XXX 487
Senior Design Phase I

Design & Analysis
Applications in
Industry & Senior Design

Some material adapted from a presentation by

Dr. Jenkins

Fall 2015

Product or Process Design in Industry

Project initiated by product or process goal

- Design process motivated by new product/process specification
  - Target new markets.
  - Reduce costs.
  - Improve product specifications for customer or marketing demands.

- **Generally**, design is an ***enhancement*** to product or process as opposed to a brand new design.

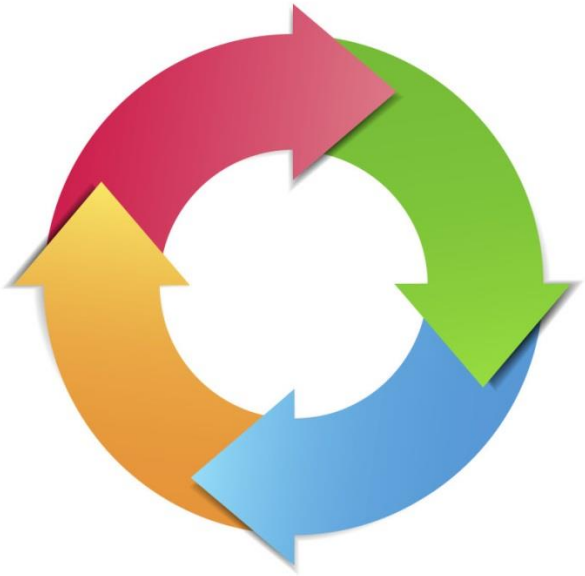
Design is a Process in Industry

- Feasibility Study
- Assemble Technical Team
- Develop Project Schedule
- Design & Implementation

  Brainstorming, Designs, Analysis,

  Selection, Approval,

  Prototype, Test
- Assessment of Results
- Repeat as necessary



Feasibility Study is Made 1st

- Determine impact of proposed new process/product/features.
  - New competitive edge, increase market share.
  - Open new markets.
- Estimate rough costs and potential schedule.
  - Is it physically possible? How long will it take?
  - What will it take ($ and time)?
- Assess whether design is economically worthy?
  - Implement or discard the idea.
  - Return on Investments (ROI), Timing, (>30% ROI is often required)
  - (Limited engineering, accounting, manufacturing resources.)

Assemble Technical Team

- Assign members from different appropriate disciplines:
  - Engineering
    - ME, EE, EVE, IE, etc.
  - IT professionals, designers, etc.
  - Technology specific vendors
  - Construction, manufacturing
  - Accounting, marketing, etc.
  - Project Manager

Develop Project Schedule

- Design and Analysis : (Typical projects)
  - Product
  - Manufacturing process
  - Product data flow
- Prototyping/testing
- Facility construction/equipment installation/tooling
- Testing and Analysis of Results
- Refinement of Design and Process
- Production Trials
- Product Launch

Design and Analysis Requirements in Industry

- **Quantity matters**
  - How many are we going to make?
    - Is the design for a consumer product?
    - How big is the market?
    - Is the design for an internal use or a production machine?

One, ten, or … millions?

Design and Analysis Requirements (How much analysis to do?)

- Safety, Cost, and Quality matter
  - How costly is a mistake?
    - Is personal safety affected by this design?

      (aircraft part, high speed equipment).
    - Is the cost of repair large? (Space shuttle, Hubbel telescope, production down-time)
    - Is the item a critical component of an expensive system (manufacturing line, luxury vehicle)?

Why Simulate & Analyze?

- Determine what is the problem to be solved.
  - Obvious symptom or solution may not be right one.
- Cannot test everything (e.g., earthquakes, wind, etc).
- Analysis takes less time than build & test
- Virtual prototyping ***costs less*** than building
- Evaluate ***more*** potential solutions.
- See what ***new*** *problems* the solutions cause.
- Explore multiple solutions: ***Determine best design***
  - Merit Analysis (Decision Matrix)
  - Controlled Convergence of a workable solution

Types of Analysis

- Product/process function & performance
  - Does it work like it should? New features?
  - Is it faster or “better” than other solutions?
- Product/process integrity
  - Will it fail under some potential conditions?
  - Will it last long enough?
- Product/process human impact
  - Ergonomics
  - Safety
  - Usability
  - Environmental effect (production & disposal)
  - Societal problems created

Types of Design Analysis

- Single-answer analysis:
  - Hand calcs: A 600 lb. container is supported by the 3/8” rope. Determine if rope fails.
  - Do I have a large enough power supply? (V*A)
- Performance analysis:
  - Strength & Mechanical Analysis: FEA (Pro/E, Ansys)
  - P-Spice, MATLAB: Will new CPU work, be fast enough? Is robot stable?
  - Arena, Excel: Can the plant produce more?
- Ergonomics (Human Data):
  - Size, force requirements, heights, font size, etc.

Design and Analysis Efforts

- High Design and Analysis Efforts:
  - **Inexpensive, high volume** products (Telephones, razors)
  - Low volume, **critical products** (NASA rocket, nuclear power plant)
  - **Safety related products** (elevators, eye lasers, hard hats, ladders)
  - **Unable to test adequately** (deep sea, costly production, etc.).
  - ***Senior design projects***

Industry Design Example: Safety Related Components

- Nuclear Power Plant Components
  - Required by US Code of Federal Regulations
    - (e.g., 10CFR50)
  - Potential (hypothetical) failures are analyzed.
    - Loss of coolant accidents (LOCA)
    - Earthquakes
    - Operational transients
  - Extensive modeling and simulation. (FEA, CFD, FMEA, PLC simulations)

Industry Design Example: Large Volume Product

- Every year the USA produces:
  - 1 billion foil-lined fruit juice boxes
  - 25 billion styrofoam cups
  - 1.6 billion disposable pens
  - 2 billion disposable razors
  - 16 billion disposable diapers

- High volume allows the cost of design and analysis to be spread over a large number of pieces.
- A mistake would be repeated millions or billions of times.
- Manufacturing tooling is expensive.

Questions?

- Thanks for your attention.
- Reminders:
  - Meeting with me on Thursday
    - See the published schedule for your meeting time.
    - Unless previously approved, ALL group members should be present.
- Next class meeting: Tuesday, February 9.