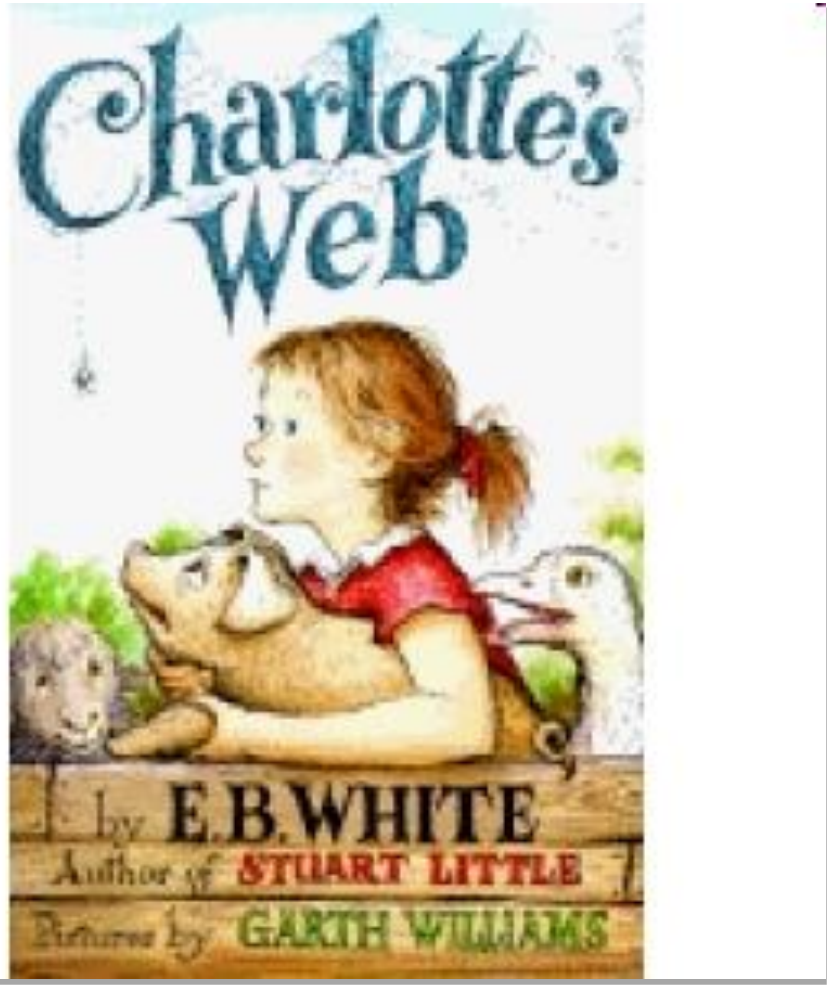
- Life is interdisciplinary and innovation crosses boundaries.
- Children see the relevance of math and science when done in a project
- Exposes children to 21st century skills of problem solving, collaboration and thinking skills

National Academies of Engineering report, Engineering in K-12 Education (2009), highlights the need to avoid a "silo" approach to engineering by integrating with other subjects

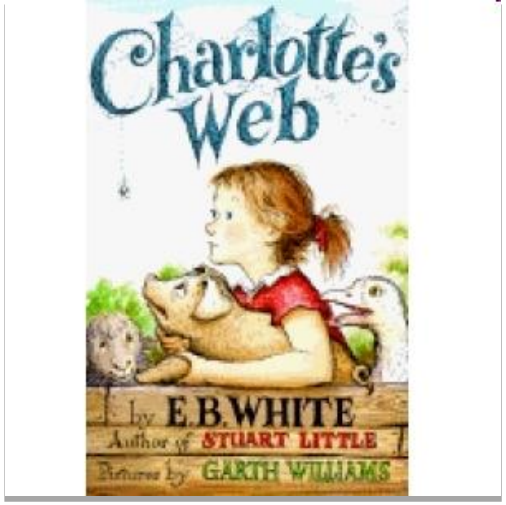
EngineeringLens

Charlotte's Web by E.B. White

Fern
Wilbur
Charlotte
Templeton
Mr. Zuckerman



Charlotte's Web by E.B. White



Design Challenges:

- Killing of the runt P1
- Keeping warm at night in the yard. P9
- Mr. Zuckerman knew that a manure pile is a good place to keep a young pig P14
- Wilber was lonely, he wanted love P27
- Have you ever tried to sleep while sitting on eight eggs asked the goose. P33
- "I happen to be a trapper", says Charlotte P39

Note: just thru pg 39 out of 184

Charlottes Web

Challenge	Math	Life	Earth & Space	Physics & Chemistry	Simple Machines	????
Keeping warm at night						

Use manure

Build a house

Use a fire

Use a ramp to lift him off the ground

Give him more food to eat

Use temp. probe

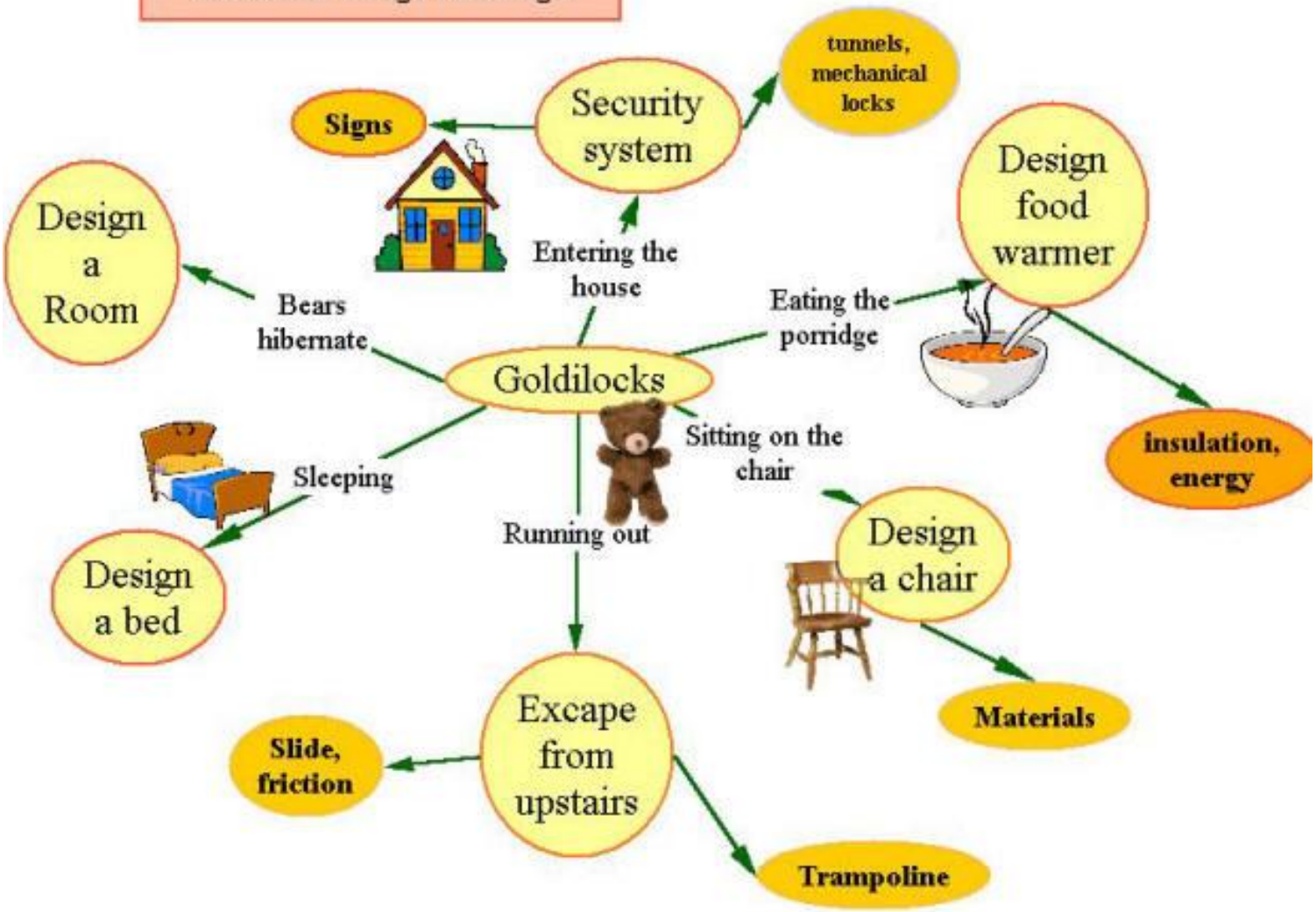
Goldilocks

Design Challenges :

- Breaks into the house
- Finds the food cold or too hot
- Breaks a chair
- Finds the beds not comfortable
- Escapes by jumping from the house.

Did not find a room for the bears to hibernate.

Goldilocks Design Challenges



Bill Wolfson. 9/16/09

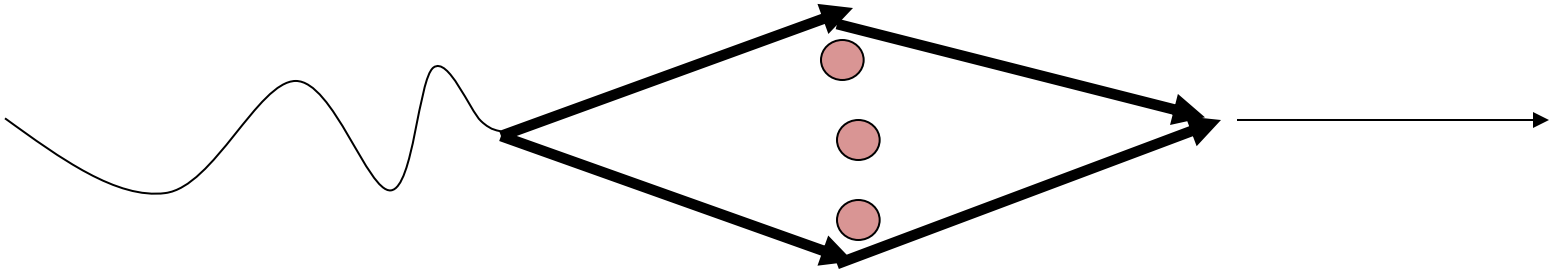
The Watsons go to Birmingham by Christopher Curtis

- Designs for the Brown Bomber
- Design a device to protect against drowning in the lake … Getting caught by “Wool Pool”
- A social system for riding a school bus without being picked on
- Getting young students to be excited about learning
- Keeping the house warm
- A system to share toys without them being taken.
- Catching the Turtle
- Designing something to keep a driver awake
- Create a concept for a motel chain that welcomes all people.

The students of the future should be able to:

- Solve problems
- Think creatively
- Think critically
- Collaboration
- Make decisions
- Generate new ideas
- Analyze information
- Plan for the future
- See science, engineering and mathematics as exciting careers.

Summary Process

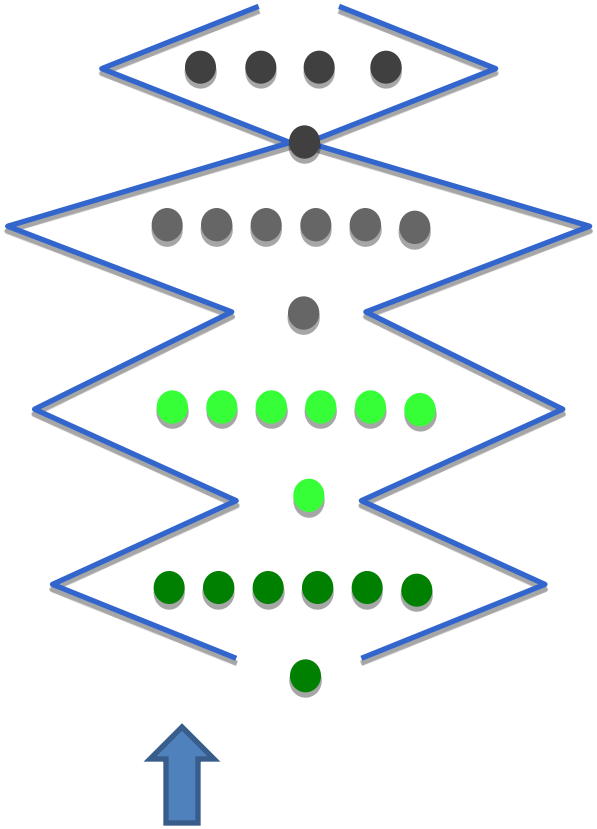


Priming	Generative	Convergent	Defining
Story Mapping	Brain Writing	Discussion of Pro/Con	Gallery Sketches
Needs	Morphological Analysis	Shaping	Modeling/Building
Problem Framing	Shaping	Requirements	Posters
Values	Brain Storming	Decision Matrix	Presentation
OTHERS (science constraint)			

Listen to the needs and values of the customers

- **Generate raw ideas for a given challenge**
- **Select an idea that is particularly interesting**
- **Identify the requirements for that concept**
- **Come up with multiple solutions that meet the requirements**
- **Select a solution, based on the requirements**

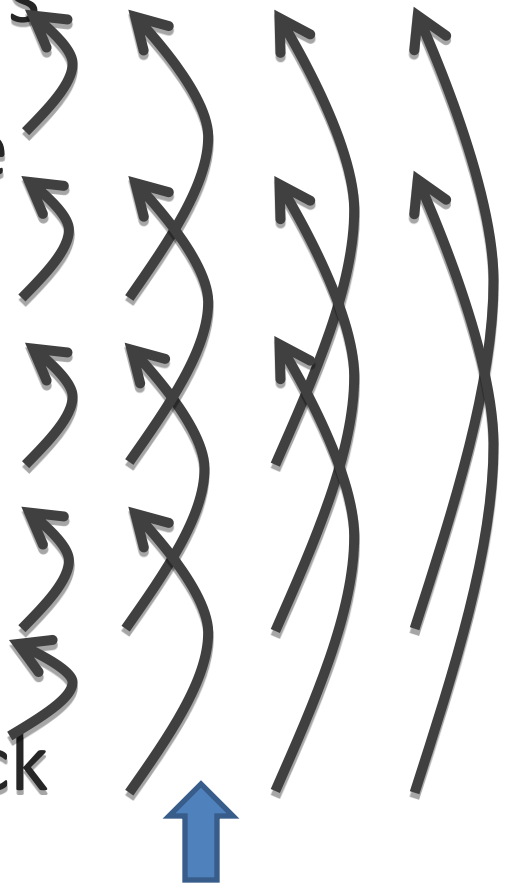
Connecting literature or Social Studies/History



Divergent/Convergent thinking

- Story/Characters
- Design Challenge
- Specification
- Designs
- Product
- Testing/ Feedback

Reporting

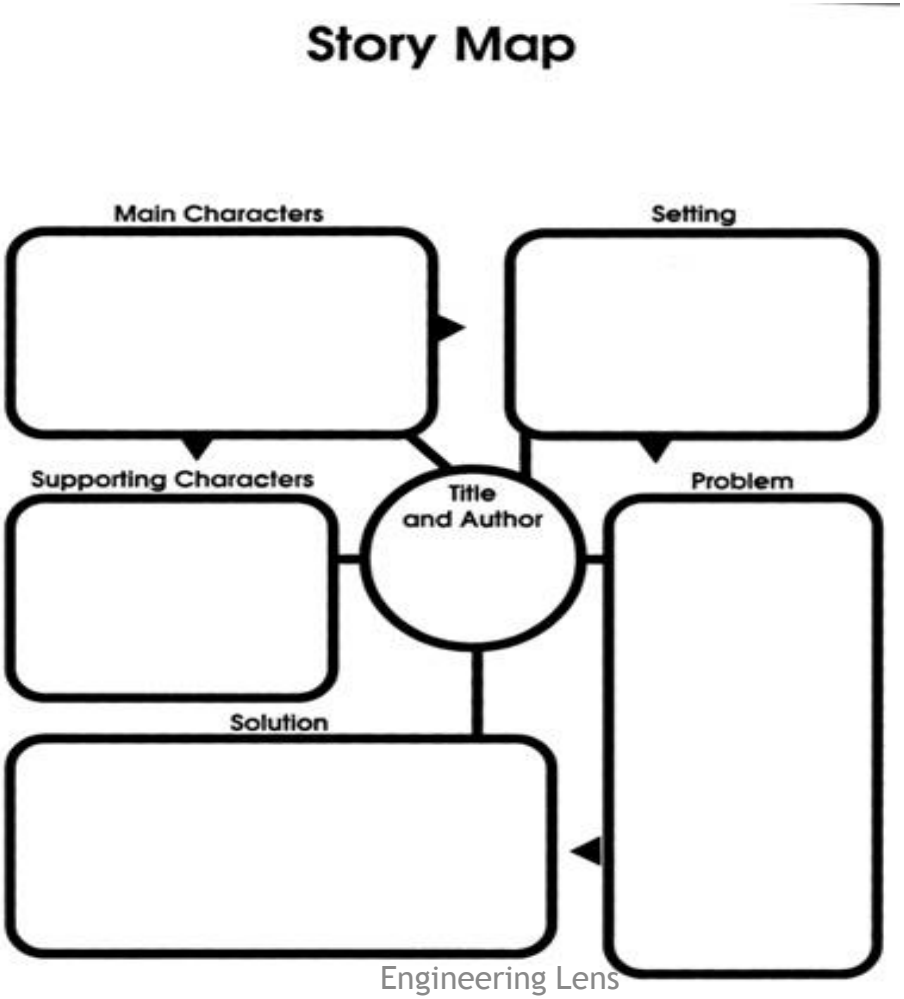


Iterative process

Mark Somerville .. Olin College

Find design challenges in Stories

'We are continually faced with a series of great opportunities brilliantly disguised as insoluble problems". John W Gardner



Engineering Design Challenge

Design Process & Thinking Skills

Tools of the Engineer

How are Thinking Skills the tools of engineering ?

Thinking Skills

Watch for the following uses:

- Creative thinking
- Critical thinking
- Reflection
- Questions

Thinking Strategy; to put them in action

Do a story

1. Listen to the needs and values of the characters in the story
2. Generate raw ideas for a given challenge
3. Select an idea that is particularly interesting
4. Identify the requirements for that concept
5. Come up with multiple solutions that meet the requirements
6. Select a solution, based on the requirements

What makes a good design challenge?

- Fun
- Solves a real problem
- Tied to science and math
- Can be done with paper or using simple materials
- Can create many learning extensions from it
- Can add your requirements to change the location or theme to suit your learning needs

Find the Design Challenge

Identify Needs/Problems in the Story ("Design Challenges")

Activity: In your teams, take 10-15 minutes to generate a list of needs/challenges in the story. These are problems that the characters in the story are having, opportunities to make things better, etc.

Who are you going to work for?

What's the real Design Challenge/ Problem?

You as the teacher can also do the following:

Change where the story takes place to enhance the learning:

IE studying about earthquakes you can move the location to the San Andrea fault area

3-Pigs Variation

- How do we design a house to also protect against the weather?
- The pigs move to an earthquake zone, build a house to protect them from earthquakes as well
- The pigs live in Outer Mongolia , What type of house would they build?
- You work for the wolf, design a suite that can protect the wolf when it goes down the chimney ; design a machine that can be used to create air pressure to blow the houses down.
- You live in a community that wants to provide a nice living space for its Pig population, what would you design and why? What would you do with the wolf population? Can you apply this to humans?
- Build house on hill and use rollers to knot down the wolf
- Build house on hill in the shape of a triangle so wind can hit only corners.
- Design a house with a strong foundation and internal structure.

Extra activities:

- Invite a parent who works in the construction industry to talk about materials and building a structure
- Draw pictures of the scenes and do role plays around the story with the engineering.
- Create a game around the story.

3-Pigs

Challenges	Materials & Energy Resources	Systems in Living Things	Position & Motion of Objects	Simple Machines
				
Build a house on a hill	Build a house			Use a ramp to roll rocks to knot the wolf off
Build a manure moot around the house (smell & energy)		Use manure		
Design food for the wolf that looks and tastes like a Pig		Give him more food to eat		

Select your “Design Challenge”

- In your teams, select the design challenge that you are most excited about solving.

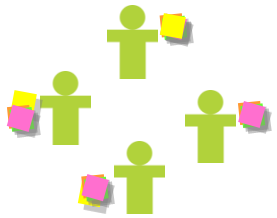
- Think about a Design constraint of Science.
  - What have you just finished or what are you planned to study?

Find Ideas … Divergent Thinking

Take 20 min. to do some brain-writing

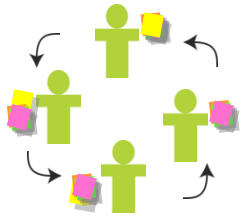
Generate Possible Solutions using Brain-writing

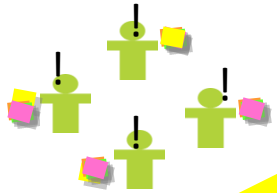
Starting with 4-5 generative framings…



Each team member generates
3-4 ideas on their own.

Pass ONE of your ideas to your right.





Read your neighbor's idea, and generate
an idea that is somehow inspired by it.

One idea per card or sticky note!!

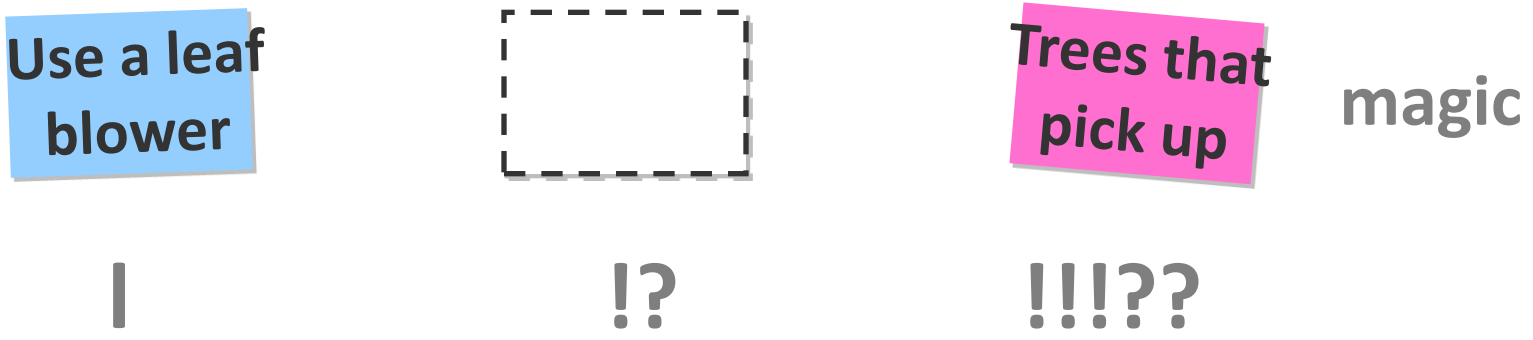
Repeat until time is up.

Shaping Ideas

Why generate crazy ideas?

So you can shape the into innovative ideas!

Leaves falling on the lawn…



Now Shape your ideas!

- Map (i.e. mundane, magical) and shape your ideas from brain-writing.
- Remember that you can shape ideas to meet constraints and values
- Choose 2-3 “favorites”, taking values and constraints into account. Create stretch’s ideas
- Be bold!
- Be prepared to share!

Take 15 minutes to sort and select

Selecting one or two Ideas

Converging

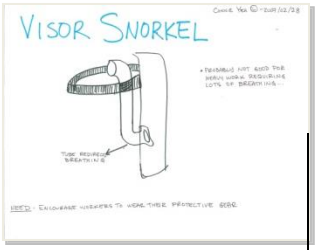
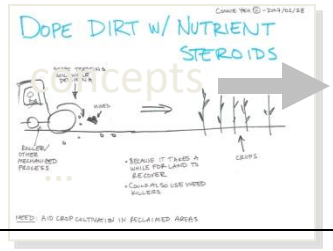
- Discussion: During the design process or problem solving we need to apply convergent thinking to narrow our option to a selection. When we have many options and are not comparing any to an existing one, the best option is to create a decision matrix where we establish a set of judgment criteria down the Y axis and weight each to its importance to judge our possibilities.

- If we are looking to compare our options against an existing choice, we can use the Pugh-method to compare against whether the criteria are better (+), less (-) or the same (S). this allows us to see where on is better but also what still are open items that can be improved.

Take 15 minutes to sort and select

concepts

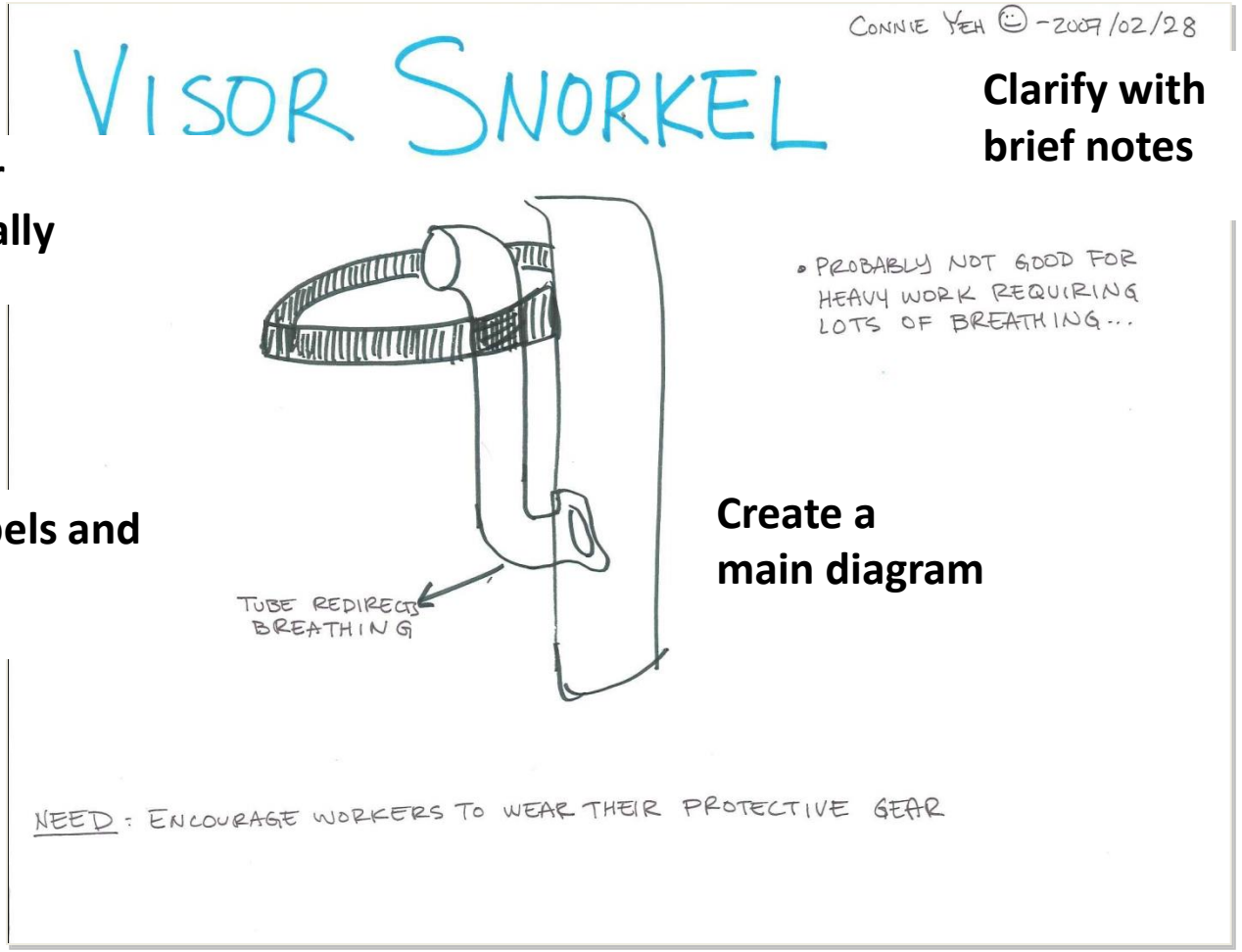
requirements

Requirement	Weight		
environment			
simple			
low cost			
Total=			

Build Sketch Models!

As a team, make three gallery sketches of possible solutions.

In pairs, make gallery sketches of possible solutions



Use color functionally

Clarify with brief notes

Add labels and arrows

Create a main diagram

Sharing

Group to share the following:

Testing approach

Their design

What science is contained in the design

Presentation of Design Solutions

- Description of need/problem addressed
- Who the intended user(s) of the product would be
- How science constraints are utilized in the solution
- Description of other requirements that were identified
- Presentation of solution sketch/model and description of how it works
- Additionally each group should comment on how the team worked together to get everything done and any challenges encountered
- *And how they resolved the challenges*

Connection to reading, social studies

Connections between engineering, writing and reading

Engineering Design Process	Writing Process	Reading Strategies
Identify Problem	Set purpose for writing	Set purposes for reading
Research	Research: read target book, learn about key concepts, and ask questions	Introduce concepts and information needed for comprehension
Brainstorm	Brainstorm	Ask guiding questions; activate background knowledge
Choose and plan	Choose a topic, plan, organize ideas	
Create	Draft	Read and monitor understanding
Test	Get response to text (peer, teacher, target audience)	Clarify understanding as needed, evaluate text for veracity or completeness
Redesign	Revise	Re-read for understanding or read another book for additional perspective/ information. Evaluate whether an established purpose was met.
Share	Share/Publish	Discussion, poster or various writing assignments

Kathleen Spencer; Tufts, 2011

Social Studies/ History

Finding Design Challenges;

Use books to also cover the social studies themes as defined in the framework.
When choosing your book, you can integrate Social Studies/History by picking books with themes that track the **Social Studies/History Framework**
Pre-Kindergarten–Kindergarten: Living, Learning, and Working Together
Grade 1 : True Stories and Folk Tales from and from Around the World
Grade2: Unum: From Many ,One
Grade 3 : and its Cities and Towns: Geography and History
Grade 4 : North American Geography with Optional Standards for One Early Civilization
Grade 5 : United States History, Geography, Economics, and Government: Early Exploration to Westward Movement
Use books to also cover the social studies themes as defined in the framework.

Examples

- Water treatment systems
- Organizing fire systems for towns
- Transportation systems

- What made up a home in the time you are studying?
- Forecasting the weather

- Move story to geographic area you are studying

Reflection and questions

End
Thank you