MECH 3200 – 12S
Notes: Eggert Chap.1

What is 'Design'?

a. Art (pure form – no function other than communication)
b. Functional products with artistic form (nicely rendered – e.g., artsy furniture, auto bodies)
c. Plans (specifications for the creation of a functional system or product - noun)
d. Process of satisfying functional needs (verb)

The correct answer is (d)

But the answer isn't complete until it includes (c),

And no one will buy it unless (b) is accomplished.

(a) is incorrect – engineering design traditionally does not extend to art.

Note:

- Engineering design is usually directed at creation of a product.
- Mechanical engineering design is usually directed at creation of a mechanical product.
- But creation of a product isn't always the best way to satisfy the original, underlying functional needs.

(An) Engineering Design Process

1. Formulate the problem
    a. Identify customers (users)
    b. Identify each customer's requirements (needs)
    c. Identify engineering characteristics (recipe for meeting needs)
    d. Determine target levels for engineering characteristics (numbers to design to)
2. Generate alternative forms
    a. Reduce functional needs to subfunctions (decomposition)
    b. Identify feasible solutions for subfunctions (analogy, ideation)
    c. Synthesize overall form alternatives (many – populate the design space)
    d. Analyze for feasibility (iterative for systems)
3. Select optimal form
    a. Decision-making (v. original requirements/needs)
    b. Form regeneration (best of what is known)
4. Develop form
    a. Check for life cycle functions (& fix up design)
    b. Manufacturing plan (& fix up design)
    c. Design communication (quality control; encourage buy-in)

Levels of Design Detail

1. Conceptual Design
    - Cartoon/sketch
    - List of features
2. Configuration Design (given a concept)
    - Arrangement drawings
    - Parts list
3. Parametric Design (given a configuration)
    - Sizing/selection analysis
4. Detail design (given settled parameters)
    - Tolerancing
    - Manufacture
    - Documentation/certification

2 + 3 = "Embodiment design"

Design Iteration

(for requirements/needs - different from iteration for solution)

1. Set general requirement (need)
2. Develop design recipe (numerical design target)
3. Adjust form to meet design target (2)
4. Evaluate form against general need (1)
    - If OK, continue
    - If not OK, return to 2.

Design Process – Truths and Truisms

"The only way to learn design is to do design"

→ David Ullman, Oregon State, author of former MECH 3200 text

- Design is a skill requiring practice
- Need for experience and visualization

"You can't teach someone how to design"

→ David Wagner, Ford, manager of advanced projects (H_2 Hybrid Flex, etc.)

- Design is largely an intuitive process

"Design is a managed process"

→ Nam Suh, MIT, founder of axiomatic design

- But there are rational steps

"90% of all failures are failures of design"

→ Michael Golden, former NASA Administrator

- Sometimes rational steps are not followed
- 'Design Process' is descended from failure analysis (functional & commercial)

"Design methodology is just a way to justify what you were going to do anyway"

→ You don't want to know

- You get out of it what you put into it

Design for Excellence

- Feasible design
  - Meets engineering requirements (result of analysis)
  - One of many – "statutory success" – valid point in design space
- Optimal design – peak point in feasible design surface
  - Result of:
    - Clear problem definition
    - Imaginative concept
    - Painstaking development
  - Commercial and social success

"Continual improvement in product and process to create product excellence"

"Strive for excellence (and sometimes achieve it!)"