

Engineering Merit Badge



What is an Engineer?

- Someone who applies scientific knowledge and ingenuity to solve practical problems...
- That is to say, someone who thinks up a machine, a product, a process, or something that fills a needs because the *thing* doesn't exist.

What's an Engineer Look Like?



What's an Engineer Look Like?



What Are Some Examples of Engineering Problems?

- Automobile fuel economy (miles/gallon) is too low so we are dependent on limited oil production and supplies
- Cell phones are too unreliable, i.e., they have poor voice quality and their batteries go dead too fast
- Video game graphics are too slow and too unrealistic

What Are Some Examples of Non-Engineering Problems?

- Our taxes are too high
- It takes too long to get in to see the doctor
- The library doesn't have the book I want when I want it
- I don't get enough exercise
- My parents make me go to school every day

Different Engineering Fields

- There are many different types of engineers because there are many different types of problems to solve

Mechanical Chemical Electrical
Biomedical Aeronautical
Power Nuclear Optical Petroleum
Genetic Welding Software Environmental

Engineering Specialties

- Within their chosen engineering field, engineers do the things that they like to do...

Research **Design** **Manufacturing**
Construction **Testing** **Quality Assurance**
Sales **Management**

Engineers in Teams

- Can one engineer do everything alone?
- Engineers need to work with other engineers of different disciplines to solve problems because they don't have all of the solutions to the problems themselves

Cross Functional Teams

	Mechanical Engineer	Electrical Engineer	Structural Engineer	Software Engineer	Manufacturing Engineer	Quality Engineer	Electrical Drafting	Mechanical Drafting	Mechanical Design	Technician
Project A	3	1	1	3	1	1	2	4	2	1
Project B	5	2	0	1	1	1	3	6	3	2
Project C	1	3	1	5	2	1	2	2	1	1

Each discipline has a functional manager:

Mechanical Engineering Manager

Electrical Engineering Manager

Software Engineering Manager

Engineers Learn and Use

- Math: algebra, geometry, trigonometry, and calculus
- Science: physics, chemistry, and biology
- Computer Programming
- English and technical writing
- Economics
- Psychology

Mathematics

- Math is the *UNIVERSAL* language that engineers use to solve and discuss problems with other engineers
- It allows engineers to precisely describe and communicate to others what they have done

The Engineering Approach

Establish a systems
Engineering Approach

What things will I need
For my Project? What
Tools? People?

Describe the project
requirements

Create a "Project Statement"
That clearly describes
Your intent

Plan and Schedule
Your Activities

Good planning helps to
Smooth workflow and
Identify problems

Conduct Research
and get ideas

Become "smart" about your project
Read books, journals, magazines
How did others solve similar
Problems?

Develop the Best Ideas
For Alternative
Solutions

Now, evaluate all of your
Ideas and pick the best three

Analyze your
Best Ideas

Draw sketches. Is it easy to build?
Can you make the parts?
Can you get the materials?

The Engineering Approach

Select Your
Best Idea



Perform the
Construction or
Solution



Evaluate your results

Describe in Writing
Why you made this
decision

Build your project

Does the finished project
Work, and solve the
Problem it was designed
For?

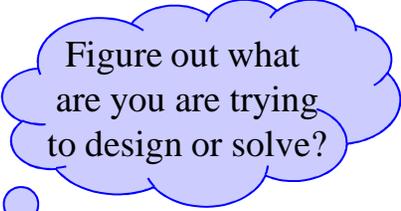
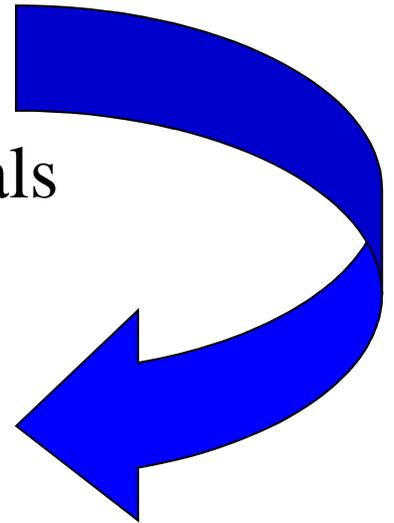
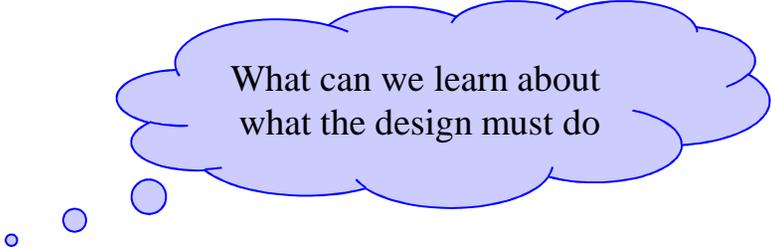


Figure out what
are you are trying
to design or solve?

- How do you figure out what to make?
 - You can ask your customer what they need
 - You can send out customer surveys
 - You can respond to request for proposals

From each of these you develop design requirements that you must meet

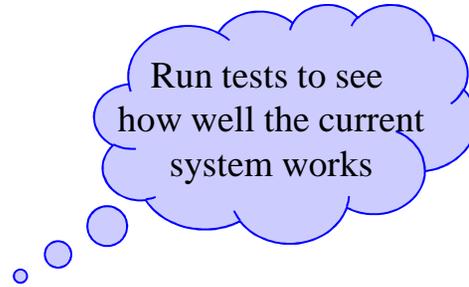




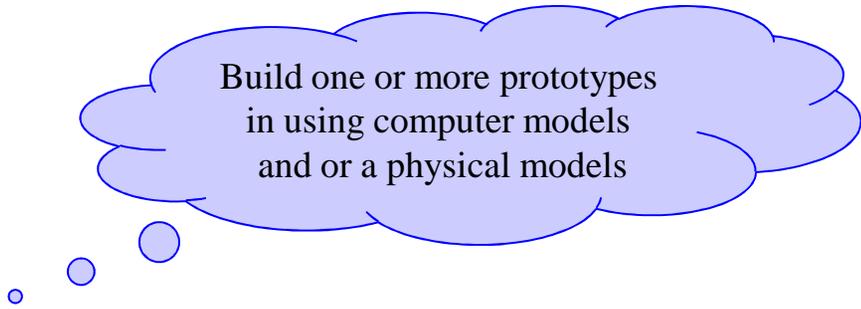
What can we learn about
what the design must do

- How do you figure out what the design must do?
 - You can ask your customer what is should and shouldn't do
 - You can have customer trials (beta versions)
 - You can use engineering judgment
 - You can work with your sales department

From each of these you develop design requirements that you must meet

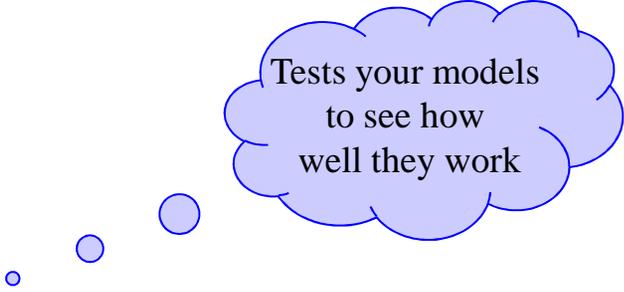


- Sometimes there isn't an existing system so you can't check how well it works... if it does, you can take measurements or data to create a *baseline* of understanding of how well it is or isn't working now



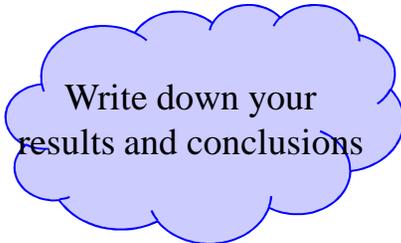
Build one or more prototypes
in using computer models
and or a physical models

- Many designs can be built in computer models... you can create solid models of your design without ever making the real thing.
- Sometimes it is faster to make a physical prototype or model

A light blue thought bubble with a black outline, containing the text "Tests your models to see how well they work". Three smaller circles of the same color and size are arranged in a diagonal line from the bottom-left towards the main bubble, suggesting a trail of thought.

Tests your models
to see how
well they work

- Once you have the model, take it for a spin, see what it can do, give it the torture test
- This allows you to try it before you commit to building the design and committing your companies resources; such as people, the manufacturing equipment, and marketing and sales



Write down your
results and conclusions

- The job's not done until the paper work is done!
- You need to summarize what was good and what was bad (or could be better) with the design.
- You need to document the lessons that you learned, so you can do a better job the next time

Engineering Tools

- Computer Based Tools for Design and Simulation are called “CAD” or Computer Aided Design
 - Mechanical – Solid Modeling (SolidWorks, Pro-E, Auto CAD Inventor)
 - Electrical – Schematic Capture / Board Design OrCAD, Allegro, Concept Capture, PADS, PSPICE, ModelSim
 - Mathematical Modeling – MATLAB, Mathworks, MapleSoft

Engineering Reports

- The documentation part of the design that many engineers dread!!
 - White Paper
 - Project Proposal
 - Hardware/Software Development Plans
 - Interface Control Document (ICD)
 - Drawings – Schematic, Assembly, Fabrication
 - Bill of Material (BOM)
 - Test Plan
 - Final Report

Engineering Approach

- You can use the engineering approach for many things, both technical and non-technical... it works to help you solve a problem.
- Things that you can use the engineering approach on:
 - Planning a camp-out
 - Planning your Eagle Project
 - Building a deck, a tree house, or anything
 - Writing an English paper

Registered Professional Engineer

- Some Engineers Become a PE
- Required for some types of work
- Especially where the engineers design may impact the safety of people
 - Structural Engineers
 - Civil Engineers
 - Some Engineers That Work for the Government

Registered Professional Engineer

- How do you become a PE?
 - Requirements vary from State to State but typically:
 - Complete a four year Engineering Degree in a program approved by the State's Licensure Board
 - Complete four years of qualifying engineering work experience
 - Pass the Fundamentals of Engineering Exam, also called the Engineer in Training exam or EIT
 - Pass the Principles and Practice of Engineering exam or PE

Engineering Code of Ethics

Fundamental Principles:

Engineers uphold and advance the integrity, honor and dignity of the engineering profession by:

- Using their knowledge and skill for the enhancement of human welfare;
- Being honest and impartial and serving with fidelity the public, their employers and clients;

Engineering Code of Ethics

- Striving to increase the competence and prestige of the engineering profession; and
- Supporting the professional and technical societies of their disciplines.

Engineering Code of Ethics

Fundamental Canons:

- Engineers shall hold paramount the safety, health and welfare of the public in the performance of their professional duties.
- Engineers shall perform services only in areas of their competence.
- Engineers shall issue public statements only in a subjective and truthful manner.

Engineering Code of Ethics

- Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest.
- Engineers shall build their professional reputation on the merit of their services and shall not compete unfairly with others.
- Engineers shall act in such a manner as to uphold and enhance the honor, integrity, and dignity of the engineering profession.

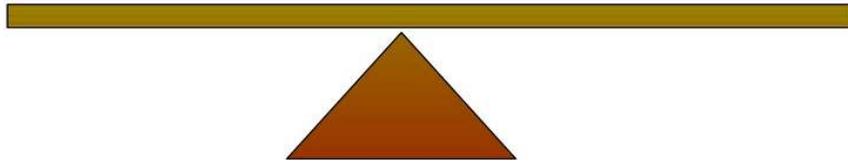
Newton's Laws of Motion

1. An object at rest, or in motion, will continue in its state until acted on by an external force.
2. If a force acts on the body, it will accelerate in the direction of the force
3. To every force, there is an equal and opposite reaction.

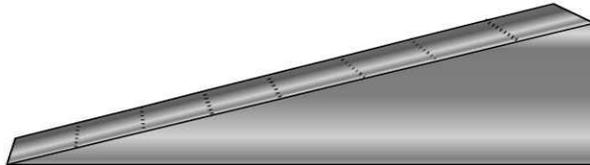
Simple Machines / Transforming Motion

- Inclined Plane
 - A simple ramp makes it easier to lift objects
- Lever and Fulcrum
 - Allows us to exert a little force to create a lot of force – Mechanical Advantage or Leverage!
- Pulleys
 - Also use leverage help to lift heavy objects
- Wheels
 - Transform rolling motion into linear motion

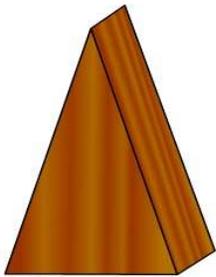
Simple Machines



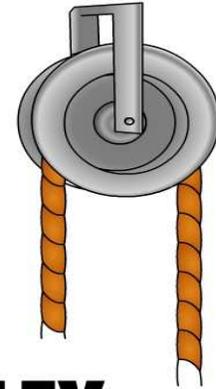
LEVER



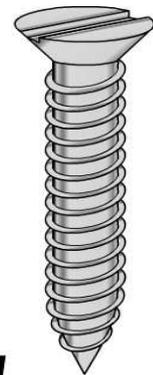
INCLINED PLANE



WEDGE

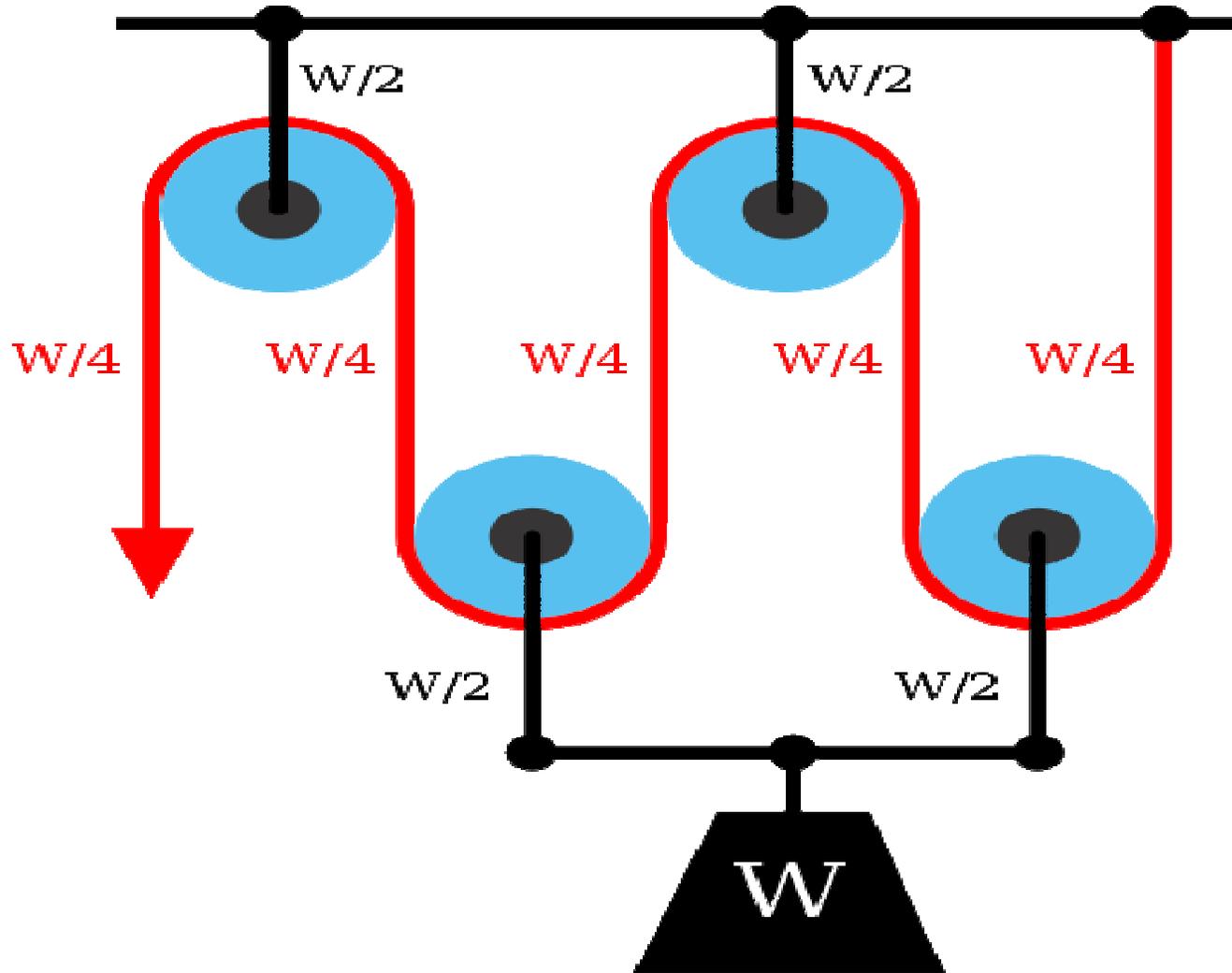


PULLEY

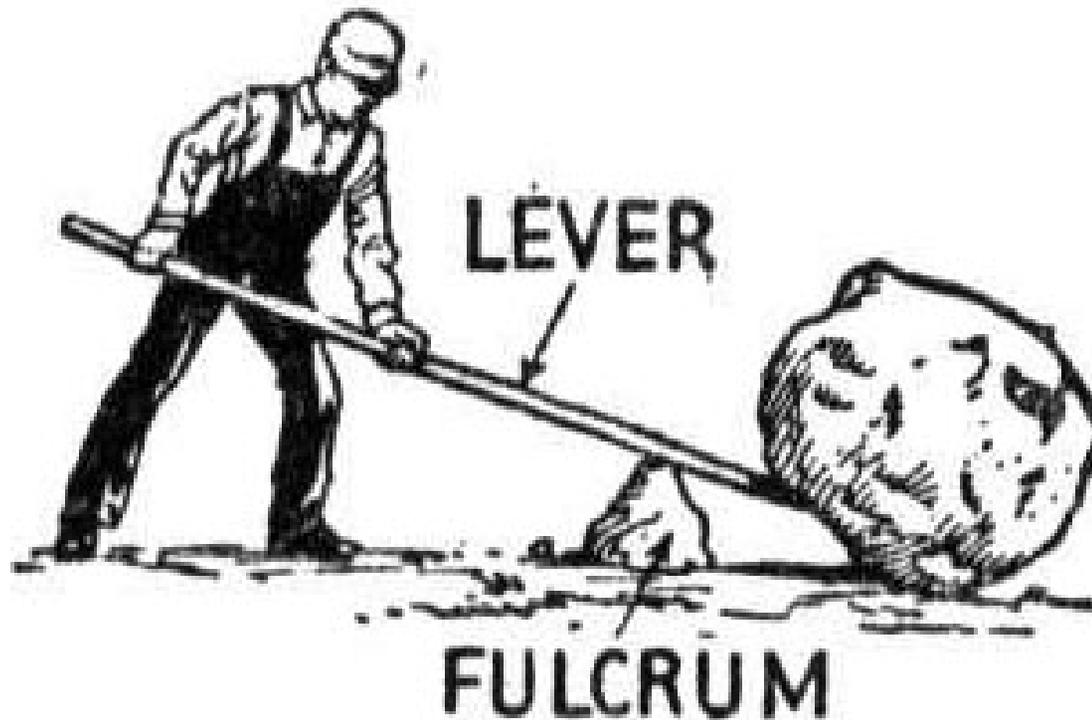


SCREW

Simple Machines



Simple Machines



Man lifting a stone
with a lever

Simple Machines

- Linkages
 - Used to transform motion to perform useful tasks
- Gears
 - Like pulleys with teeth!
 - Many different types:
 - Screw
 - Spur
 - Bevel
 - Planetary

Some of the Greatest Engineering Achievements of the Twentieth Century

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- Electrification
- Automobile
- Airplane
- Water Supply and Distribution
- Electronics
- Radio and Television
- Agricultural Mechanization
- Computers
- Telephone
- Air Conditioning and Refrigeration
- Highways
- Spacecraft
- Internet
- Imaging
- Household Appliances
- Health Technologies
- Petroleum and Petrochemical Technologies
- Laser and Fiber Optics
- Nuclear Technologies
- High-performance Materials

Resources for the Engineering Merit Badge

- Check the Troop 426 website for this presentation (If Mr. Anker can put it up there!)
- Check out meritbadge.org it contains *lots* of links to engineering websites and to engineering colleges

Good luck and have fun!!