Introduction

- Bill Wolfson, BSEE, MS
- Introduce each other

- What do YOU want to get out of this Presentation?

- Review, Reflection, Next Steps

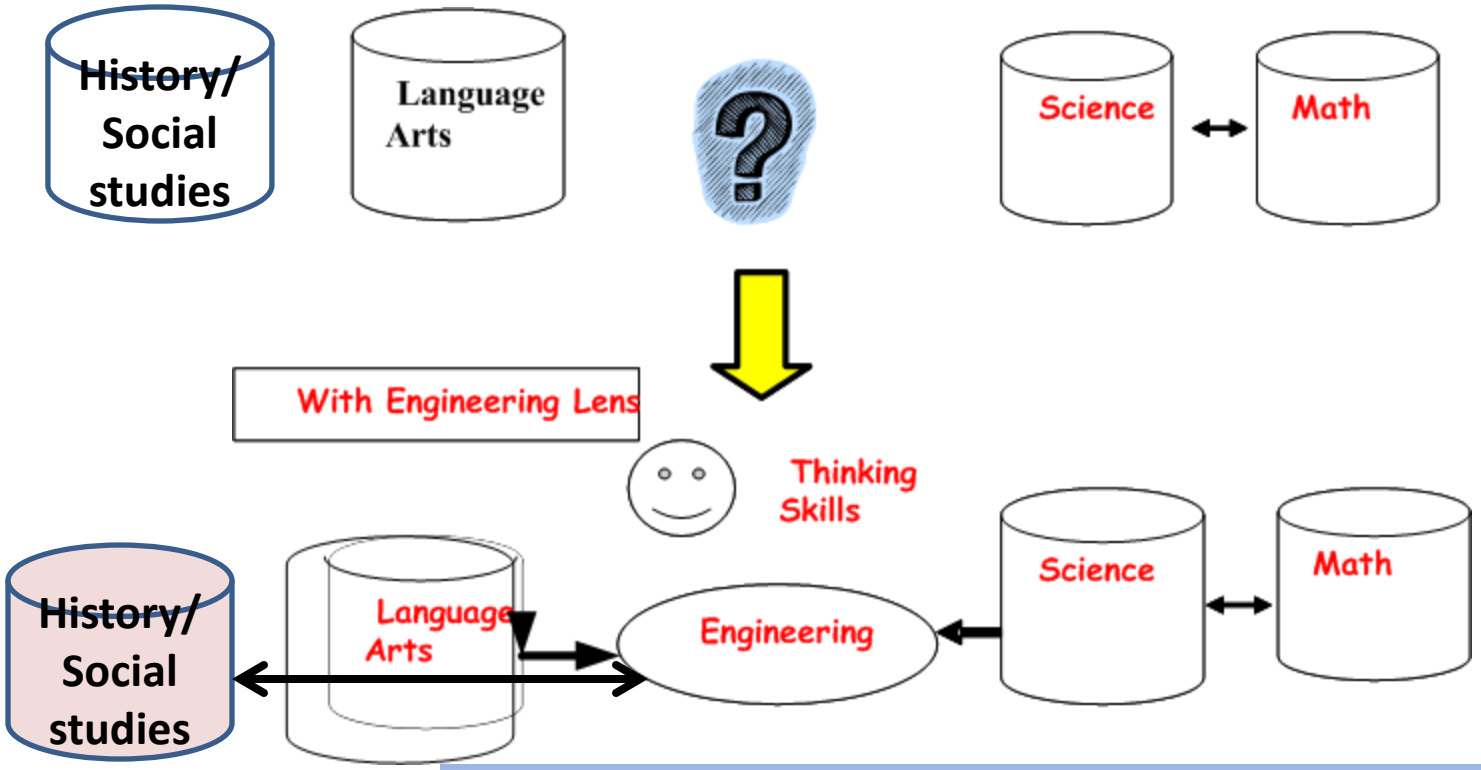
What is different in Next Generation Science Standards(NGSS)?

(NGSS) is a commitment to fully **integrate engineering design**, technology, and mathematics into the structure of science education by raising engineering design to the same level as scientific inquiry when teaching science disciplines at all levels, from kindergarten to grade 12.

This new integrated approach to science education is sometimes referred to by the acronym STEM.

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

Definitions:

- **Engineers** design useful products & processes for society using all disciplines but mainly science and mathematics. (composite)
- **Science** is about explaining patterns in the universe. (composite)
- **Mathematics** is the language to manage/explain a design & account for the patterns in nature. (composite)

- **Entrepreneurship** is the practice of starting new organizations or revitalizing mature organizations, particularly new businesses generally in response to identified opportunities. The behavior of the entrepreneur reflects a kind of person willing to put his or her career and financial security on the line and take risks in the name of an idea, spending much time as well as capital on an uncertain venture. (Wikipedia) **Creating value where there was none!**
- **Artist:** a person whose creative work shows sensitivity and imagination. A follower of a pursuit in which skill comes by study or practice - the opposite of a theorist. people who use imagination, talent, or skill to create works that may be judged to have an aesthetic value. (Wikipedia)
- **Technologies** (products and processes) are the result of engineered designs. They are created by technicians to solve societal needs and wants. (Science Framework)

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

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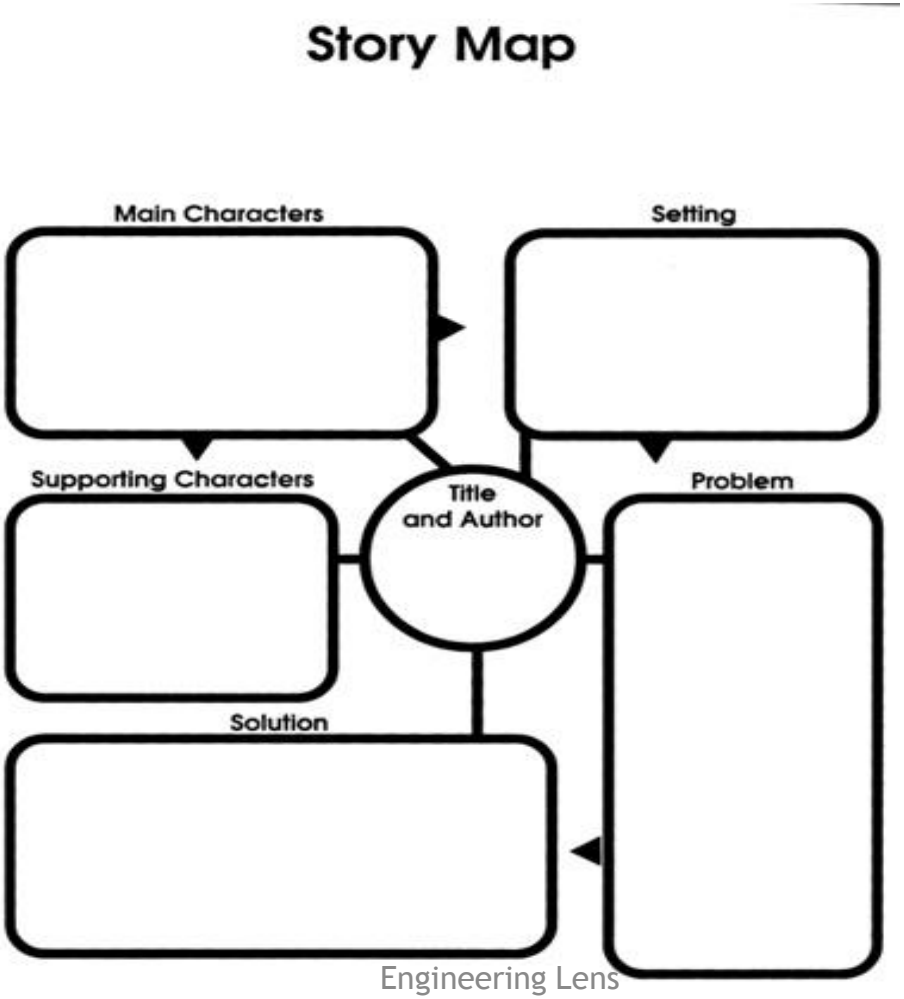
Find design challenges in Stories

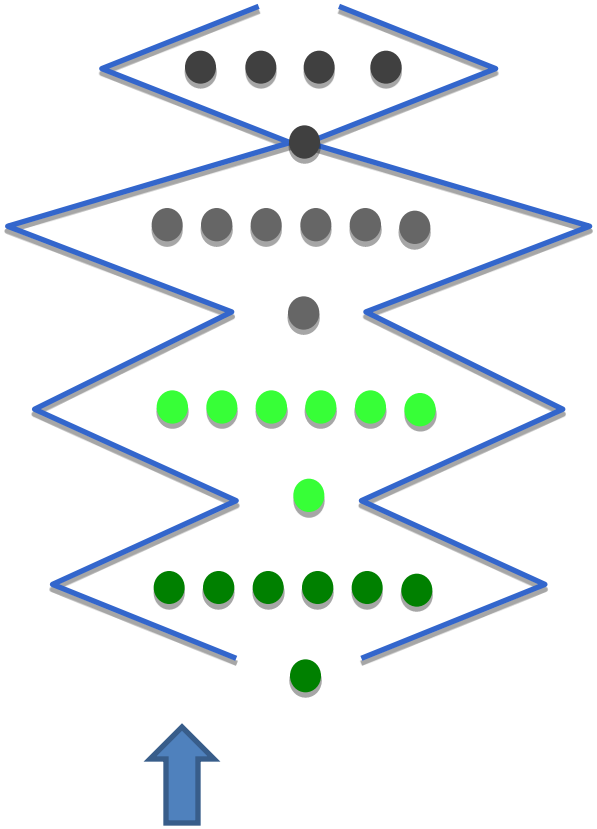
'We are continually faced with a series of great opportunities brilliantly disguised as insoluble problems". John W Gardner



Engineering Design Challenge

Design Process & Thinking Skills

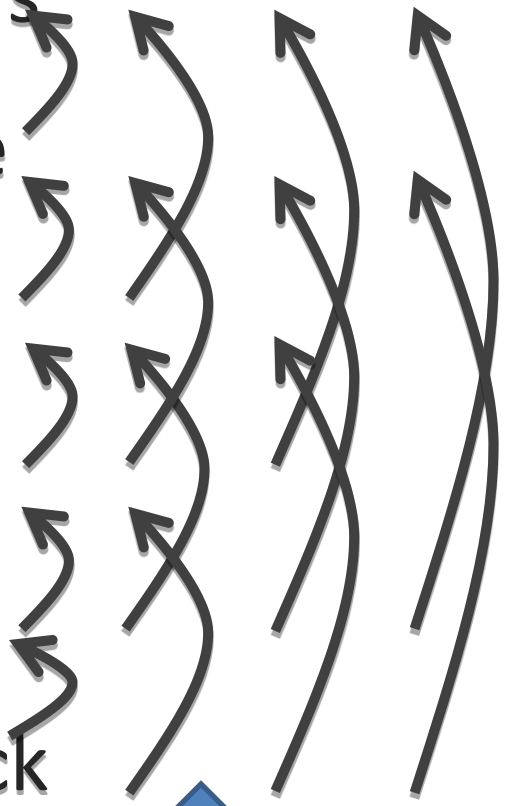
Connecting literature or Social Studies/History



Divergent/Convergent thinking

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

Reporting



Iterative process

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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,

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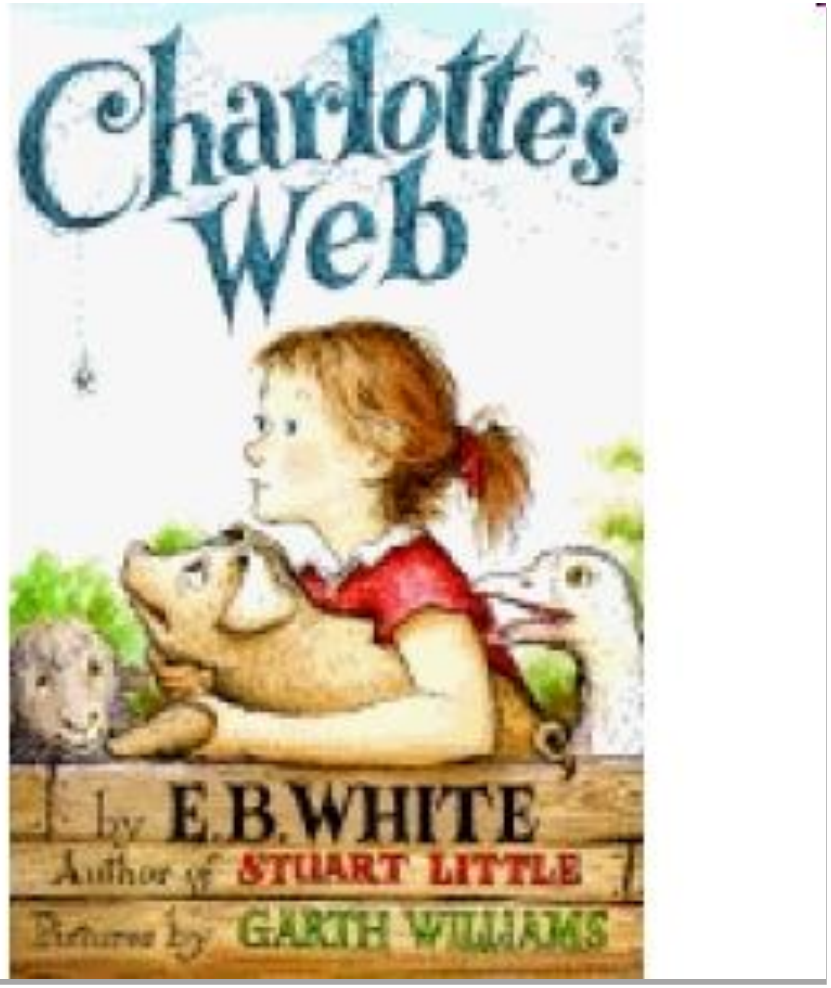
Charlotte's Web by E.B. White

Fern
Wilbur
Charlotte
Templeton
Mr. Zuckerman



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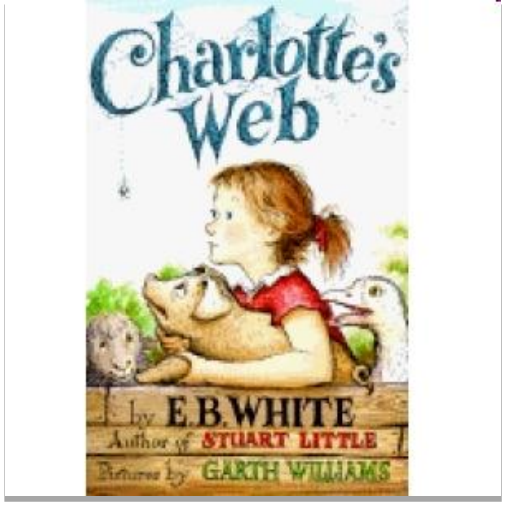
Charlotte's Web by E.B. White



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

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Let's Generate some ideas for Design Solutions!

Design challenges	Sciences	Filters	Results
	Earth & Space	Energy in the Earth System Materials and Energy Resources Earth process and Cycles Structure of the Earth Earth in the Solar System	
	Life science	Characteristics of Living Things Systems in living Things Heredity Evolution and Biodiversity Living things and their environment	
	Physic & Chemistry	State of Matter Position and motion of objects	
	Engineering	Tools Materials Engineering Design	

www.engineeringlens.org

How to support different modes of learning

Design Process Step	Auditory	Visual	Kinesthetic
Identify Need	Discuss/Brainstorm; Listen for issues that bother people	Look around; pay attention to signs of problems	While walking around, keep a journal of "bugs"
Research the Need/Problem	Listen to Podcasts; videos	Reading/internet; videos	Interviews; experiments
Develop Possible Solution(s)	Record brainstorming sessions	Brainstorm - draw pictures/ idea maps	Brainstorm (while experiencing need)
Select the Best Possible Solution(s)	Debate/discuss	Create a visual to represent pros/cons	Write list of pros/cons
Construct a Prototype	Describe how the prototype should be constructed	Create a visual to represent the prototype	Construct – hands on
Test & Evaluate Solution(s)	Ask for feedback: conduct focus group	Write up test plans	Test it out
Communicate the Solution(s)	Articulate the solution	Make a visual to communicate the solution	Demonstrate the solution
Redesign			

How?

- Interdisciplinary learning
- Engagement & Ownership
- Professional Development and follow up
- Web based repository

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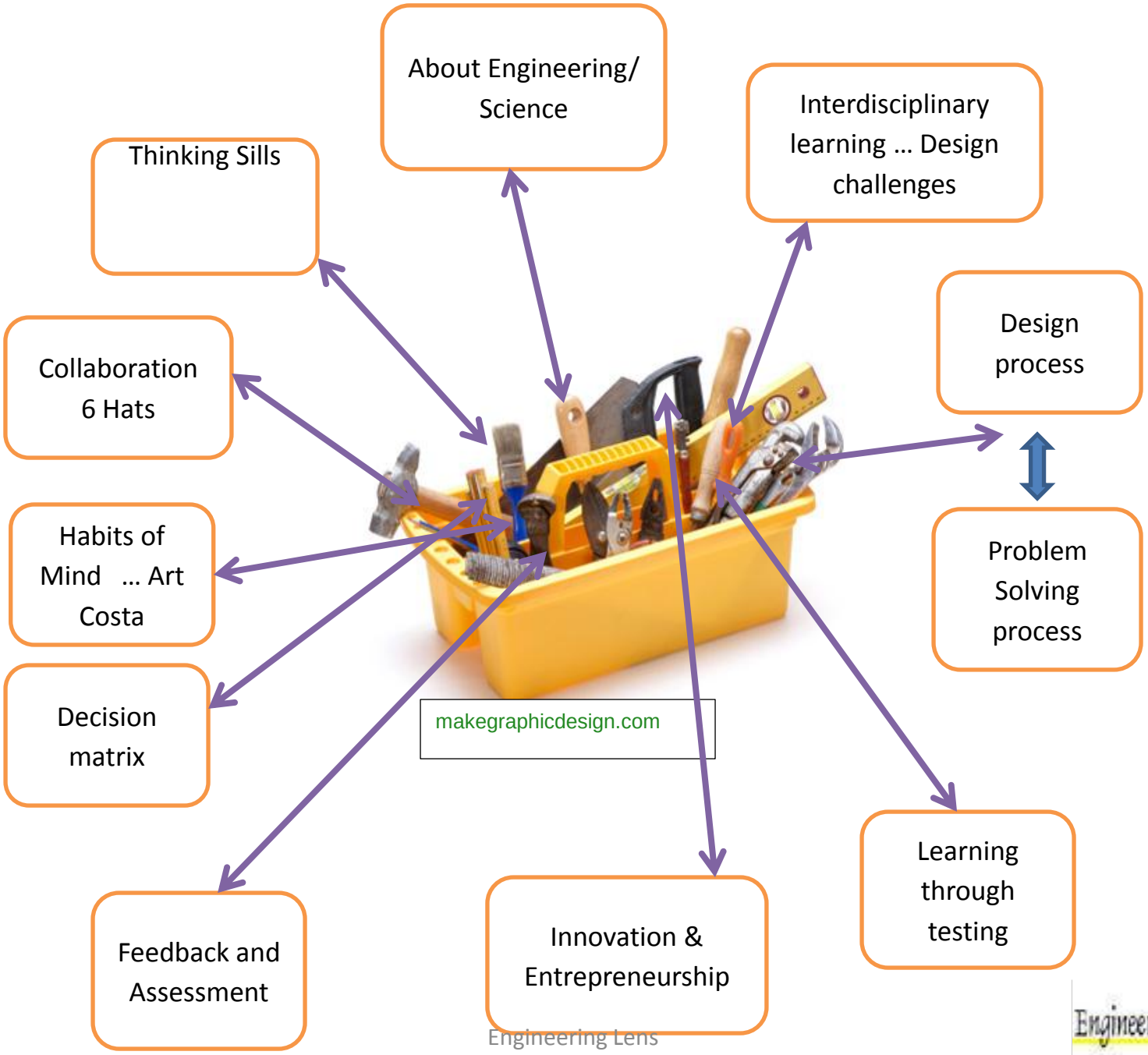
Connection between Literature and Engineering

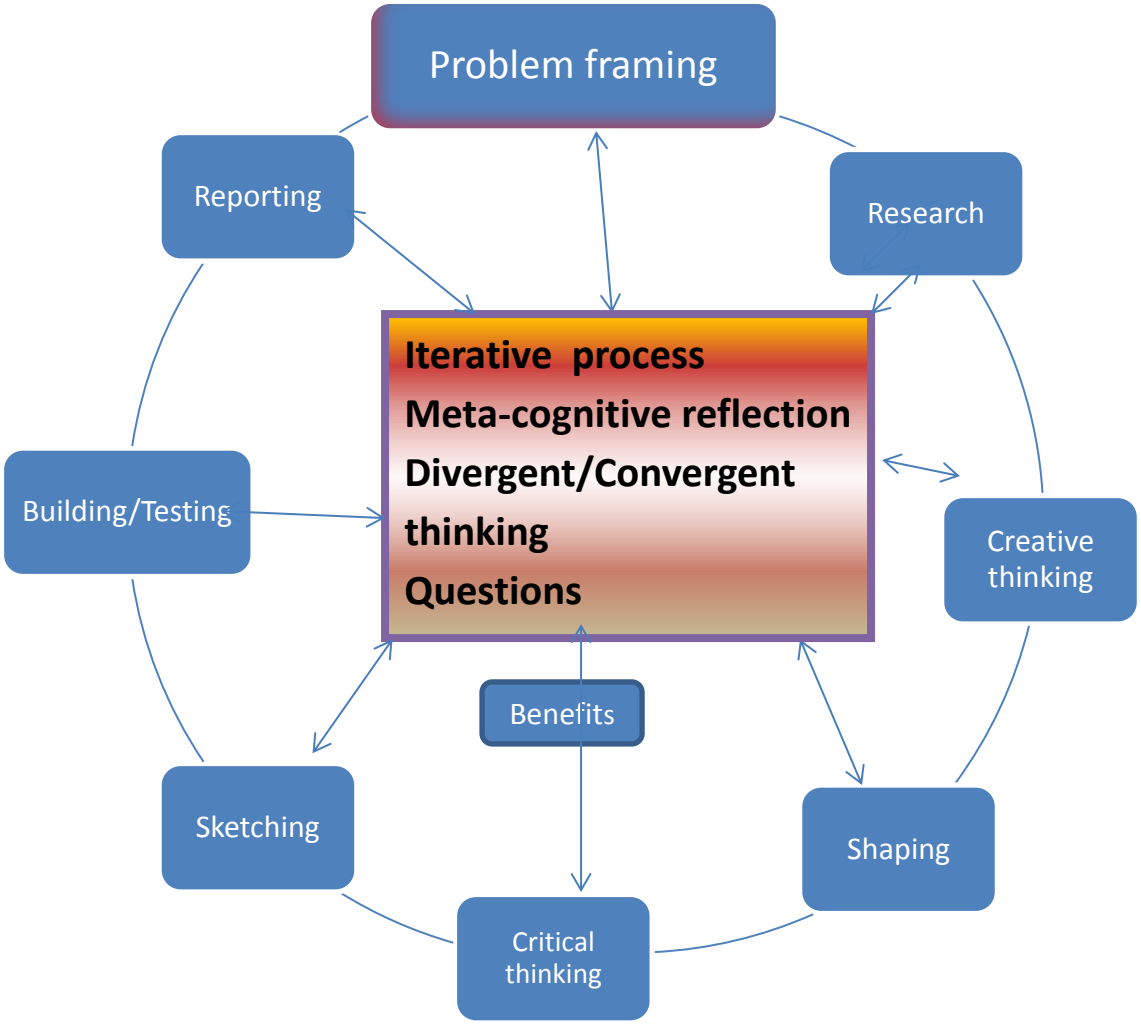
Engineering	Writing	Reading
ID problem	Genre of writing topic	Protagonist's problem
Research	Personal com. Research	Evidence
Generate ideas	Story mapping, pictures, writing	Make predictions
Converge/ plan	Outline	Inferences & connections
Create	Rough draft	Disc (plan for) questions
Test	Per conf. – read aloud to self	Respond, challenge
Redesign	Revise	
Share	Publish- Author's chair	Character's changes

The Engineering Toolbox for Continuous Learning

- Collaboration… 6 Hats
- Thinking Skills… Creative and critical thinking, questioning and meta-cognitive reflection
- About Engineering/Science/Math …Engineering is everywhere
- Problem Solving process
- Design process
- Interdisciplinary learning … Design challenges
- Decision matrix
- Feedback and Assessment
- Learning through testing
- Innovation & Entrepreneurship
- Habits of Mind … Art Costa


About Engineering/ Science
Interdisciplinary learning … Design challenges
Thinking Sills
Design process
Collaboration 6 Hats
Habits of Mind … Art Costa
Problem Solving process
Decision matrix
makegraphicdesign.com
Learning through testing
Feedback and Assessment
Innovation & Entrepreneurship

Design/ Problem solving process



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Tools of the Engineer

How are Thinking Skills the tools of engineering ?

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Use of the mind to form thoughts, to reason, to reflect. Translating thoughts into actions

Thinking Skills

Foundation and Objectives

- Objectives
- Foundation
- Learning outcomes

- awareness of themselves as thinkers and learners
- practice strategies for effective thinking
- develop the habits of intelligent behavior that are needed for lifelong learning

Connected to the Disciplines / Common Core

- Literature
- Science
- Mathematics
- Social Studies/ History
- Art/Music

Society Needs

- Industry
- Traits
- Society

provides students opportunities to develop **character traits** such as **personal responsibility, self-respect, respect for others and trustworthiness**—all essential to overcoming social skills deficits.
... *George Rogers*

What is Thinking?

- Benefits
- Thoughts Can
- Visible

Learning Environment

- Culture
- Centers of Learning
- Society

Elements of Thought

- Questioning
- Meta-cognitive reflection
- Creative thinking
- Critical thinking
- System thinking

Levels of thinking

- Bloom(new)
- Marzano
- Higher/ Lower order

Thinking does not occur spontaneously but must be evoked by problems and questions or by some perplexity; confusion or doubt
... John Dewey

Critical Thinking * **Analyzing the past** * **What evidence?** * **What is the author's purpose?** * **Convergent thinking** * **Skepticism is a virtue**	**Creative Thinking: Creativity improves pupils' self-esteem, motivation and achievement** * **Brain storming** * **Divergent thinking** * **Exploring your environment & testing many options** * **Stimulate curiosity** * **Innovation & entrepreneurship**
Meta-cognitive reflection * What do I want to understand? * What have I learned? * What do I still need to learn? * Provide feedback for reflection * Regulate ones behavior	**Questions … Engaging the student** * Logical Sequential * Open ended * Listening is the first step in good questioning * Provocative * Engage * Encourage higher order thinking

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Teaching through Assessment and Feedback

- Gives teachers a number of thinking-centered lenses through which to examine students' thinking and understanding performances.
- Teaching thinking through assessment helps provide teachers and students with a common set of tools they can use to communicate and articulate their ideas about what's good and not so good about their thinking.
- Assessment can be a powerful approach for teaching thinking as well.

Project Zero ... Harvard Graduate School of Education

What about us?

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Activities www.engineeringlens.org

- Created Syllabus for 3 credit course (FSC)
- One-credit on-line course FSC
- First major implementation in Millis Public Schools (9/2009 to 1/2010), Hopedale, Milford
- Working with K-12 outreach at WPI
- Created on-line learning site in Moodle Learning software
- With Tufts CEEO, have won a NSF research grant(DRK-12) based on this concept.
- Have done one and two day workshops

Call to Action

1. Started as a life goal to get children excited about engineering careers.
2. Team of academics, school teachers and a few retired engineers.
3. Goal is to create curriculum for PD for educators, assessment in urban, suburban and rural school districts.
4. Sustainability model is:

- taught as supplemental curriculum to teachers in college
- interactive web site for collaboration
- ownership by major NP education corp.

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Syllabus 3 credits PD

Mon	Tues	Wed	Thurs	Fri
Teachers as students	***Teachers as learners***	***Teachers as learners***	***Teachers as teachers***	***Teachers as teachers***
Intro to Engineering	Continuation of The 3 Little Pigs	Owl Moon	What makes a good book?	Build models
6 Hats Exercise	Building Mockup	Shaping Requirements	Choosing a book	Review/ reflection
Using artifacts to show **engineering is everywhere**	Reflection	Morphological analysis	Development of lesson plans	Presentations
The 3 Little Pigs using the design process	MA Frameworks (Science/ Engineering)	Measuring Success, assessment strategy	Create sketch models	Other activities using Design Thinking
	Connecting Math & Science: Charlotte's Web	Developing thinking skills:	Assessment/Feedback	Planning
			21st Century Skills	Celebration/ reflection

Feedback from the teachers

Important learning/changes participants will make to their teaching:

- Divergent and convergent thinking
- Integrating the design process with thinking skills, science, math, and literature
- Connecting the engineering framework to my teaching
- Engaging students in looking at multiple aspects of problems and solutions
- Will ask my students more questions rather than giving them answers
- Will engage students more in their learning
- Will use more self-assessment
- Brain writing technique
- How to reach all learners
- Will encourage more creativity

What participants liked about the course:

- Safe learning environment
- Having a finished product (lessons to use in classroom)
- Hands-on learning
- Demonstration that the engineering design process can be used in the classroom
- Participants' feedback was welcomed and used to improve class
- Openness of presenters
- Engaging presenters
- Interesting materials

Post-Assessment Survey … Integrating Engineering & Thinking Skills

Total of 11 forms completed out of class of 11 … ***8/06/2010***

3. Have you seen how you can use engineering design to connect literature to science and math? **Little = 1 2 3 4 5 = Lots**	**8 … 5's** **3 … 4's**
4. Do you feel comfortable in describing what engineers do? Poorly = 1 2 3 4 5 = Excellent	8 … 5's 2 … 4's 1 … 3's
5. Comparing the beginning of the class to now, has your knowledge of engineering and the design process increased? Little = 1 2 3 4 5 = Lots	7 … 5's 4 … 4's
6. Can design thinking be used to engage your students in their studies? No = 1 2 3 4 5 = Very much	7 … 5's 3 … 4's 1 … 3's
7. Was this course helpful to you as a professional educator? No = 1 2 3 4 5 = Most important	8 … 5's 2 … 4's 1 … 3's

Find Ideas … Divergent Thinking

Shaping

Shaping Ideas

Ice Cream scooper's

Reflection and questions

End
Thank you

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