Engineering

It is a great profession. There is the fascination of watching a figment of the imagination emerge through the aid of science to a plan on paper. Then it moves to realization in stone or metal or energy. Then it brings homes and jobs to men. Then it elevates the standards of living and adds to the comforts of life. That is the engineer's high privilege.

The great liability of the engineer compared to men of other professions is that his works are out in the open where all can see them. His acts, step by step, are in hard substance. He cannot argue them into this air or blame the judge like lawyers. He cannot, like the politicians, screen his shortcomings by blaming his opponents and hope the people will forget. The engineer simply cannot deny he did it.

On the other hand, unlike the doctor his life is not among the weak. Unlike the soldier, destruction is not his purpose. Unlike the lawyer, quarrels are not his daily bread. To the engineer falls the job of clothing the bare bones of science with life, comfort, and hope. No doubt as years go by the people forgot which engineer did it, even if they ever knew. Or some politician put his name on it. Or they credit it to some promoter who used other people's money… But the engineer looks back at the unending stream of goodness which flows from his successes with satisfaction that few professionals may know. And the verdict of his fellow professionals is all the accolade he wants.

~Herbert Hoover, American Mining Engineer and 31st U.S. President (1874-1964)

SES: Summer Engineering Seminar 2016

Dr. Jessica Anderson Kuczenski (Dr. JAK)

Welcome to the School of Engineering at SCU!!

An Introduction to Engineering

- **Five most frequently asked questions:**
  - What is engineering?
  - What is the difference between engineering, science and technology?
  - What are the career areas in engineering?
  - What does the future hold for engineers?
  - How do I know if engineering is for me?

What is Engineering?

- **Background of the word in Latin:**
  - *ingenerare* – to create
  - *ingenium* – the product of genius
  - *ingen* became engine and people who designed creative things were known as engine-ers
- **So, what is an engineer?**

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- **So, what is an engineer?**
  - An engineer is a creative, ingenious person

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- **So, what is an engineer?**
  - An engineer is a creative, ingenious person
- **What does an engineer do?**
  - Engineers create (i.e. design) ingenious solutions to societal problems

What is Engineering?

Define "What is Engineering" with a neighbor!

Introduce yourselves briefly. You have 3 minutes!

Be prepared to report out your thoughts.

What is Engineering?

- The application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems ~ American Heritage Dictionary
- "Engineering is the profession in which a knowledge of the mathematical and natural sciences, gained by study, experience, and practice, is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind." ~ ABET

ABET

- **Accreditation Board for Engineering and Technology**

ABET Assuring Quality • Stimulating Innovation

- **The only accrediting agency for engineering programs in the U.S.**
- **Very important for students considering engineering**
  - For professional registration
  - For transfer between schools
  - For admission into graduate programs

What is Science?

- Theodore Von Karmen, an aerospace engineer, put it nicely when he said, **"Scientists discover the world that exists; engineers create the world that never was."**
- **Science** is defined as the observation, identification, description, experimental investigation, and theoretical explanation of phenomena.
- **Scientist seeks to know, the engineer aims to do**
  - How does this thing work? What is it made of? How did it get to be that way?

What is Technology?

- **Technology** is the application of knowledge, creativity and resources to solve real world problems and extend human capabilities
  - Technology is the Stuff…Engineering is the process.

Engineering, Science & Technology

Skill	Technologist	Engineer	Scientist
Type of work	Application of designs	Translates science into design	Searches for new knowledge
Demand	Low	High	Low
Supervisory	Sometimes	Frequently	Sometimes
Training required	2-4 years	4-7 years	4-7 years
Salary	Medium	High	Medium

Skill-based

Knowledge-based

What is Engineering?

Many Different Engineers…

- = Aerospace
- = Agricultural
- = Architectural
- = Biomedical
- = Ceramic
- = Chemical
- = Civil
- = Computer
- = Construction
- = Electrical
- = Environmental
- = Geological
- = Geotechnical
- = Industrial
- = Manufacturing
- = Marine/Ocean
- = Materials
- = Mechanical
- = Metallurgical
- = Mining
- = Nuclear
- = Petroleum
- = Software
- = … and I've missed some

Engineering Employment (2014)

Mechanical: 270,700
Civil: 263,460

Industrial: 236,990

Electrical: 174,550

Electronics, except computer: 133,990

Computer hardware: 76,360

Aerospace: 69,080

Environmental: 53,240

Petroleum: 33,740

Chemical: 33,470

Materials: 24,990

Health and safety, except mining safety and inspectors: 24,530

Biomedical: 20,080

Nuclear: 16,520

Mining and geological, including mining safety: 8,200

Marine and naval architects: 7,570

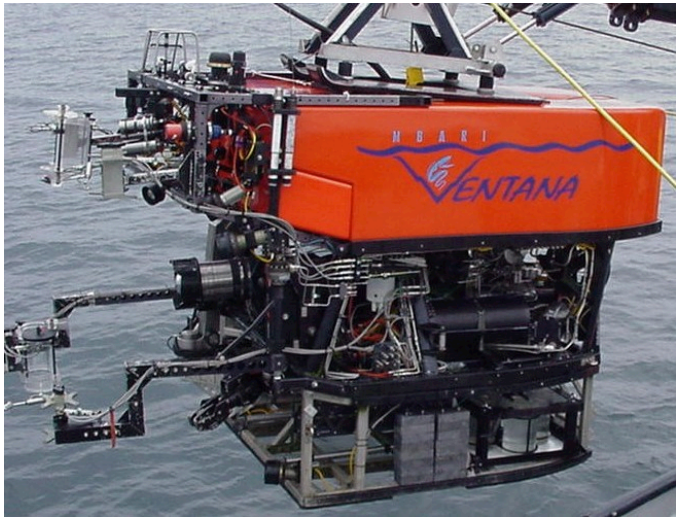
Agricultural: 2,450

Engineers, all other: 124,570

From Bureau of Labor Statistics, U.S. Department of Labor, http://www.bls.gov/oes/current/oes_stru.htm#17-0000

Some things that engineers make

More things engineers make

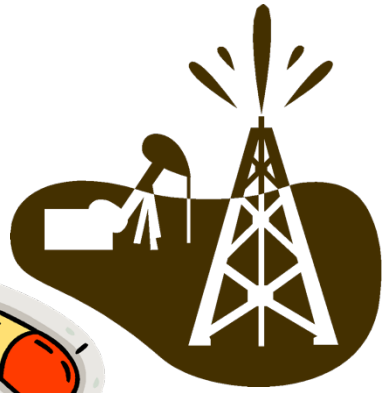


Common Engineering Fields

- Chemical Engineering
- Civil Engineering
- Computer Engineering
- Electrical Engineering
- Industrial Engineering
- Mechanical Engineering

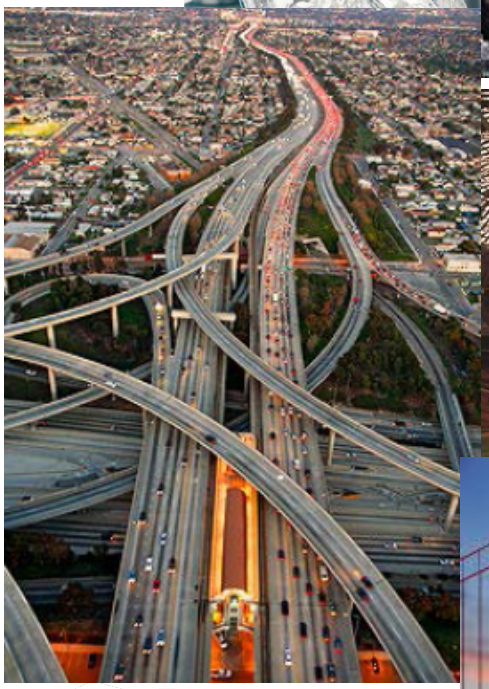
Chemical Engineering

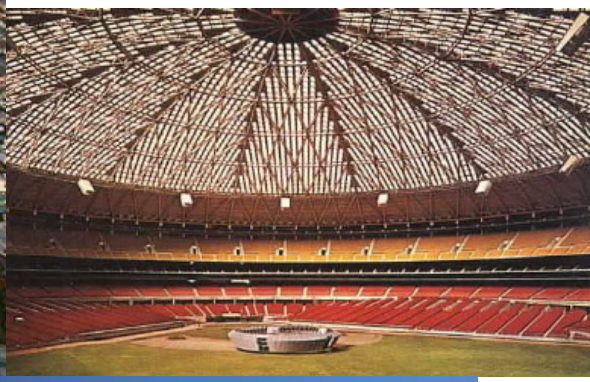
- **Practical application of chemical processes in the development and refinement of materials and products**
- **Work in:**
  - Manufacturing
  - Pharmaceuticals
  - Healthcare
  - Design and construction
  - Pulp and paper
  - Petrochemicals
  - Food processing
  - Specialty chemicals
  - Polymers
  - Biotechnology
  - Environmental health and safety

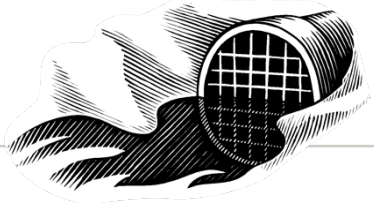


Civil Engineering

- **Have always advanced civilization**
- **Seven major branches:**
  - Structural
  - Environmental
  - Geotechnical
  - Water resources
  - Transportation
  - Construction
  - Urban planning





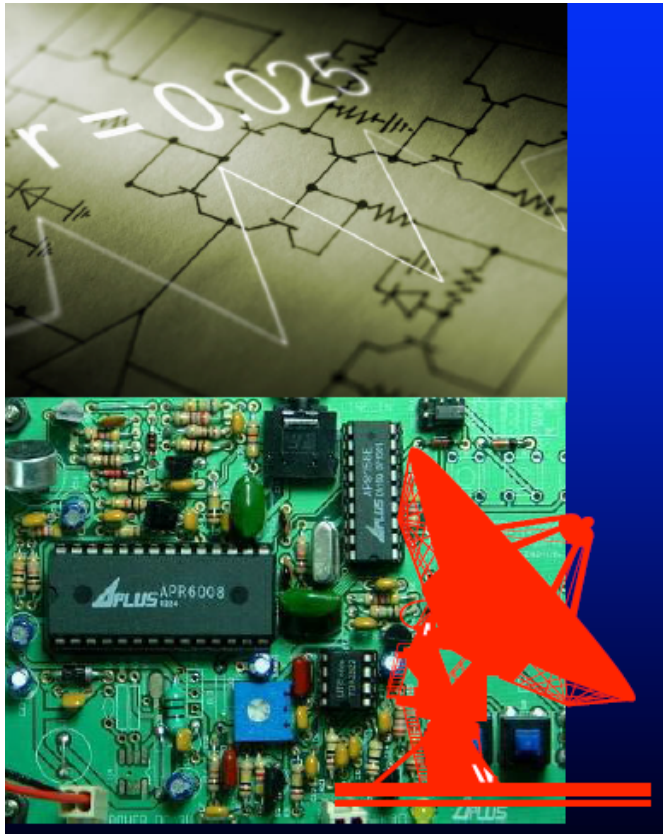


Computer Engineering

- Analyze, design and evaluate computer systems
- Often focus on problems or challenges that result in new state-of-the-art products that integrate computer capabilities
- Hardware, operating systems, and software

Electrical Engineering

- **Design and development of electronic systems and the manufacture of electrical and electronic equipment and devices**
- **Common subfields:**
  - Telecommunications
  - Power engineers
  - Computer industry
  - Semiconductor technology

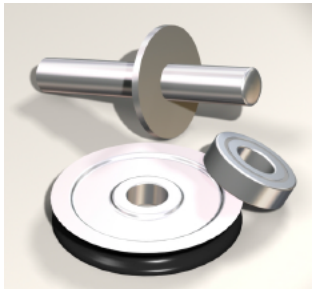


Industrial Engineering

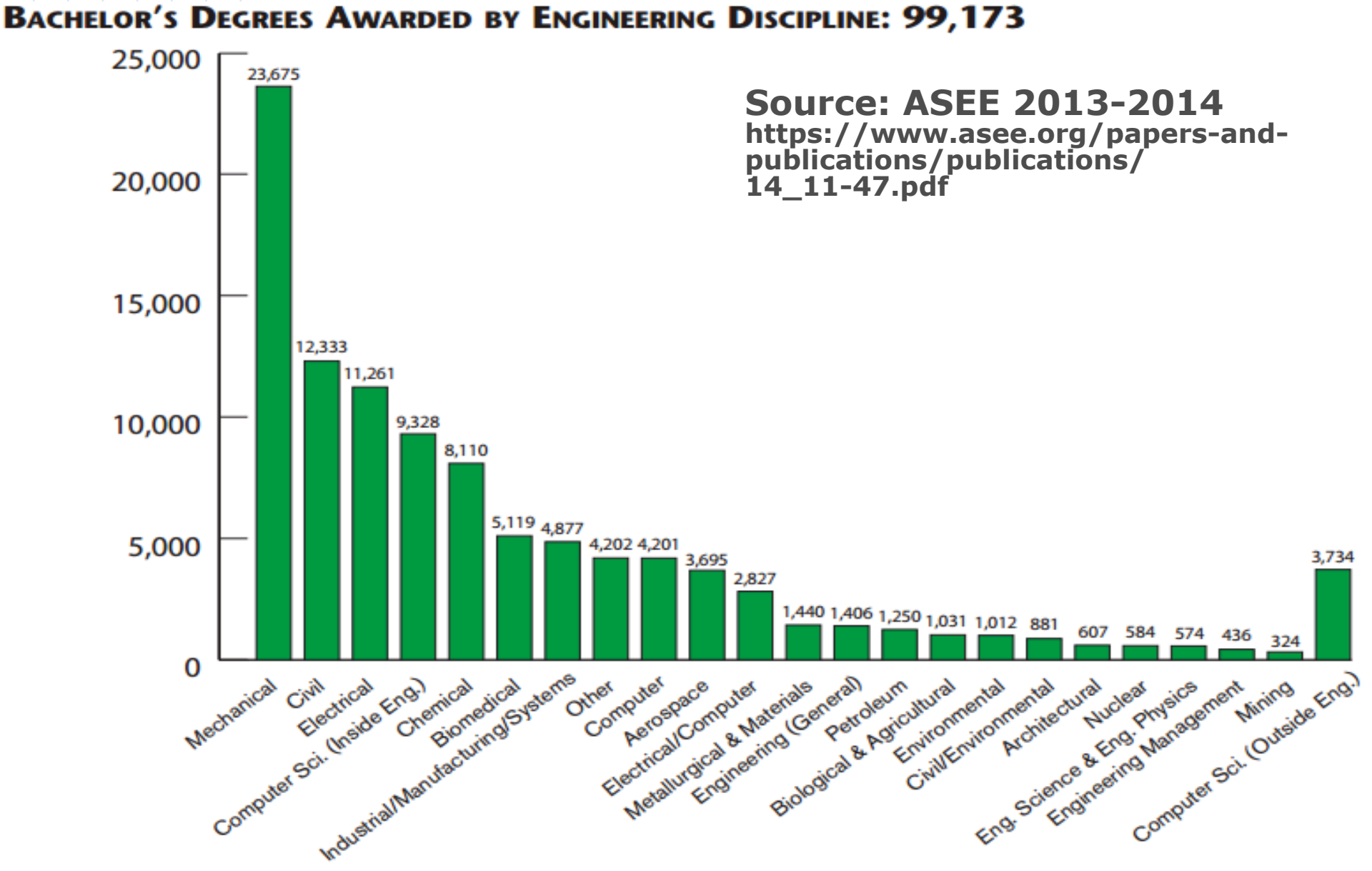
- **Determine most effective ways to use the basic factors of production**
  - People, machines, materials, information, and energy
- **Bridge between management goals and operational performance**
  - Management control systems
    - Financial planning, Cost analysis
  - Physical distribution of goods and services
  - Plant location
    - Raw materials
    - Transportation
    - Costs

Mechanical Engineering

- **If it moves or involves energy – it was probably designed and built by a mechanical engineer**
- Use principles of energy, materials, and mechanics to design and manufacture machines and devices
  - Power producing machines
  - Power using machines
  - Material handling systems
  - Machine tools
  - Robotics
  - Fluids



Engineering Disciplines



Source: ASEE 2013-2014
https://www.asee.org/papers-and-publications/publications/14_11-47.pdf

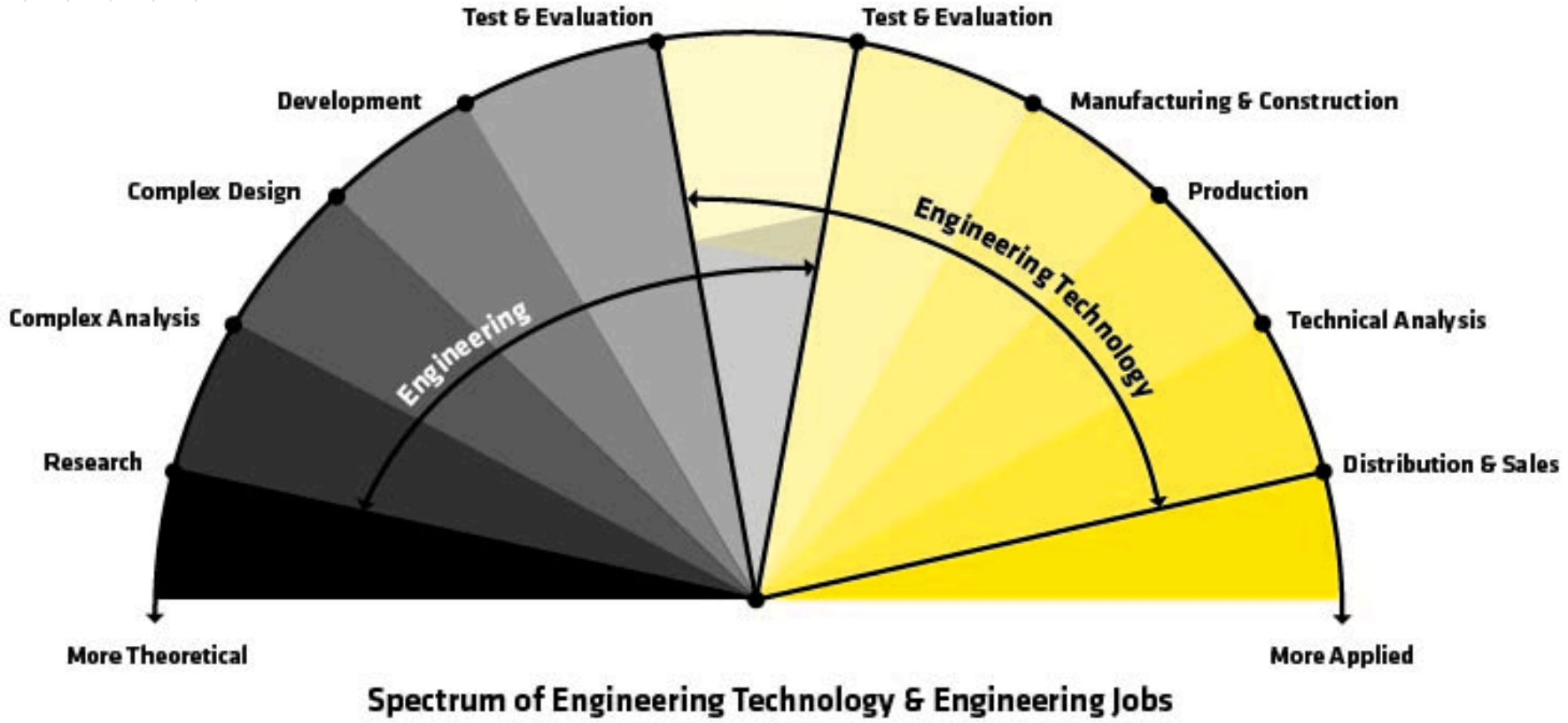
Engineering Functions

- **Functions of engineering as important as the disciplines!**

Discipline + Function = Career

- **Research** – searching for new technology
- **Development** – improving technologies to make them economically feasible
- **Design** – translating technology into products and processes
- **Construction/production/manufacturing** – making the technology
- **Operations/maintenance** – working with the final products
- **Sales** – providing service to design engineers
- **Management** – leading people on engineering projects to make optimum use of their skills and knowledge

Engineering Functions



Spectrum of Engineering Technology & Engineering Jobs

Wichita State University
College of Engineering

Image: Web. Accessed 4/11/16. http://webs.wichita.edu/depttools/depttoolsmemberfiles/engineeringtech/Engineering_career-spectrum_WEB.jpg

What is Engineering?

- Create things or processes that people need or want to improve
- Make things that do not yet exist
- Use resources efficiently
- Address grand challenges of the time

What problem do you want to solve?

~ or ~

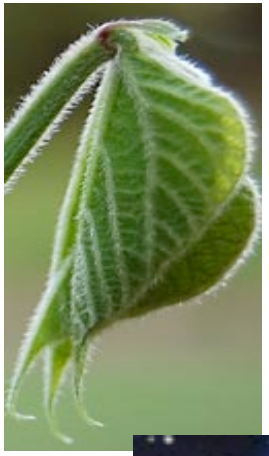
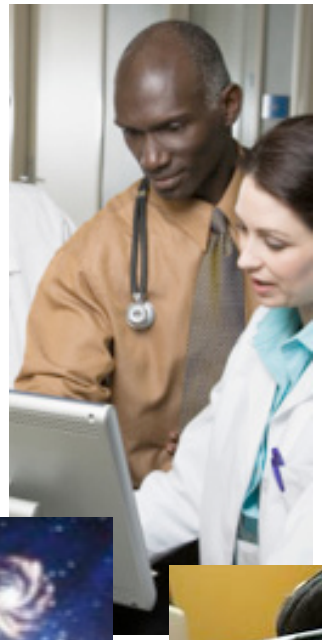
What do you think is a grand challenge we face in the future?

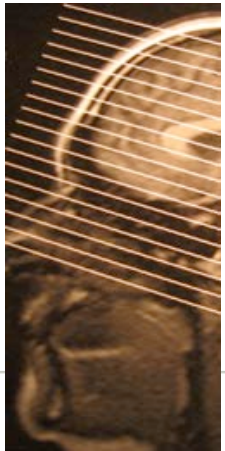
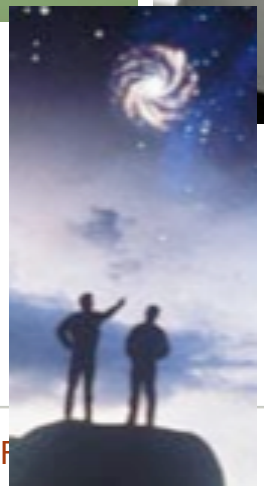
Some Grand Challenges

- Energy
- Environment e.g.Clean Water
- Better Health
- Infrastructure for increasing populations
- Competitive Edge in World Market – finding niches, globalization and local self-sufficiency





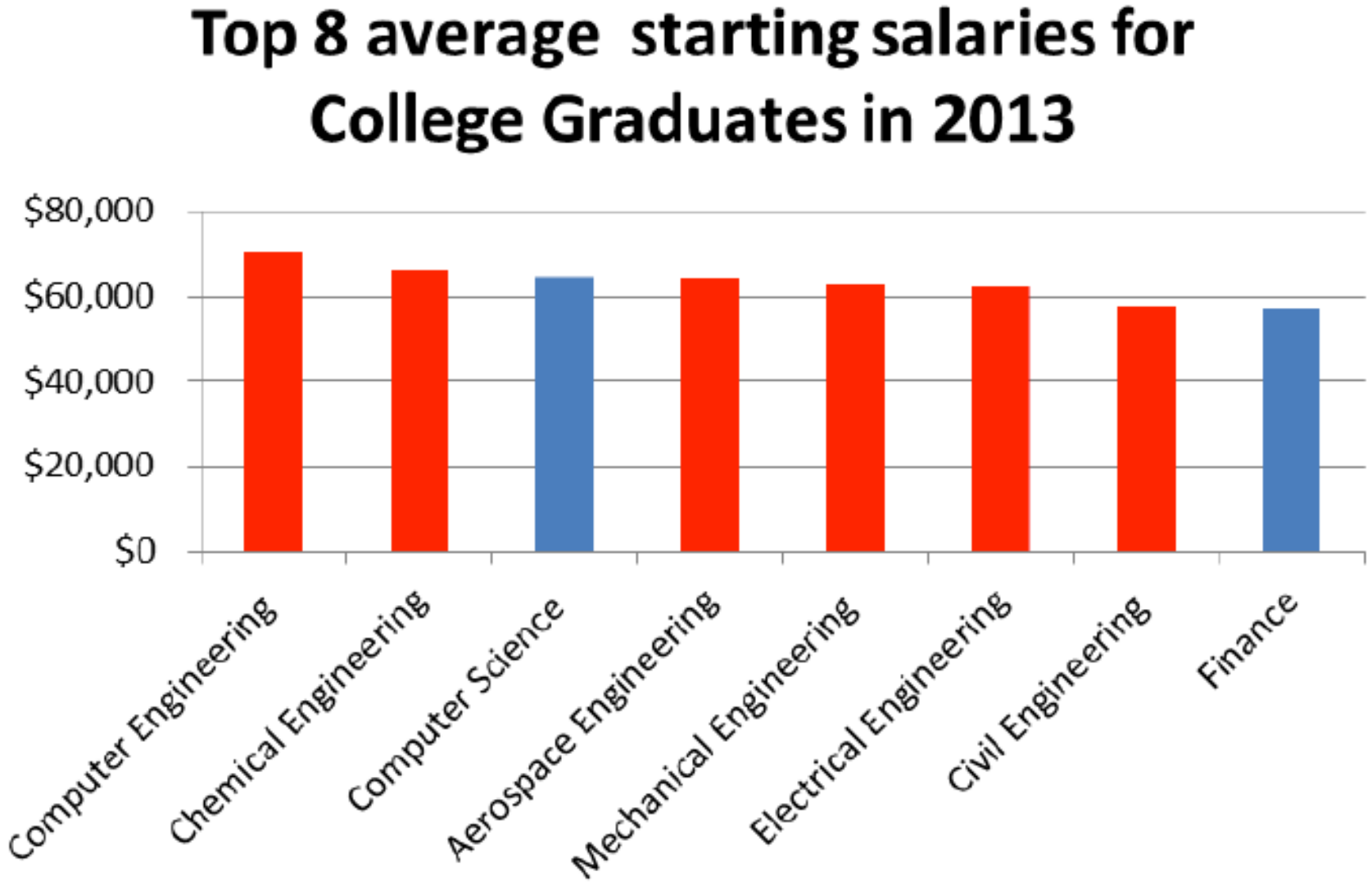




How do you know if Engineering is for you?

- Do you want to work in making processes and products that really help people?
- Do you enjoy mathematics and science?
- Are you curious about how things work?
- Do you like puzzles and problem solving?
- Are you willing to undertake a rigorous training in exchange for career rewards?

Engineering as a Career



Source: http://www.forbes.com/sites/susanadams/2013/01/24/college-degrees-with-the-highest-starting-salaries-2/

Engineering as a Career

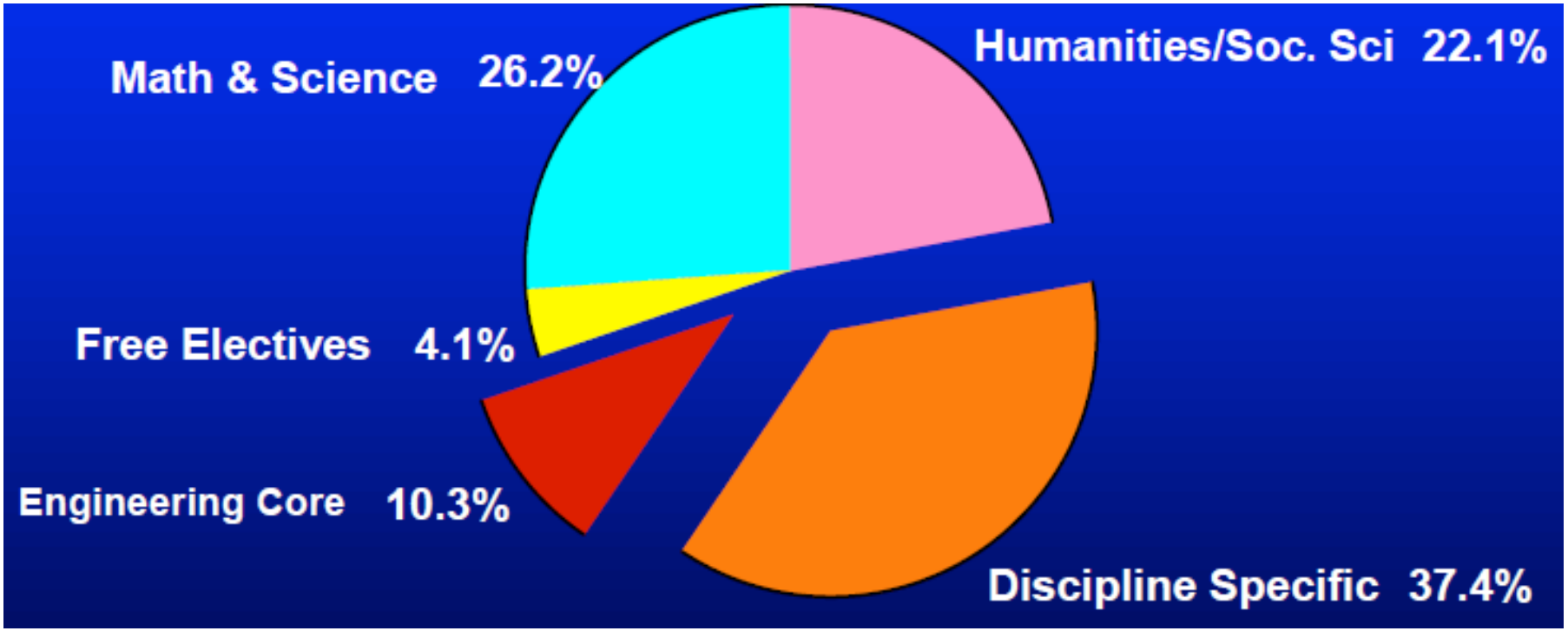
- **The changing face of the U.S. workforce:**
  - 50% of the U.S. engineering workforce is more than 48 years old and thus will be replaced over the next 17 years
  - 85% of new workers entering the California labor force in the next decade will be minority and/or female
  - Expanding role for engineers in our tech world

Year	Ratio of Engrs and Scientists to working population
1900	1:1800
1950	1:190
1960	1:130
1980	1:65
2000	1:35
2010	1:20

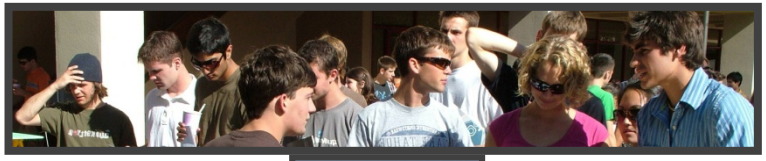
Engineer as a Professional

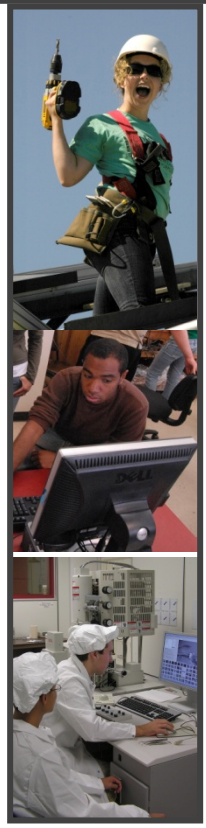
- **Six characteristics of a profession:**
  - Members are highly trained in a specific area
  - Members engage in continuing education
  - Members operate with standard of ethics
  - Members are responsible to serve the public
  - Members have professional organizations
  - Members are often registered or licensed
- **Engineer's creed:** As a professional engineer, I dedicate my professional knowledge and skill to the advancement and betterment of human welfare.

Undergraduate Engineering Program at SCU



T-Model of Engineering Education





- **Deep technical core (hard skills – left brain):**
  - Coursework: Math, Science, engineering
  - Project work: design, …
- **Broad range of soft skills (right brain)**
  - Communication
  - Ethics, Integrity
  - Entrepreneurial mindset
  - Creativity
  - Global view…

- **Educating engineers to:**
  - Understand difference between private interest and public good
  - Lead the world in introducing and applying new technology critical to improving life