ENGINEERING byDesign™

Foundations of Technology

The Engineering Design Process

Teacher Resource – Unit 2 Learning Cycle 1

ITEEA

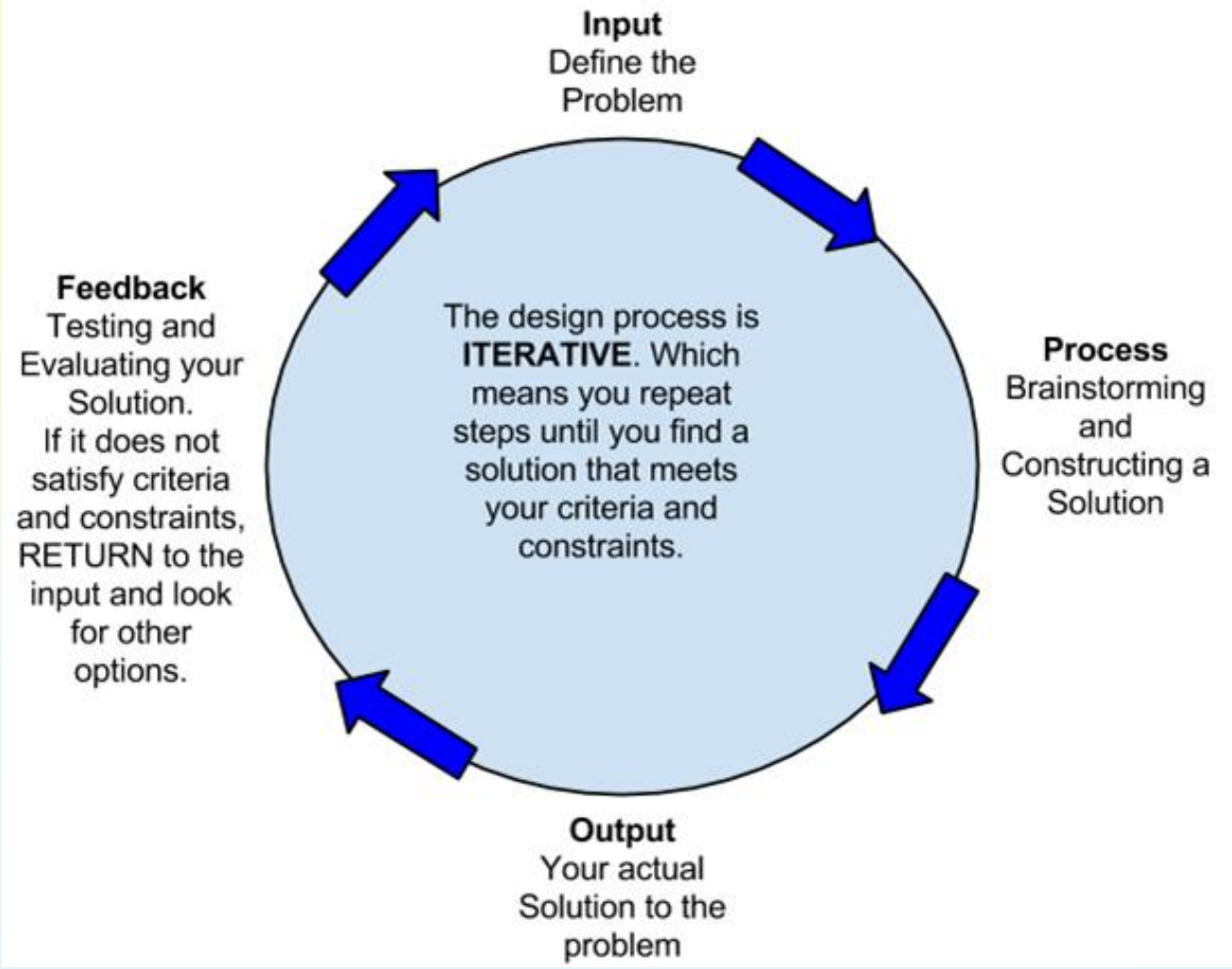
The BIG Idea

- **Big Idea*:***

The Engineering Design Process is a systematic, iterative problem-solving method that produces solutions to meet human needs and wants.

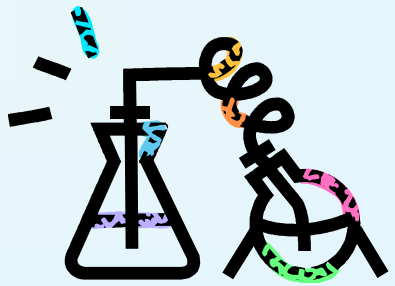
Iterative:

- **Iterative means a repetition of the process.**
- **This often means you must go through the steps numerous times.**
- **Each time you go through the design process, you think of ways to improve your solution to the problem based on performance or testing.**



Defining Science

- Science:
  - Systematic knowledge of the physical or natural world gained through observation and experimentation.
  - Focuses on how and why things happen.
  - Scientists answer questions.

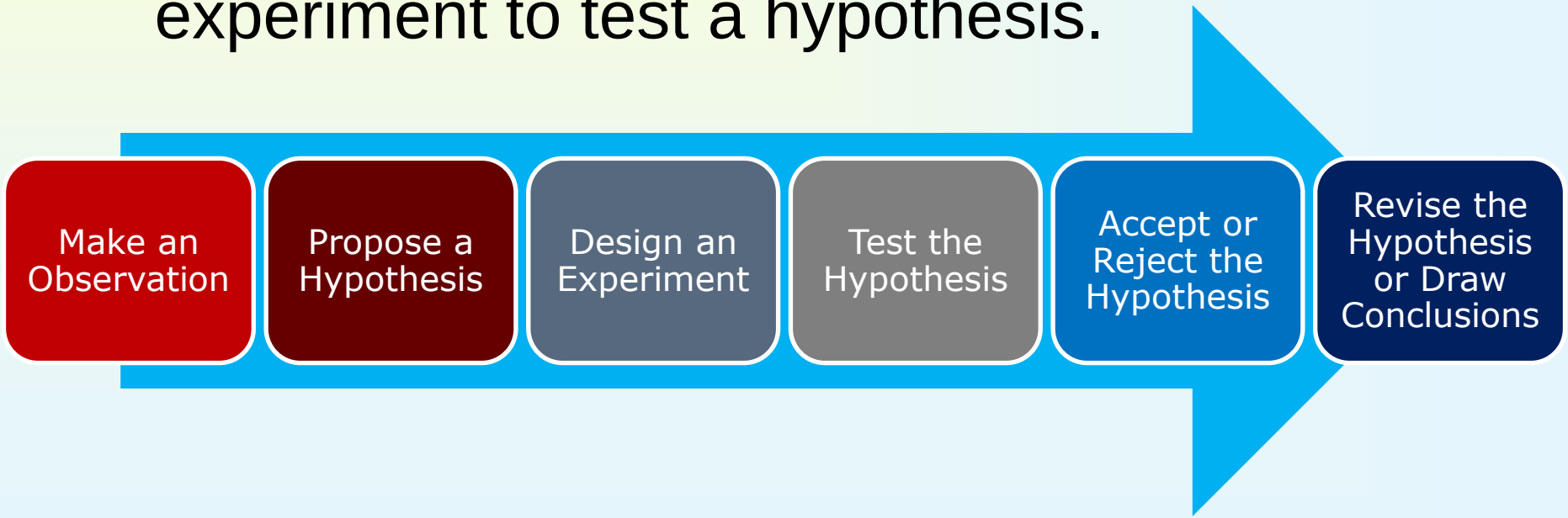


Defining Technology

- Technology:
  - Application of knowledge to solve practical problems or to change/manipulate the human environment.
  - Focuses on making things happen.
  - Engineers solve problems.

The Scientific Method

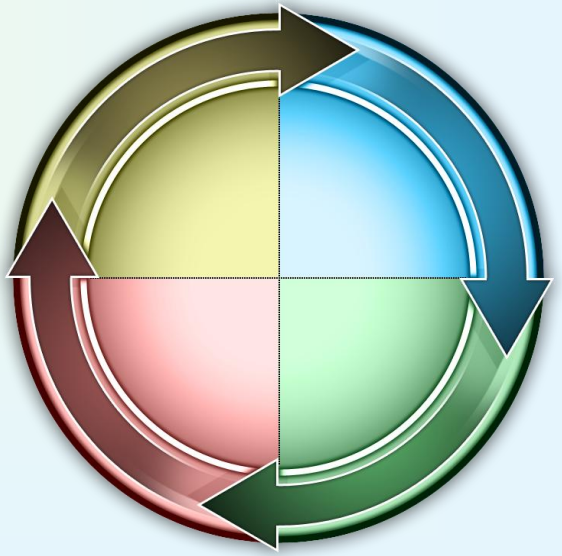
- The Scientific Method is a linear method for conducting an investigation that involves making an observation and performing an experiment to test a hypothesis.



The Engineering Design Process

- The Engineering Design Process is a systematic, iterative problem-solving method that produces solutions to meet human needs and wants.

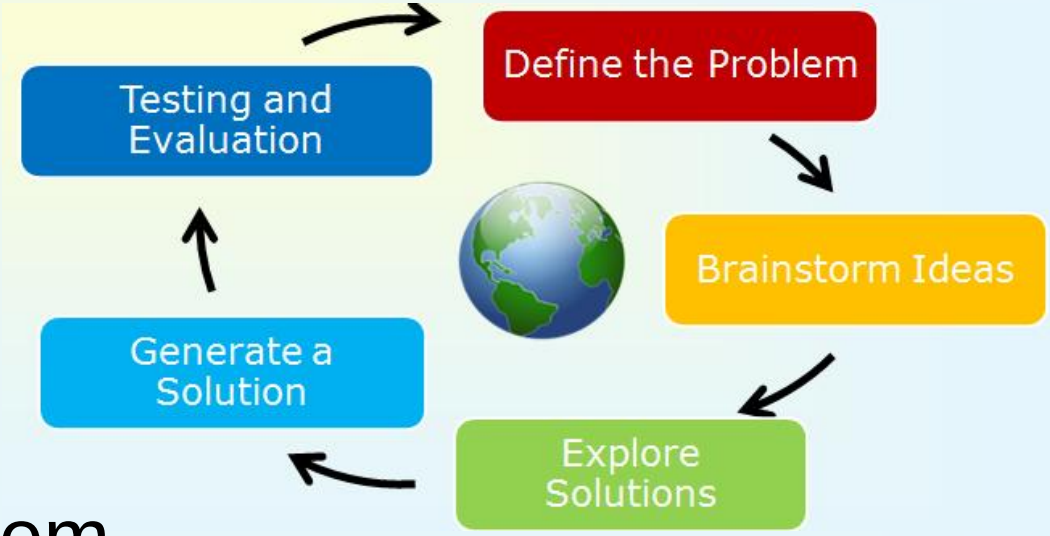
- Systematically applies mathematics and science to produce tangible products that meet human needs or wants.



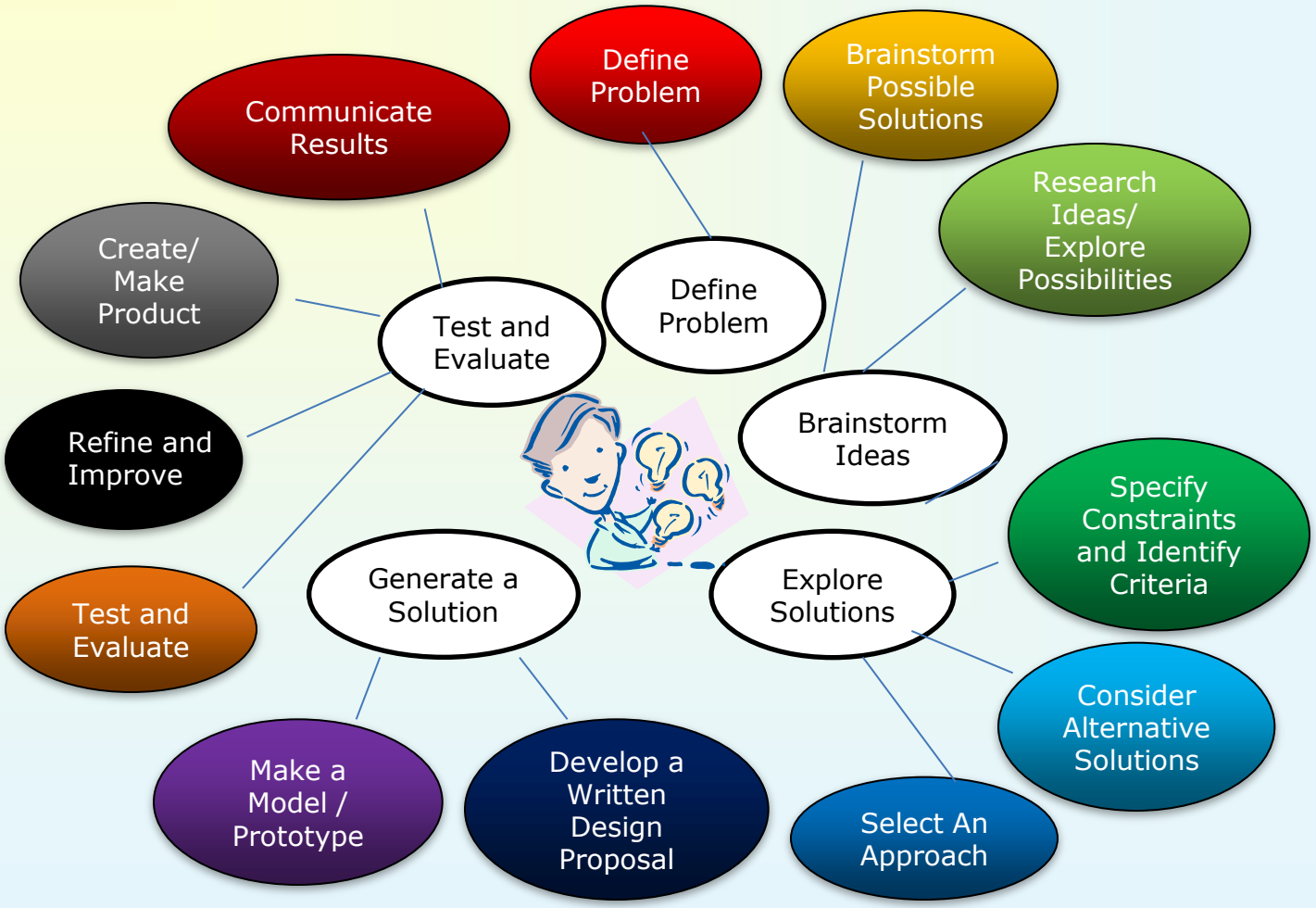
The Engineering Design Process

- At the beginning of the course, we used a simple version of the Engineering Design Process, which involved five steps.

- As problems become more complex so does the process used to solve them.



The Engineering Design Process



Engineering Design Process Vs. Scientific Method

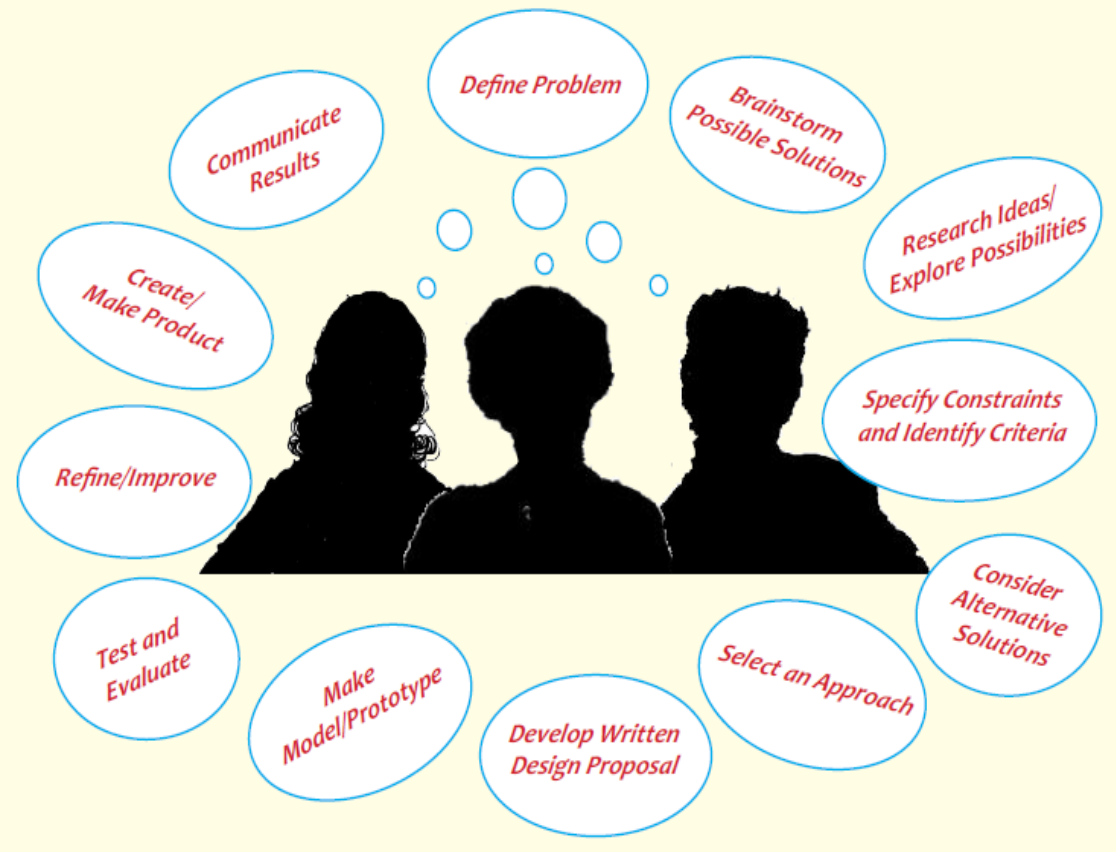
- Match the term to either the Scientific Method or the Engineering Design Process
  - Defined Starting Point
  - Meets Human Need or Want
  - Continuous Improvement
  - Hypothesis
  - Linear Procedure
  - Involves Criteria and Constraints
  - Conduct Research
  - Follow a Process

Engineering Design Process Vs. Scientific Method

- The Scientific Method:
  - Defined Starting Point
  - Hypothesis
  - Linear Procedure
  - Conduct Research
  - Follow a Process
- The Engineering Design Process:
  - Involves Criteria and Constraints
  - Meets Human Need or Want
  - Continuous Improvement
  - Conduct Research
  - Follow a Process

The Engineering Design Process

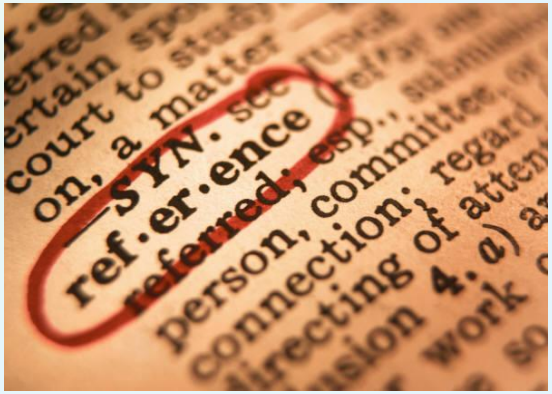
- Use the Engineering Design Journal to record each step in the Engineering Design Process.



Define the Problem

- Develop a problem statement that identifies the what, who, when, and how the problem should be addressed.

- The problem statement should be short, descriptive, and referenced as you work through the Engineering Design Process.



Brainstorming Solutions

- When working as a group, record your ideas and employ the rules of brainstorming:
  - One conversation at a time; stay focused.
  - Encourage wild ideas, quantity vs. quality.
  - Defer judgment and build on the ideas of others.

- Use Mind Mapping, the da Vinci Method, or Inventive Problem Solving as appropriate.

Research Ideas/ Explore Possibilities

- Research is essential in determining the best possible solution.
- Identify how the problem or a similar problem was addressed in the past.
- Determine what mathematical and/or scientific background knowledge is essential to solve the problem.

Specify Constraints and Identify Criteria

- Good design follows a set of given or identified criteria and constraints:
  - Criteria = Guidelines
  - Constraints = Limitations
- Document the essential criteria and constraints needed to solve the problem.

Consider Alternative Solutions

- Always consider alternative solutions and DO NOT allow preconceptions to limit your ideas.
  - It is important to stay open-minded.
  - Compare each of your design ideas with the criteria and constraints to determine how well they solve the problem.

Select An Approach

- Determining the “best” solution will involve trade-offs.
- The “best” solution should:
  - Align to the problem statement.
  - Meet the identified criteria and constraints.
- Use a Decision Matrix to help identify the best solution.

Select An Approach

- The Decision Matrix is a simple way to chart your proposed solutions (x axis) against the requirements (y axis).

- Establish a point scale to help determine the "best" idea.

x →

y ↓

Constraint/Criterion	Idea 1	Idea 2	Idea 3
Problem Statement	3	3	1
Constraint 1	1	3	2
Criteria 1	2	3	1
Total	6	9	4

3 pts = easily meets - 2 pts = somewhat meets - 1 pt. = does not meet

Develop a Written Design Proposal

- Once an idea has been selected, it is important to develop a plan of action.

- A Design Proposal is a way to manage simple projects, which includes:
  - The who, what, when, where, and how to deliver the work.
  - Often includes descriptions, sketches, and technical drawings.
  - Begin to plan how the solution will be evaluated.

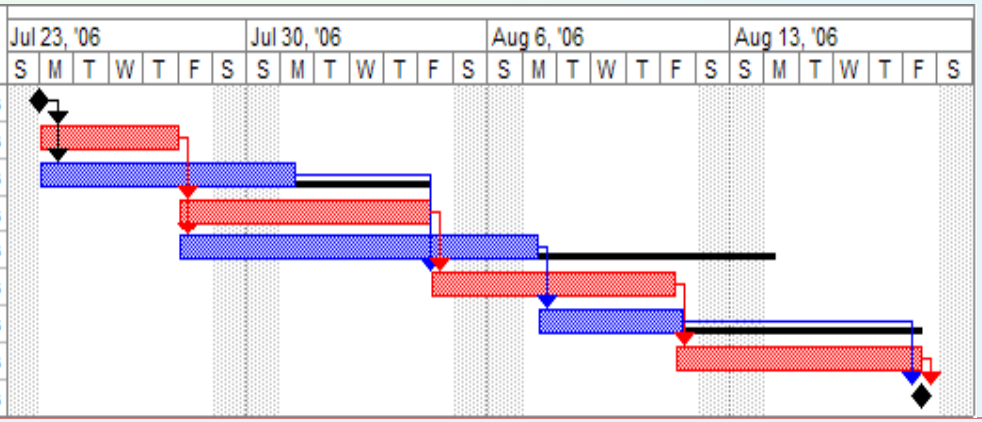
Develop a Written Design Proposal

- When developing a design proposal, you will need to plan ahead to determine how you will evaluate your design.
  - What tests will be conducted to determine if criteria are being met?
  - What data will be collected?
  - How will those data be used to improve the solution?

Develop a Written Design Proposal

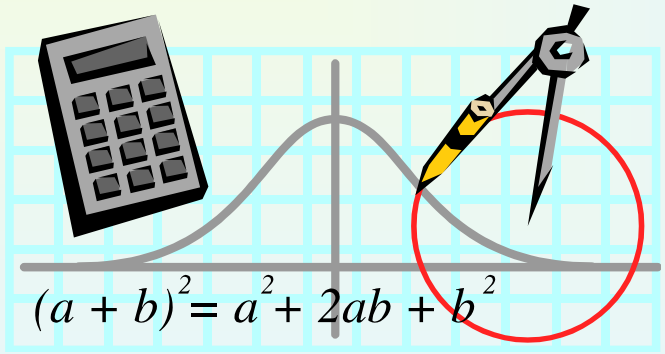
- Larger projects may require the use of a project management technique or a Gantt Chart.
- A Gantt Chart is a type of bar chart that shows a schedule of when/how the project can be completed.

ID	Task Name	Predecessors	Duration
1	Start		0 days
2	a	1	4 days
3	b	1	5.33 days
4	c	2	5.17 days
5	d	2	6.33 days
6	e	3,4	5.17 days
7	f	5	4.5 days
8	g	6	5.17 days
9	Finish	7,8	0 days



Make a Model/Prototype

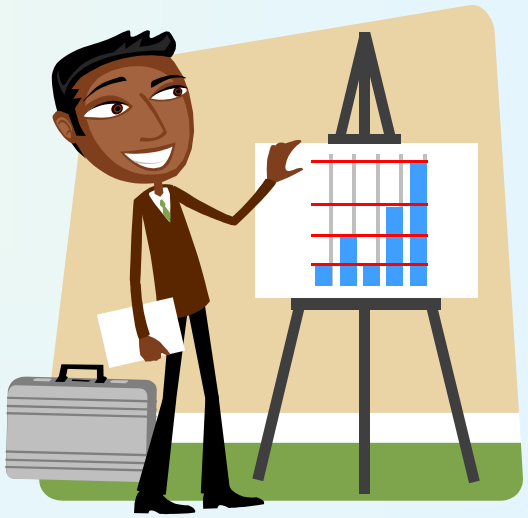
- Models can be conceptual, mathematical, or physical.



Make a Model/Prototype

- Conceptual models are abstract models that use language and graphic-based representations to convey meaning.

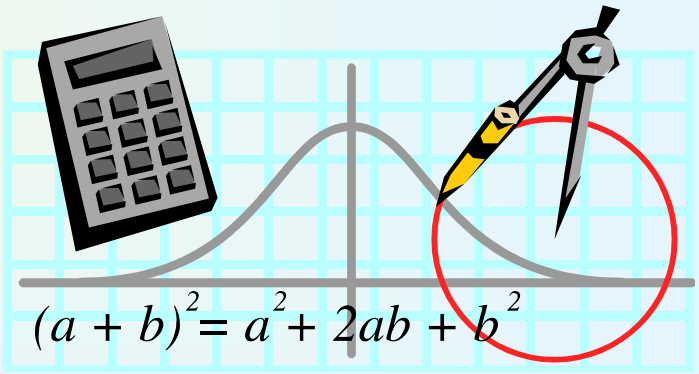
- They can include:
  - Technical Writing
  - Graphs and Charts
  - Annotated Sketches
  - Technical Drawings



Make a Model/Prototype

- Mathematical models are abstract models that use the language of mathematics to describe the behavior of the solution.

- They can include:
  - Statistical models
  - Differential equations
  - Game theoretic models (computer simulation)



Make a Model/Prototype

- Physical models are three-dimensional models that represent the solution.

- They can include:
  - Mock-Up – a representation of the final solution that does not function.
  - Prototype – performs the final solution and can be used for testing/evaluation.

Test and Evaluate

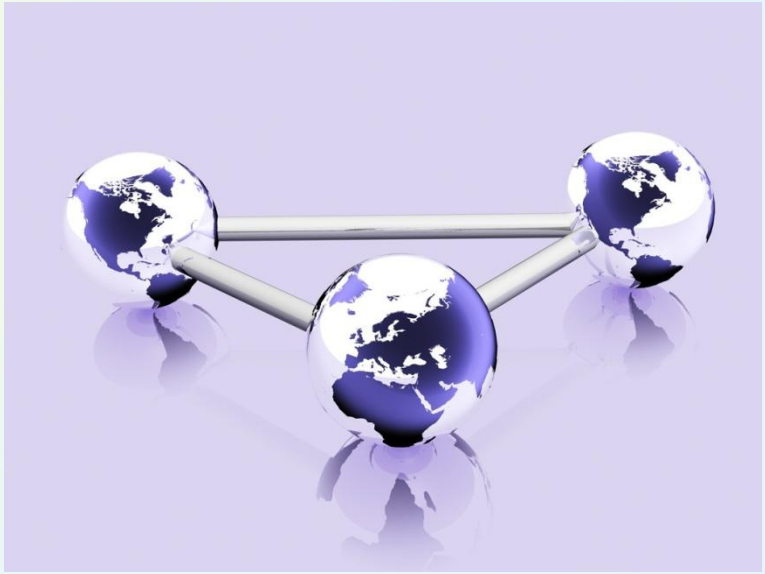
- Project planning and evaluation go hand-in-hand.
- Based on the information you projected in your design proposal you will:
  - Record and analyze results
  - Correct problems with the design that are discovered during testing

Refine/Improve

- Employ data-driven decision making.
  - Use the data collected during the test and evaluate phase to justify improvements to the solution.
- The solution should be continuously improved as you move through the Engineering Design Process.
  - Remember to document all project improvements in your journal.

Create/Make Product

- Working independently or in a group, develop the final physical solution.
  - The final solution should represent the revision made as you followed the Engineering Design Process.



  - The product produced should clearly reflect refinements made to the design throughout the process.

Communicate the Results

- Use the Engineering Design Journal to record and document each step in the Engineering Design Process.

- A more formal presentation or demonstration of the solution may be required, which should:
  - Summarize your work (includes problem statement, design proposal, evaluation methods, etc…)
  - Highlight why you chose the final solution.