WHAT IS ENGINEERING?
root of the word...

ENGINEER
root of the word...

ENGINEER

not English

French "ingénieur"

"ingenuiter"
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.
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.
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

Fundamental Materials Research
Crash Safety Engineering
Weight Reduction
CAE
Concept Engineering
Systems Engineering
Business/ Engineering Integration
Subsystem Quality
Global Process Commonality
Reuse Architecture.
RECOMMENDATIONS

have fun AND learn

have fun

AND be professional