

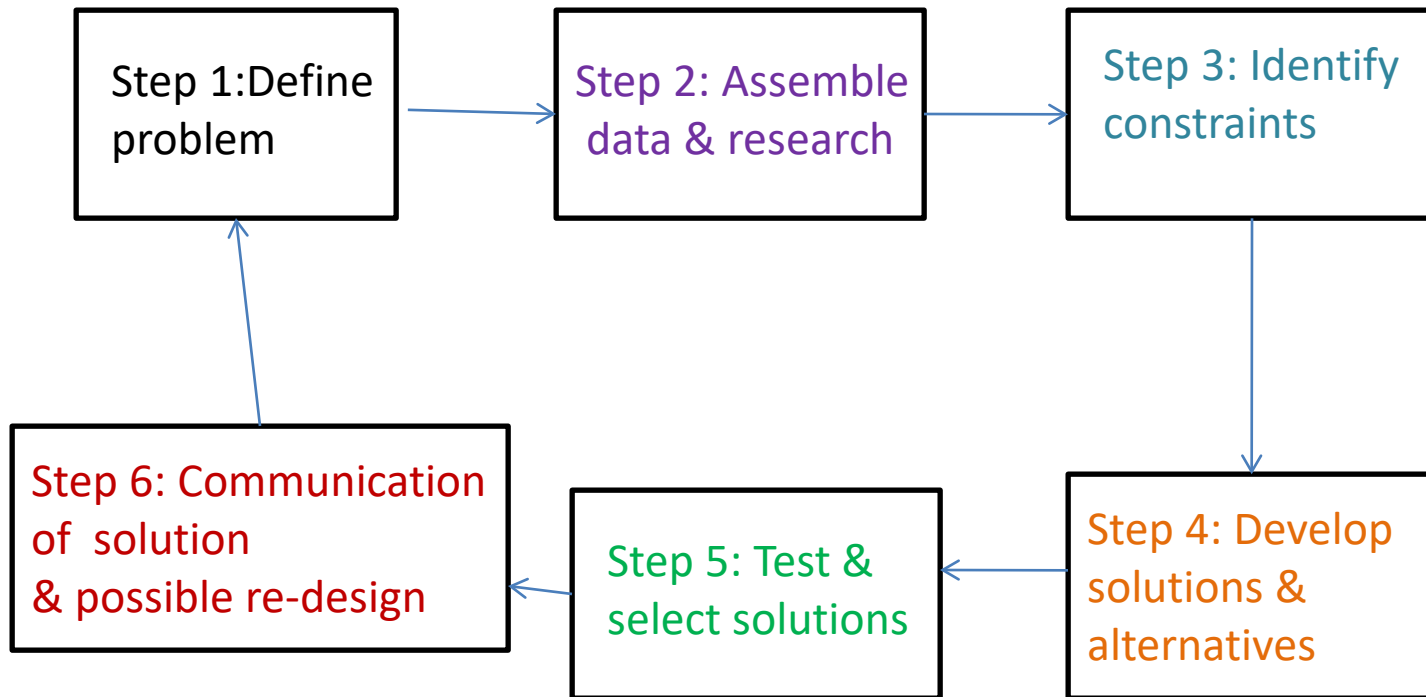
The Engineering Design Process

Engineering Problem-Solving

A Note About Teams

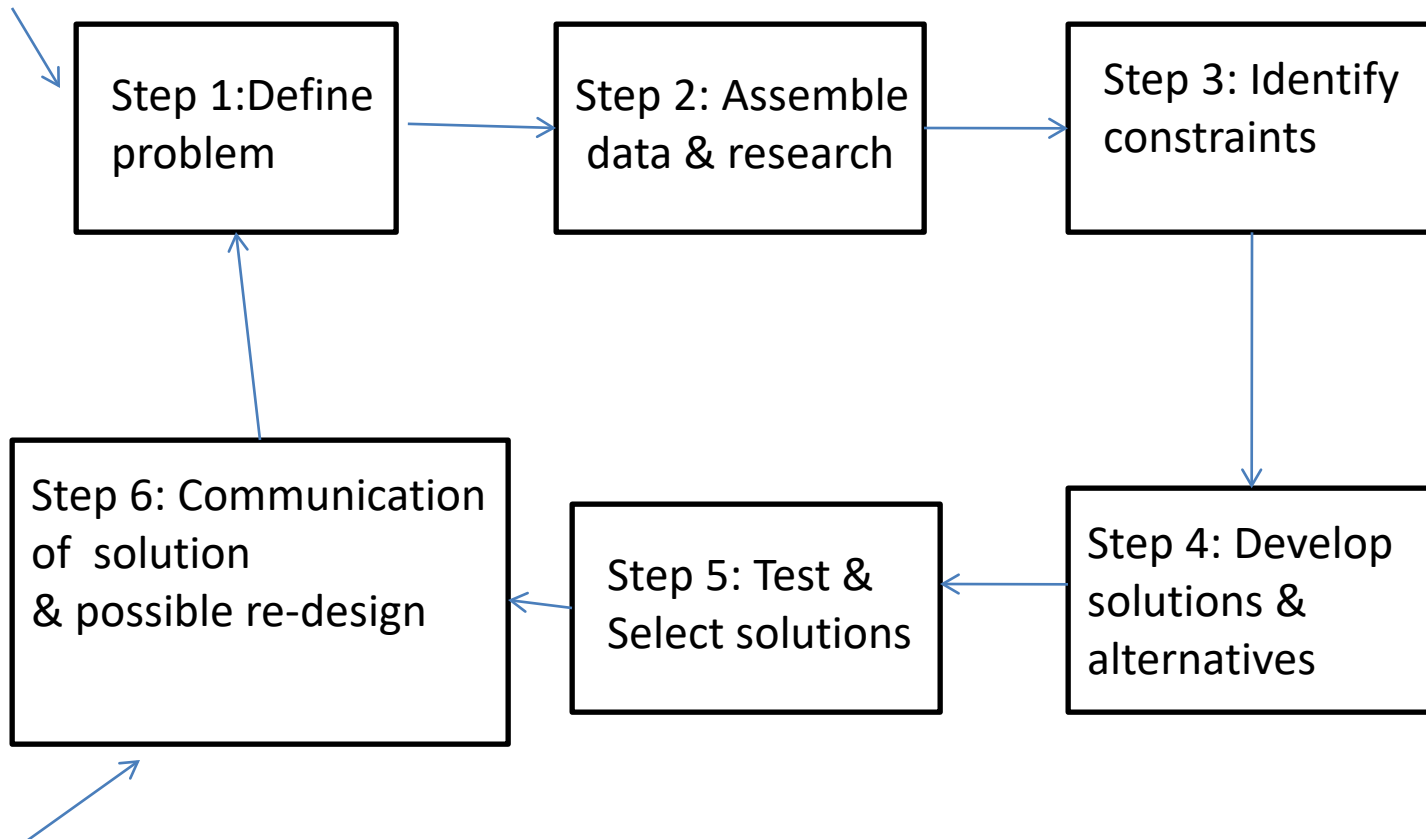
- This is a good time to assess how effectively your team is functioning
 - good communications
 - productive meetings
 - decisions made by consensus
 - everyone involved and participating
- Need to make sure that your team is working effectively before tackling the main projects.
- If your team wants/needs some mentoring, talk to me.

The Engineering Design Process



The Engineering Design Process

May need to refine the problem/specifications/constraints



Design is often iterative

Design Constraints

- technical requirements
- capital cost
- operating cost
- time, e.g. deadlines
- safety
- environment
- social
- ethical
- ??

Refining a Problem Specification

Initial Problem Statement may be:

- open-ended
- broad
- somewhat fuzzy
- biased by preconceived notions

Example: An “environmentally concerned” client wants to dramatically reduce her heating costs. She believes that by switching from electric heat to a different form is the best way to accomplish this.

Is this a good description for an engineering design project? Why or why not?

Refining a Problem Specification

In what ways should the previous problem statement be clarified?

- More clear
- More precise
- Cost
- Constraints stated

Refining a Problem Specification

Possible Refined Problem Statement:

The client wishes to reduce her heating costs as much as possible.

- To achieve this, she is willing to invest as much as \$10,000.
- Any investment must be fully recouped by reduced heating costs within 10 years.
- Environmental considerations are important to the client and will be a critical factor in her acceptance of the solution.

The Problem Solving Process

- What are some possible solutions?
 - new furnace (gas, oil, geothermal, high efficiency, etc)
 - solar
 - insulation
 - new windows
 - ...
- How do we evaluate the trade-offs
 - research
 - analysis
 - experimentation
 - ...

Iteration Example: History of paper clip

Simple, but over the past centuries, no one has invented a better method of holding loose sheets of paper together.

A wonder of simplicity and function, so why it wasn't invented earlier.

For centuries, straight pins, string and other materials were used as fasteners, but they punctured or damaged the papers. While the paper clip seems like such an obvious solution, its success had to wait for the invention of steel wire, which was "elastic" enough to be stretched, bent and twisted.

History of paper clip (continued)

- PROBLEM:** Holds several sheets of paper together, leaves the paper intact and can be easily removed.
- SOLUTION:** In the 13th century, people put ribbon through parallel incisions in the upper left hand corner of pages. Later people started to wax the ribbons to make them stronger and easier to undo and redo.

History of paper clip (continued)

- PROBLEM:** Damage the paper and always leave holes in the paper.
- SOLUTION:** In 1835, a New York physician named John Ireland Howe invented straight pins. Although they were originally designed for temporarily fastening cloth together, straight pins were used to hold the papers.



History of paper clip (continued)

PROBLEM: Not easy to use and still leave holes in the paper.

SOLUTION:

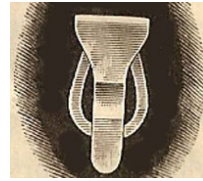
- 1867 Samuel Fay invented and patented a Ticket Fastener.

Philadelphia

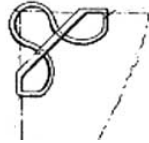


- In 1904, Cushman & Denison obtained a trademark for "Gem" used in connection with paper clips.





Eureka Clip



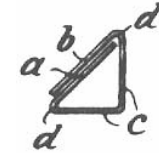
NIAGARA CLIP



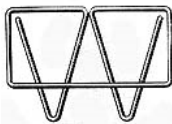
PATENTED AUG. 10, 1897



The Clipper Clip



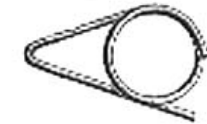
The Mogul Clip



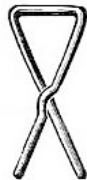
L. B. Expansive Clip



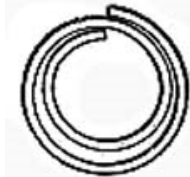
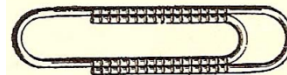
PAT. MAY 12, 1900



Standard



COLLETTE CLIPS





FAILURE IS THE MOTHER OF INVENTION

Example: THE STORY OF THE BEVERAGE (FOOD) CAN

- **PROBLEM:** Keep food from spoiling
The canning process dates back to the late 18th century in France when the Emperor Napoleon Bonaparte, concerned about keeping his armies fed, offered a cash prize to whoever could develop a reliable method of food preservation.
- **SOLUTION:** [Nicholas Appert](#) conceived the idea of preserving food in bottles, like wine. After 15 years of experimentation, he realized if food is sufficiently heated and sealed in an airtight container, it will not spoil. In 1809 Nicholas Appert invented a process and was awarded 12,000 francs by the French government.
 - In 1810 Appert wrote a book *L'art de Conserver* (very successful and profitable).



THE STORY OF THE BEVERAGE CAN (continued)

- **PROBLEM:** Bottles break easily.
- **SOLUTION:** Peter Durand (London) in 1810 devised a sealed tin container which was perfected by Bryan Dorkin and John Hall, who set up the first commercial canning factory in England in 1813. As more and more of the world was explored, and as armies took on greater importance, the demand for canned foods grew. In 1846, Henry Evans invents a machine that can manufacture tin cans at a rate of sixty per hour.



THE STORY OF THE BEVERAGE CAN

(continued)

- **PROBLEM:** How to open the tin? Soldiers used knives, bayonet and even rifle. A tin of roast veal carried on one of William Parry's arctic expeditions had the instruction, "Cut round on the top near the outer edge with a chisel and hammer."
- **SOLUTION(S):**
 - Create specialized tools for opening cans
 - 1858 Ezra Warner (Connecticut) got a patent for a can opener that looked like a bent bayonet. Its large curved blade was driven into a can's rim, then forcibly worked around its edge. Stranger yet, this first type of can opener never left the grocery store. A clerk had to open each can before it was taken away!
 - In 1866, J. Osterhoudt patented the tin can with a key opener that you can find on sardine cans.
 - 1870 William Lyman (Connecticut) patented a can opener with a wheel that revolved around a center hole punched in the can. An electric version of the same type of can opener was first sold in December of 1931.



Various can openers

http://cgi.ebay.com/Antique-primitive-cast-iron-tools-can-opener-ice-chisel_W0QQitemZ110287136803QQihZ001QQcategoryZ1217QQsPageNameZWDVWQQrdZ1QQcmdZViewItem



THE STORY OF THE BEVERAGE CAN

(continue)

- **PROBLEM:** Lyman's can opener had to be adjusted for each can size and the punching of the center hole had to be exact.
- **SOLUTION:** Modern style can opener was patented in 1925. There is still room for improvement.
- 1935, the first canned beer, "Krueger Cream Ale," was sold by the Krueger Brewing Company of Richmond, VA.
- In 1959, Ermal Fraze invented the pop-top can (or easy-open can) in Kettering, Ohio.



THE STORY OF THE BEVERAGE CAN (continued)

- **PROBLEM:** Thin cans lacked stiffness and buckled.
- **SOLUTION(S):**
 - Add a rim at top and bottom.
 - Corrugate the sides.

THE STORY OF THE BEVERAGE CAN (continued)

- **PROBLEM:** Beverage cans opened with can openers had jagged edges and too big an opening.
- **SOLUTION:** The “Church Key” can opener.



THE STORY OF THE BEVERAGE CAN (continue)

PROBLEM: It kept getting lost or you didn't have it with you when you needed it.

SOLUTION: Cans with discardable pull tabs, called pop tops.



THE STORY OF THE BEVERAGE CAN (continued)

- **PROBLEM:** What to do with pull tabs after removal?
 - Discard them? – Littering
 - Make chains? – Artistic
 - Drop them in the can? – Dangerous
- **SOLUTION:** Pop tops that stay attached to the can.



THE STORY OF THE BEVERAGE CAN (continued)

PROBLEM: Some people with long finger nails or weak, arthritic fingers cannot open them.
AND SO ON, AND ON, AND ON, AND ON, AND