CHAPTER 1

The History of Engineering

Early Engineering

- Engineering began millenia ago (Egypt, Rome) which had huge public works (pyramids, aquaducts) and military projects (roads, bridges, siege engines, fortifications).
- Engineering was a craft and was taught through apprenticeship, much like smithing or carpentry.

Formal Engineering[1]

- mid-1700s: King Louis XV gives Jean Rodolphe Perronet authority to establish a school of engineering.
- 1747: Corps des Ponts et Chaussees established.
- 1775: Three year curriculum has evolved. School renamed Ecole des Ponts et Chaussees. This is the first formal School of Engineering in history.
- 1794: Napoleon creates Ecole des Travaux Publics to train engineers for both military and civilian service. This institute evolved into the Ecole Polytechnique.
- Early engineering schools (Ecole) do not fit into the Greek-style University system.
- Early engineering disciplines are still "craft-based" and not "scientifically-based."
- Polytechnic derives from "polys" meaning many and "technik" meaning art or craft. Engineering can be seen to be multidisciplinary from the start and craft based (applied).

[1] This section is derived from George A. Hazelrigg, Systems Engineering: An Approach to Information-based Design, Prentice-Hall, 1996.

Civil Engineering – The Grand-daddy of them all

- At the conclusion of the Napoleonic Wars, there was a surplus of Military Engineers. This situation has been reflected many times in recent history, including the conclusion of the Vietnam war, which resulted in lay-offs and recession in the United States.
- These Military Engineers had a stigma associated with them as well. Like any good public relations specialist, when in disfavor, change your name. In order to generate the maximum contrast, the new engineers called themselves Civil(ian) Engineers.
- The primary benefits of these engineers was to design and build roads, bridges, buildings, causeways, and other public works. Civil engineering carries this flavor today.

Early American Engineering Schools

- 1824: Rensselaer Polytechnic Institute awarded the first U. S. engineering degree.
- Through WWII, engineering was primarily taught by engineers educated to the Master's level.
- 1862: Morrill Act. Land Grant College System established (e.g. University of Arkansas at Fayetteville). French Polytechnic system was copied in the United States. Primary foci, Military engineering and Agricultural engineering.
- Thus began the A&M colleges and the Polytechnic universities.

The Scientific Revolution

- Wars favor the side with technological superiority.
- During WWII, inventions such as radar, cryptography, and the atomic bomb required hard science to design and develop.
- Technological advances were becoming too rapid to pass along through apprenticeship. Engineering needed to be formalized on scientific foundations.
- 1952: Gordon Brown, chairman of MIT's Course VI (electrical engineering), implements Karl Compton's idea and underpins engineering education with basics in physics, mathematics, and chemistry.

The 60s, Man.

- During the 1960s and 1970s, engineering schools put their programs firmly on a scientific basis by hiring primarily Ph. D. trained engineers.
- Practical experience is gained through an apprenticeship in industry.
- By 2012, most practical engineers had been bred out of the faculty of the major engineering universities.
- Engineering is now being taught by Applied Scientists, many of whom have never served an apprenticeship in industry.
- Industry has been pushing for more "soft skills" (communications, management, team work).
- Engineering education is starting to return to practice, with "hands on" work increasingly emphasized.

What is Engineering?

- Most people consider engineering "problem solving." This is partially true.
- However, problem solving is not the principal activity of engineers, it is a consequence.
- Decision making is the principal attribute of engineering.
- From Hazelrigg,
  - "**Science**: is the process of rationally and methodically seeking to understand nature, with the principal objective of developing a predictive or problem solving capability."
  - "**Engineering** involves the manipulation of nature to create systems for the benefit of at least some segment of mankind."
  - "**Systems engineering** is the treatment of engineering design as a decision-making process."
- Although all engineering is related to decision making, the traditional disciplines focus more on specific analysis skills (the creation of information relating to specific established phenomena, such as mechanics or electromagnetics) than on decision making.
- Systems engineering focuses more on decision making skills and considers a wider variety of analytical domains in less depth.

Introduction

- **Definition of Engineering[1]**
  - The profession in which knowledge of the mathematical and natural sciences, gained by study, experience, and practice, is applied with judgment to develop ways to use, economically, the materials and forces of nature for the benefit of mankind.

[1] From Accreditation Board for Engineering and Technology (ABET) – www.abet.org

Some Engineering Disciplines

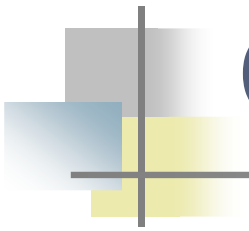
- Mechanical
- Electrical
- Computer
- Telecommunications
- Systems
- Biomedical
- Civil
- Aerospace

Mechanical Engineering

- Foundation is Newton's Laws (mechanics)
- Application to machines
- Power plants, HVAC, Boilers, Pressure Vessels
- Vehicles (automobile, air plane, space vehicles)
- Manufacturing
- Weapon Systems
- Measurements
- Every branch of engineering will ultimately touch the mechanical sciences.
- Electronic devices must be made. Computer simulations model mechanical systems and must be validated.

Electrical Engineering

- Electrical is the largest branch of engineering
- Involved in:
  - Communication Systems
  - Computers and Automatic Controls
  - Power Generation and Transmission
  - Integrated circuit design and layout
- Sciences: electricity and magnetism, solid state physics



Computer Engineering

- Started as a subdiscipline of Electrical Engineering
- Combines aspects of solid state physics and aspects of computer science
- Software related tasks
  - Embedded and real time programming
  - Operating system design and integration
- Hardware related tasks
  - VLSI circuit design and layout

Telecommunications Engineering

- Started as a subdiscipline of Electrical Engineering
- Provide telephone and high-speed data services
- Some contact with mechanical sciences through acoustics (science of sound transmission).
- Signal processing is one of the most important fields within telecom (how to compress and transmit data)
- Antenna design and signal transmission

Systems Engineering

- Systems Engineering is an interdisciplinary approach and means to enable the realization of successful systems.
- Define customer needs and required functionality early in the development cycle
- Document requirements
- Design synthesis and system validation while considering the complete problem