STEM Fundamentals

The Model #302 telephone was the standard for forty years.

How long will this one last?

Foundation Concepts for Teaching Problem Solving

Engineering Design

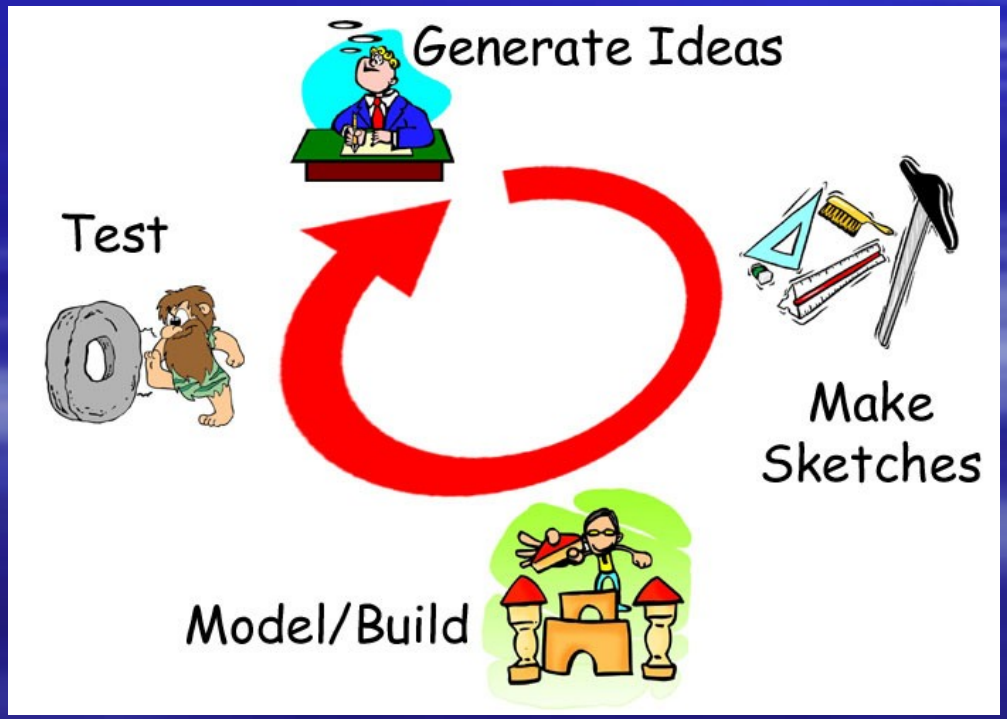
- "Design" is to Technology what "Inquiry" is to Science and "Reading/Writing" are to Language Arts
- Design is the core problem solving process
- Design problem solving extends learning beyond the classroom

The Design Loop

Different tasks to be completed

- Suggested, rather than prescriptive

1. Identify the problem
2. Investigating
3. Developing ideas
4. Refining the idea
5. Modeling/prototyping
6. Evaluating/assessing
7. Communicating

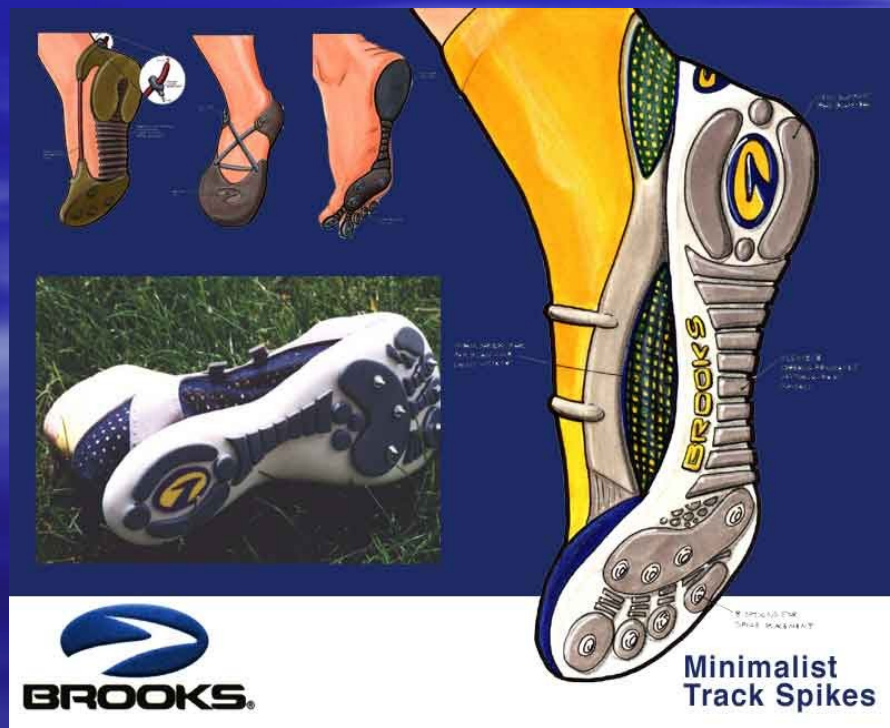


1. Understand the Problem

- Before attempting to solve the problem, we must:
  - Analyze the situation
  - Determine “what is the actual problem?”
  - Define the problem
  - Understand the problem

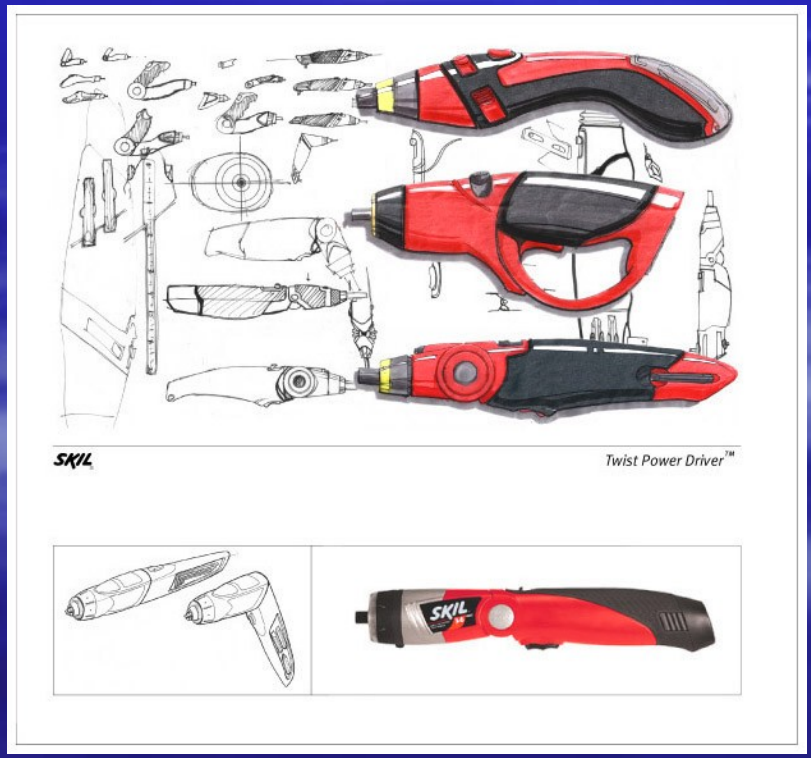
2. Investigate the Problem

- Explore possible alternative solutions
  - Conduct research
    - Past experiences and knowledge
    - Observations (examine similar problems/solutions)
    - Discussions with people who have faced similar problems (interviews, telephone calls, e-mail)
    - Search for new information (books, Internet, search of similar products)
    - Explore community resources (shops, businesses, museums, industries)



3. Develop Ideas & Potential Solutions

- Designers must ask questions
  - Brainstorm
  - Generate multiple ideas
  - Consequences (intended and unintended)
  - Identify alternatives
  - Consider constraints
  - Consider limits
  - Consider specifications
  - Consider risks/benefits



4. Refine & Detail Ideas

- Sketches and drawings
- Combining/separating ideas
- Assessing the potential of various ideas
- Generating specifications
- Idea selection
- Creating working and final drawings

5. Mock-ups, Models & Prototypes

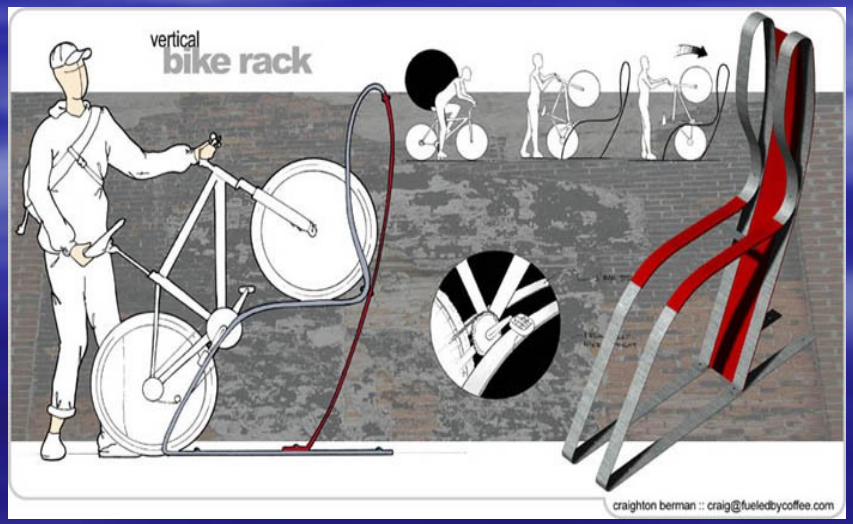
- Planning (tools, energy, time, money)
- Gathering materials and resources
- Fabrication (models, prototypes)
- Refinement
- Testing

6. Evaluation & Assessment

- Testing the solution
  - Did the product/system solve the problem?
- Evaluating the process
- What could be changed in the future?
- Is the proposed solution the simplest possible?

7. Communication

- Recording and presenting the idea
  - Drawings, sketches, graphs, materials lists
- Documentation of:
  - Major steps
  - Materials/techniques used
  - Discarded ideas
- Demonstration of proposed solution
- Future changes/ideas

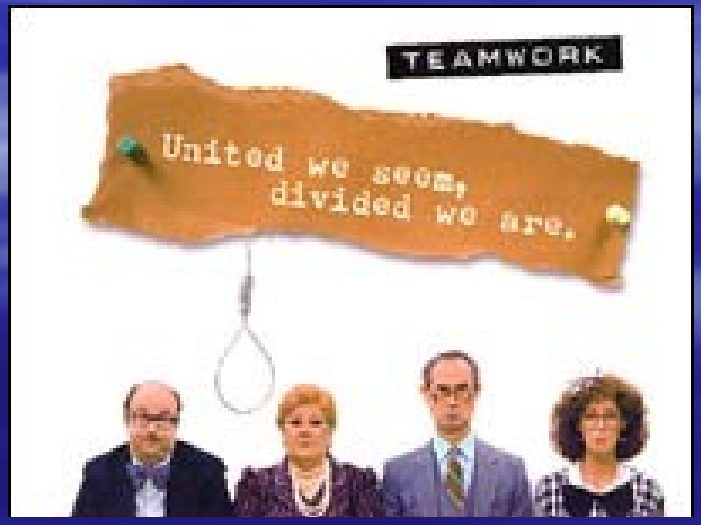


Applying Proven Solutions

- We call it “problem solving,” but it is really a process of applying proven solutions from our memory of experiences!
  - Allows the student to begin building that mental warehouse!

What do students learn by solving STEM problems?

- Contributing to the team
- Strategies for conducting research and solving problems
- Techniques for making models and prototypes
- Methods for assessing their own work
- Techniques for communicating team process and results



Methods Used to Deliver Engineering Design

- Engineering design is delivered in the classroom using technological problem solving.
  - Invention/Innovation
  - Research and Development
  - Experimentation
  - Troubleshooting
  - Design Problem Solving

Why use STEM Activities?

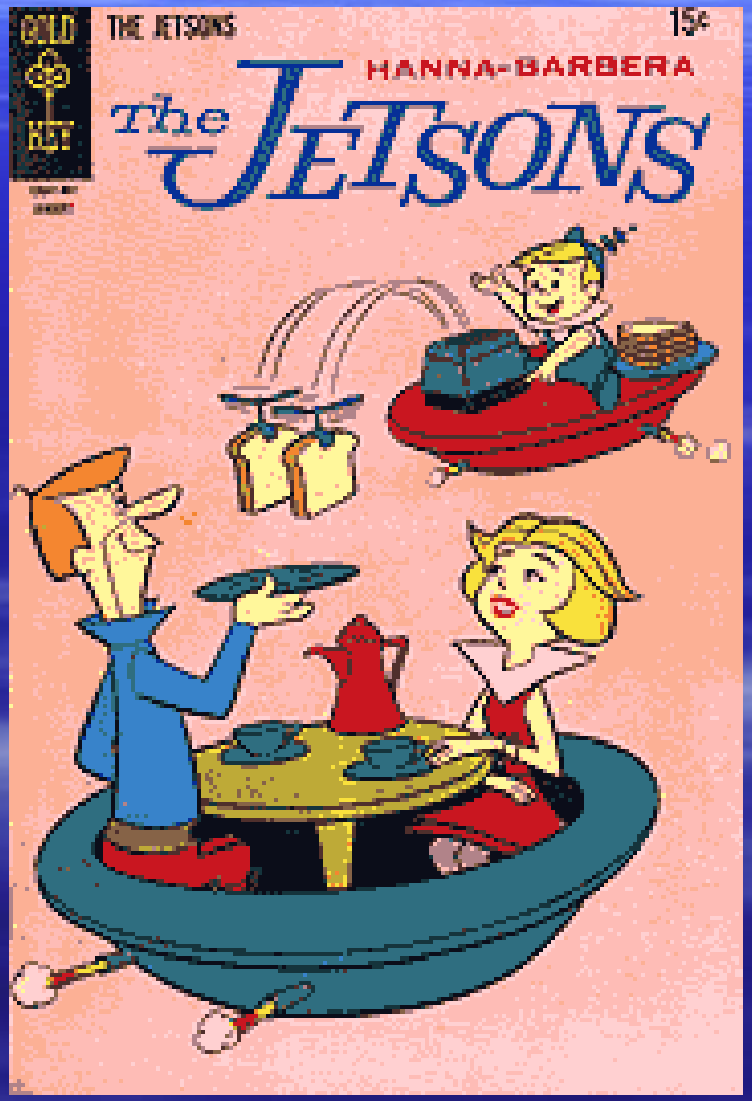
- Reinforces course content
- Forces students to apply recently learned information (to solve a real problem)
- Requires clear written/oral communication
- Requires team work (cooperation)
- Welcomes curiosity/rewards creativity
- Does not emphasize memorization

Role of the Instructor During Stem Activities

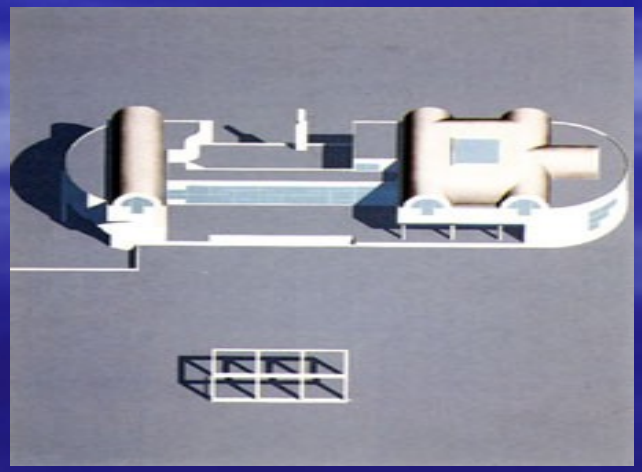
- Providing the foundation for learning
- Determining content
- Developing design problems for solving
- Asking probing questions
- Serving as a resource person
- Facilitating cooperation among teams

The Progression of Design

Toasters of the Future?



Limits on Design

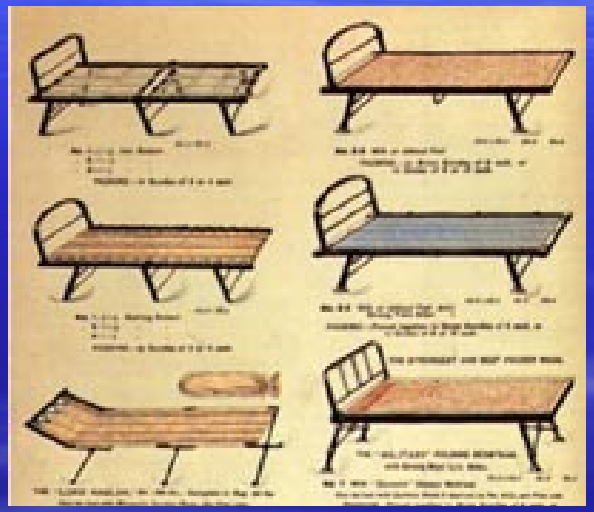


Form Follows Function!

Design Reflects the Era

Design Reflects Changes in Technology

Design Reflects Changes in Culture



Design Reflects Changes in Consumer Expectations

Some Design Changes Aren't Accepted!

Which of these Concept Cars will be Accepted?