WHAT IS ENGINEERING?

root of the word...

ENGINEER

root of the word...

ENGINEER

not english

french “ingenieur”

“ingenuiter”

the SCIENTIST / MATHEMATICIAN vs the *ENGINEER*

CONFOUNDING FACTS

- Engineering requires thorough mathematical & scientific knowledge
- Engineers study science and math extensively
- Engineers may conduct scientific experiments while doing Engineering
- Scientists use engineering methods
- Some great engineers trained as scientists & mathematicians
- Some great scientists trained as engineers
- All require intensity, passion, creativity & intellectual effort

BUT, THEY ARE DISTINCT

"The scientist seeks to understand what is; the engineer seeks to create what never was" **-Von Karmen**

ENGINEERING **is a human activity aimed at creating new artifacts, algorithms, processes and systems that serve humans**

BROAD HUMAN WANTS

- **Shelter**
- **Food**
- **Transportation**
- **Communication**
- **Security**
- **Longevity, personal and progeny**
- **Entertainment**
- **Aesthetic pleasure**
- **Social, Emotional, Spiritual & Psychological rewards etc.**

United States National Academy of Engineering

Greatest Engineering Achievements of the 20th Century

NAE Greatest Engineering Achievements of the 20th Century

- . Electrification
- . Automobile
- . Airplane
- . Water Supply and Distribution
- . Electronics
- . Radio and Television
- . Agricultural Mechanization
- . Computers
- . Telephone
- 10. Air Conditioning and Refrigeration

NAE Greatest Engineering Achievements of the 20th Century

- 11. Highways
- 12. Spacecraft
- 13. Internet
- 14. Imaging
- 15. Household Appliances
- 16. Health Technologies
- 17. Petroleum and Petrochemical Technologies
- 18. Laser and Fiber Optics
- 19. Nuclear Technologies
- 20. High-performance Materials

WHAT SKILLS ARE NEEDED TO BE AN

EFFECTIVE

ENGINEER?

Continuation of *Engineering* vs Math and Science

ETHICAL CONSTRAINTS DIFFER

- **Science and Math: intellectual honesty**

- **Engineering: far broader…**
  - **economical**
  - **safe**
  - **environmentally sound**
  - **social impact**
  - **etc.**

…thus, involving greater tradeoffs and judgement calls

ENGINEERS
SCIENTISTS / MATHEMATICIANS
ARTISTS / WRITERS

SHARE

- **The excitement of discovery**
- **The satisfaction and frustration of creative processes & results**

BUT, THE ESSENTIAL DIFFERENCE IS...

Engineering creation almost always requires a TEAM effort

AN ENGINEER SHOULD BE ABLE TO...

- Determine quickly how things work
- Determine what customers want
- Create a concept
- Use abstractions/math models to improve a concept
- Build or create a prototype version
- Quantitatively and robustly test a prototype to improve concept and to predict
- Determine whether customer value and enterprise value are aligned (business sense)
- Communicate all of the above to various audiences

- Much of this requires “domain-specific knowledge” and experience
- Several require systems thinking and statistical thinking
- All require teamwork, leadership, and societal awareness

Boeing List of "Desired Attributes of an Engineer"

- A good understanding of engineering science fundamentals
  - Mathematics (including statistics)
  - Physical and life sciences
  - Information technology (far more than "computer literacy")
- A good understanding of design and manufacturing processes (i.e. understands engineering)
- A multi-disciplinary, systems perspective
- A basic understanding of the context in which engineering is practiced
  - Economics (including business practice)
  - History
  - The environment
  - Customer and societal needs
- Good communication skills
  - Written
  - Oral
  - Graphic
  - Listening
- High ethical standards
- An ability to think both critically and creatively - independently and cooperatively
- Flexibility. The ability and self-confidence to adapt to rapid or major change
- Curiosity and a desire to learn for life
- A profound understanding of the importance of teamwork.

- *This is a list, begun in 1994, of basic durable attributes into which can be mapped specific skills reflecting the diversity of the overall engineering environment in which we in professional practice operate.*
- *This current version of the list can be viewed on the Boeing web site as a basic message to those seeking advice from the company on the topic. Its contents are also included for the most part in ABET EC 2000.*

Quality vs Quantity Undergraduate Engineering Education

Premise: It is impossible to teach a student everything he or she needs to know as preparation for a professional career in a four or five (or ten) year university program.

- **Demonstrate that engineering is practiced within a much broader societal context - not as an end in itself.**
- **Teach students how to learn - and make it clear that it is a life-long pleasure.**
- **Develop a fundamental understanding of the unity of the fundamental tools and concepts needed for engineering practice (rather than providing them a vast bag of tricks for solving selected problems). These basic fundamentals include:**
  - **Mathematics**
  - **Information technology**
  - **Science, including the "engineering sciences"**
  - **Design and manufacturing**
  - **Economics and business practices**
  - **Communication skills (written, oral, graphic and listening)**
- **Emphasize "design" [Creative thinking and open-ended problem solving in the most general sense] and its close connection with manufacturing (i.e. "If you can't build it, you can't use or sell it".]**
- **Show students how to get information and how to deal effectively with too much of it (i.e. emphasize critical thinking and evaluation skills)**
- **Emphasize teamwork (not merely "group work") and communication skills**
- **Emphasize the "Why" and "What" of theory, and how these basics are then applied in practice. (the "How" in applications can then be gained by experience and subsequent training).**

Positions/ Jobs

Research Scientist

3-4 years

Research Engineer/ Supervisor

3 years

Advanced Engineering Leader

3-4 years

Technology Development Manager

8 years

Director Concept Engineering Office

3 years

Chief Engineer Advanced Vehicle Office

4 years

Director Vehicle Systems Engineering

4 years

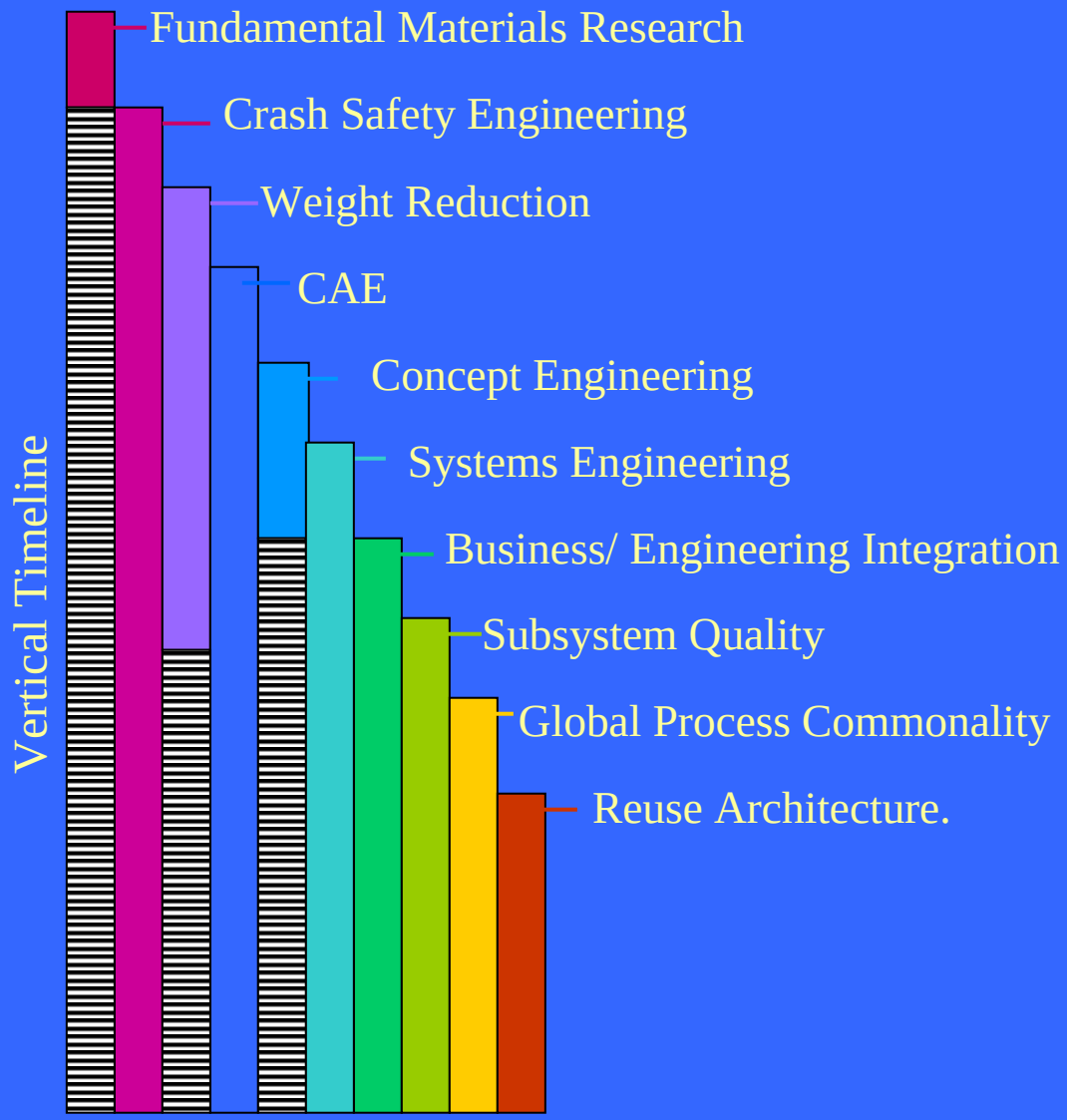
Director Vehicle systems and Concepts Engineering

4 years

Executive Director Program and Advanced Engineering

2 years

Types of Work Done



RECOMMENDATIONS

have fun AND learn

AND be professional