Engineering design can be an art, in the same way that architecture, sculpture, painting and music are arts. And like those arts, it makes use of science to achieve its ends. Its ends are usually more mundane and it uses a broader range of sciences to achieve them and so engineering designers are often thought of, and sometimes seek to be thought of, as “scientists.”

The business of engineering, particularly design engineering, is creation (although one must sometimes discover and describe in order to create). The business of science is discovery and description (although one must sometimes create in order to discover and describe).

Design

- Engineering is the principled application of science, methods, tools, and experience to the production of designed objects.

  "The study and practice of how things ought to be and therefore is the central activity of engineer."
  - Herbert Simon, Nobel Prize winner

  "The discipline of applying technology to satisfying the needs of people"
  - David Kelso, Northwestern University

- "Design is that which separates engineering from natural sciences."
  - Kappel & Rubenstein

  "The idea of design - of making something that has not existed before - is central to engineering"
  - Henry Petroski, "To Engineer is Human."

The Design Process

- Design – a systematic plan that details a (creative) engineering solution
- Process – a methodic series of actions that brings about a particular change, action, or result.

No one plans to fail... though they might fail to plan.
The Design Process

1. Identify the need
2. Define the problem
3. Search
4. Criteria and constraints
5. Alternative solutions
6. Analysis
7. Decision
8. Specification
9. Communication

The Design Process

1. Understand the Problem
2. Gather Information
3. Analyze
4. Synthesize Solutions
5. Select the Best Solution
6. Develop the Solution in Detail
7. Test the Solution
8. Finished Design
9. Iterate as necessary

The Design Process

1. Exploration
2. Generation - iterative
3. Evaluation - iterative
4. Communication

The Design Process

1. Recognition of a Need
2. Definition of a Problem
3. Gathering of Information
4. Conceptualization
5. Evaluation
6. Communication of the Design

The Design Process

1. Problem Definition
   a) Recognition of need
   b) Study of state-of-art
2. Problem Evaluation
   a) Needs analysis
   b) Specifications, requirements, goals and preferences
   c) Feasibility
      1) Physical
      2) Company
      3) Economic
   d) Development of alternative design concepts
   e) Selection of most promising alternatives
3. Analysis
   a) Mathematical models
   b) Computer simulation
   c) Test of physical models
   d) Optimization of design
4. Communication for Manufacture
   a) Drawings
   b) Assembly list
   c) Reports
   d) Test data
   e) Computer files
   f) Discussions
The backbone of real estate is location, location, location...

The backbone of engineering must be communication, communication, communication...

Remembering that communication must be a two way street. Engineers must be able to effectively present their ideas, as well as listen to their clients, employers, regulators, etc.

It is tempting to define the design process as a linear progression of steps from the recognition of a need to the solution of that need. As with many artistic processes, the engineering design process is not quite that neatly packaged. The process is based on numerous assumptions and decisions, some of which are found to be erroneous as the project progresses. Consequently the process is iterative with returns to preceding steps to correct the process.
Designers always stop before they have reached perfection…

Only a design that will never be built is without flaws…
But ideally those flaws are minor, and will not lead to a catastrophic end.

“It’s not rocket science.”

Because rocket science is really Rocket Engineering, and at times even Ag & Bio Engineering has the potential to be that tough.