COLLEGE OF
ENGINEERING, ARCHITECTURE
AND TECHNOLOGY

西南交通大學
Southwest Jiaotong University

INTRODUCTION TO ENGINEERING (ENGR 1111)

Joint Bachelors Degree Program of Oklahoma State University & Southwest Jiaotong University

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Title： Associate Professor

INTRODUCTION TO ENGINEERING

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Chapter 1: What is Engineering?

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Chapter 1: What is Engineering？

Engineering

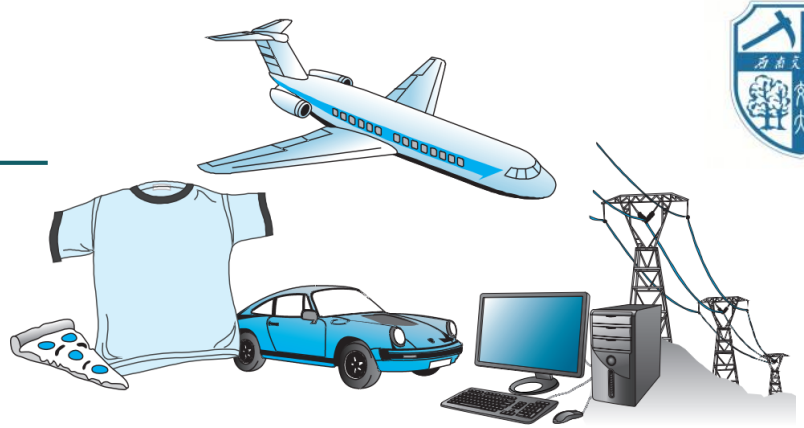
The term *engineering* is derived from the Latin *ingenium*, meaning "cleverness" & *ingeniare*, meaning "to contrive, devise".

Engineering is the **application of science & mathematics to solve problems.**

Engineering is the creative application of science, mathematical methods, and empirical evidence to the innovation, design, construction, and maintenance of structures, machines, materials, devices, systems, processes, and organizations.

Goal: SOLVE PROBLEMS!

What do Engineers Do?



- Engineers **apply physical & chemical laws and mathematics** to design millions of products & services that we use in our everyday lives.
- Engineers consider important factors such as cost, efficiency, reliability, & safety when designing the products.
- Some engineers work as sales representatives for products, while others provide technical and customer support for customers to assist with installation, operation, and maintenance of various products and machines..
- Engineers work in departments of agriculture, defense, energy, transportation, aerospace etc.

A Scientist and an Engineer

- **Scientists & Engineers:**
- **Scientist (A practitioner of Science)**
  - Seeks to expand knowledge
  - Draws general conclusions
  - Produces knowledge

> Scientists investigate that which already is; Engineers create that which has never been.
>
> — Albert Einstein —

- **Engineer (A practitioner of Engineering)**
  - Seeks to apply knowledge
  - Translates general knowledge to specific solutions
  - Produces devices to meet human needs and solve problems

Engineers

- Have the newest technology at their disposal.
- Create new materials to meet the needs of their design.
- Develop new methods of construction and production

Question!

Name three engineered inventions, that are still being used today, that changed the course of mankind.

The Engineer

- The outer circle possesses a different professional expertise.
- An engineer acts as central coordinator.
- An engineer's educational background enables him to communicate with anyone in the professional circle.

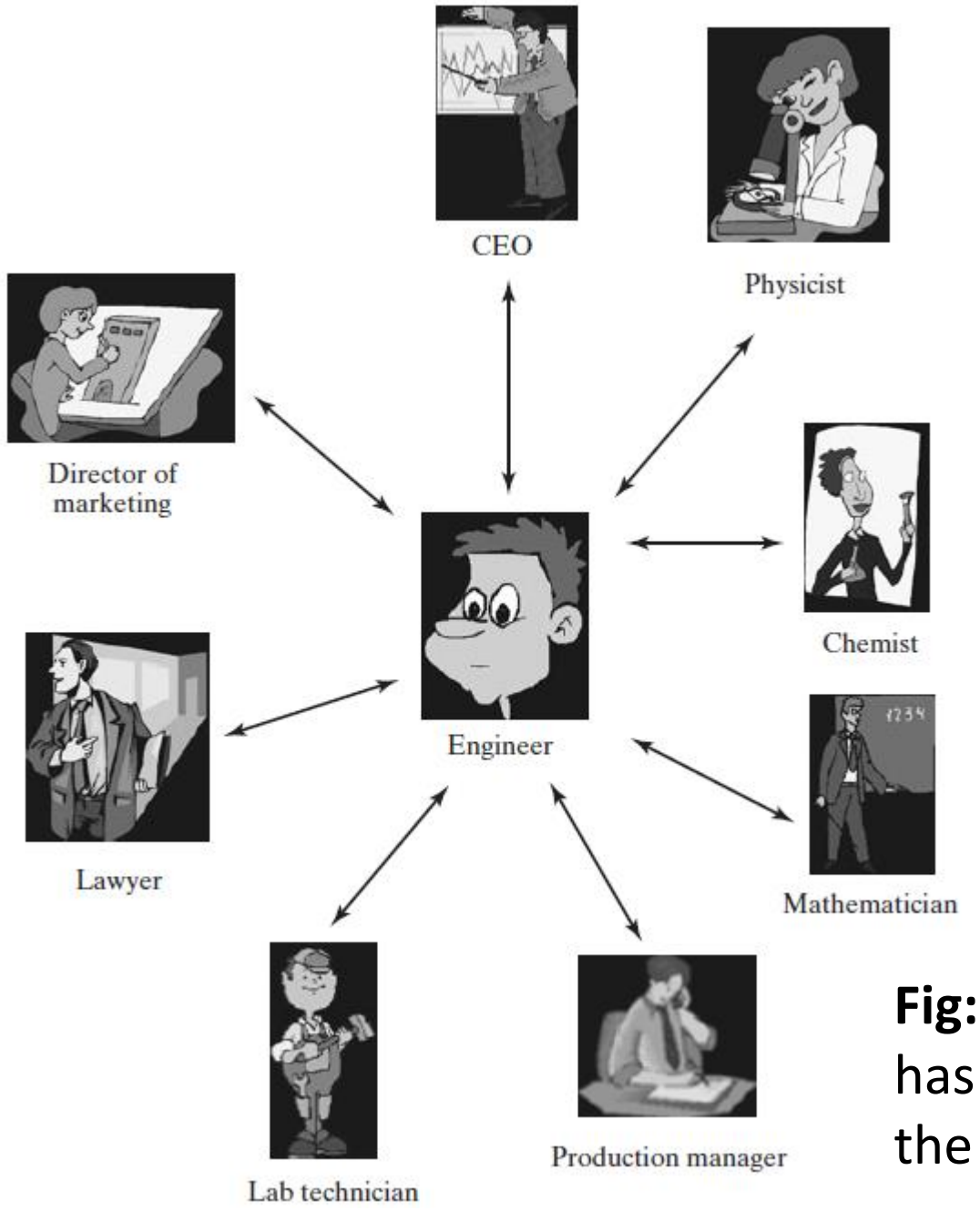
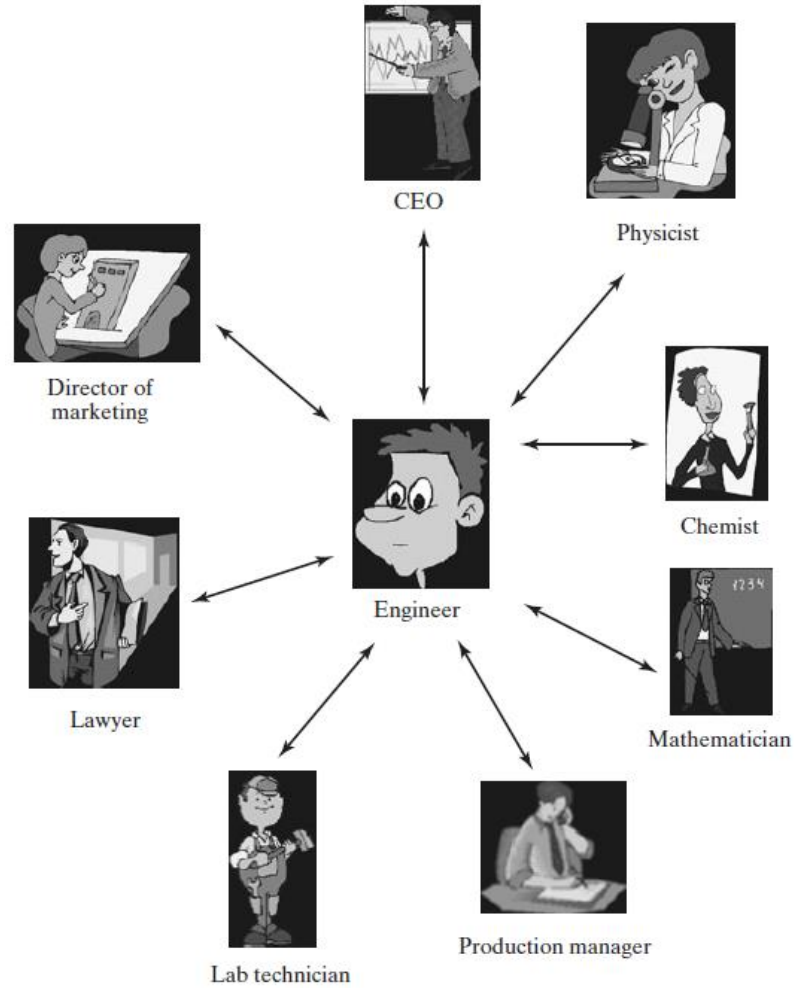


Fig: The *professional circle* has the *design engineer* in the center.

The Engineer

The Physicist

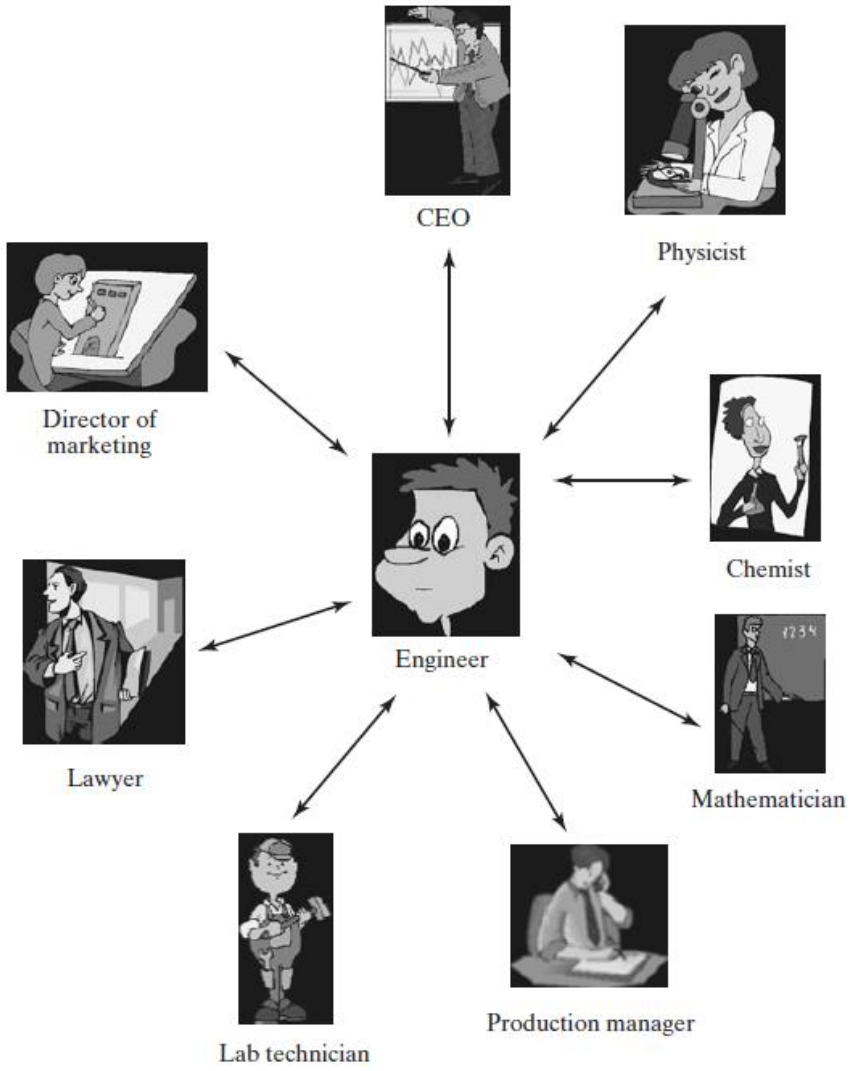
- *Role:* Responsible for understanding the basic principles related to company's products.
- Laboratory work
- Potential discoveries



The Engineer

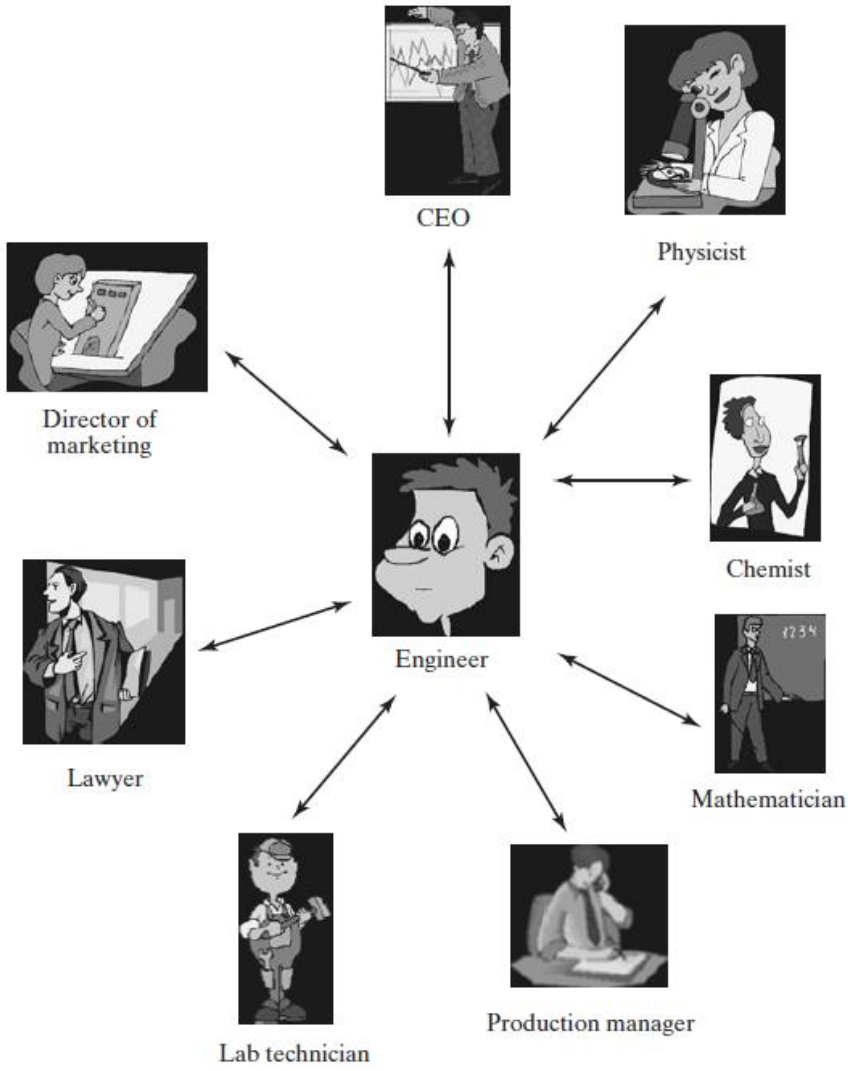
The Chemist

- *Role:* Analyses materials for company products
- *Leadership:* Directs a team of experimentalists in the lab to discover improved, durable products
- *R&D:* conducts research on complex organic compounds & molecular based nanobiotechnology.
- Translate chemical reactions into manufactured products.



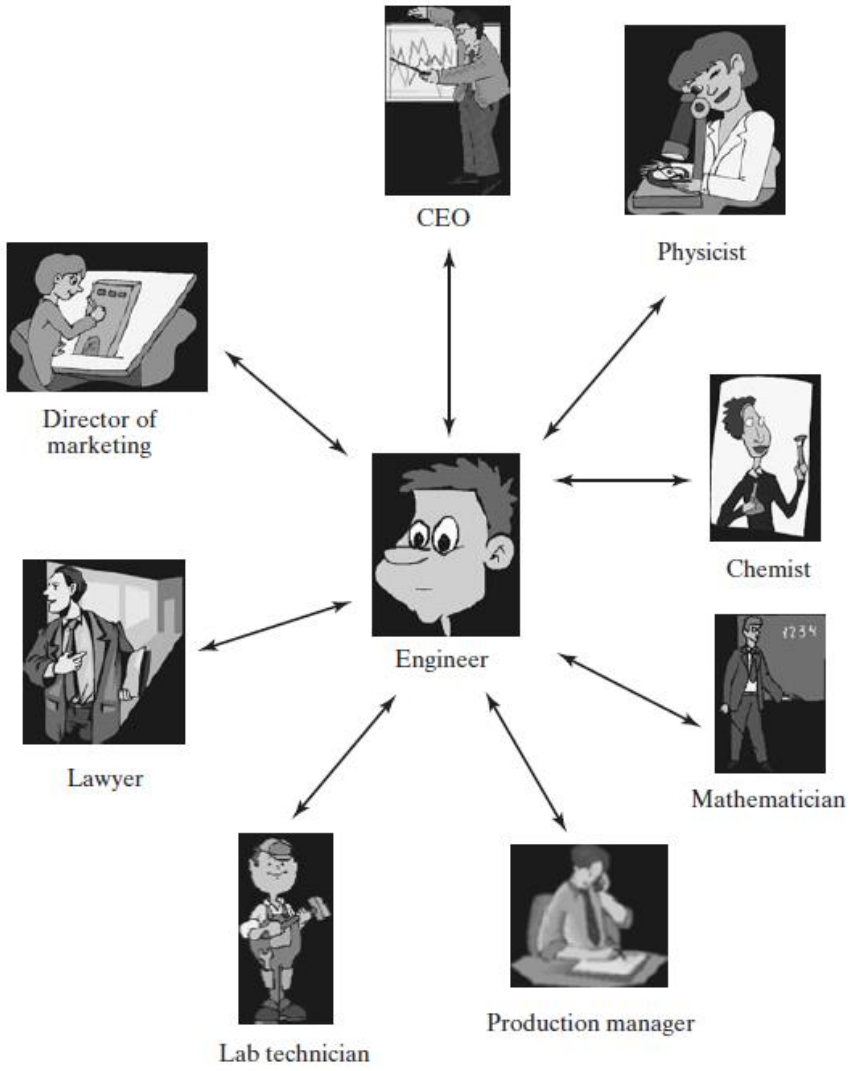
The Mathematician

- *Role:* Focus on modelling, statistics, database & forecasting to support company operations.
- *Mathematical Knowledge needed:*
  - Calculus, Differential equation, algebra, Statistics, Probability etc
- *Application:* engineer can apply concepts to solve problems in engineering design.



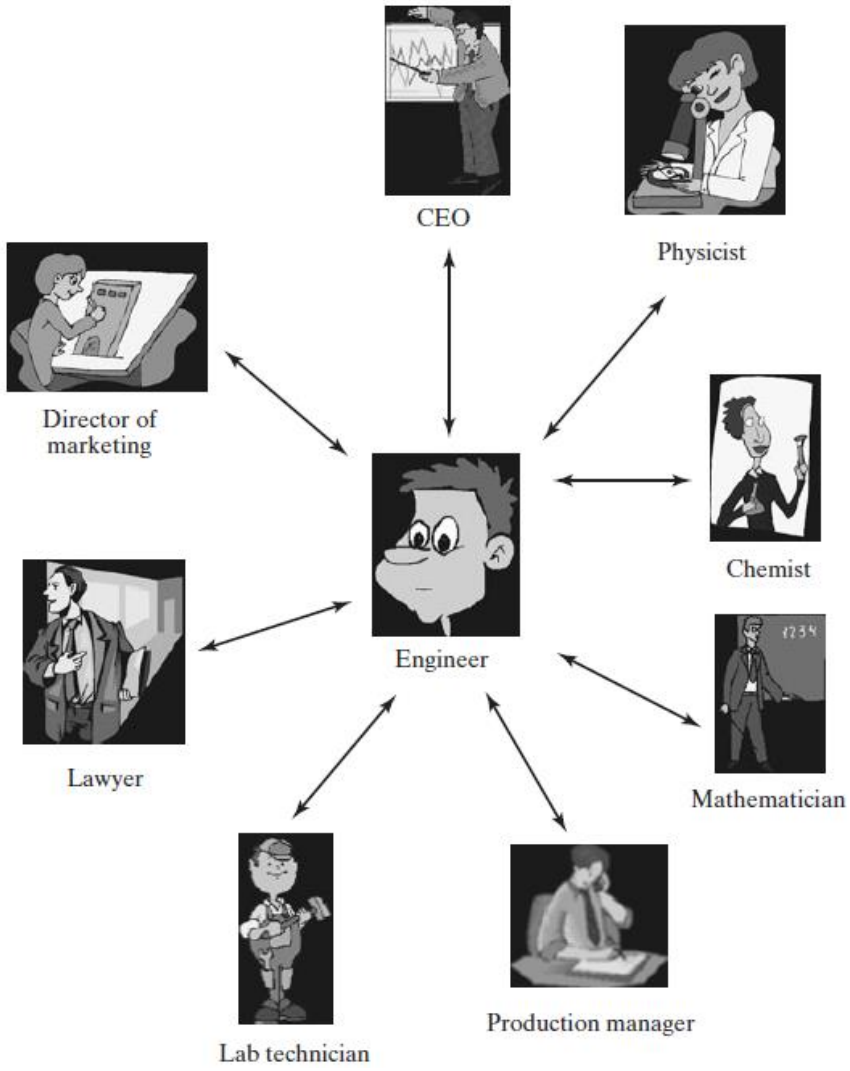
The Production Manager

- *Role:* responsible for organising materials, supplies & personnel to manufacture company products.
- Oversee Job scheduling, quality control, materials allocation, quality assurance testing & yield.
- *As* engineer collaborate with production manager to ensure the design aligns with the company's capability.



The Lawyer

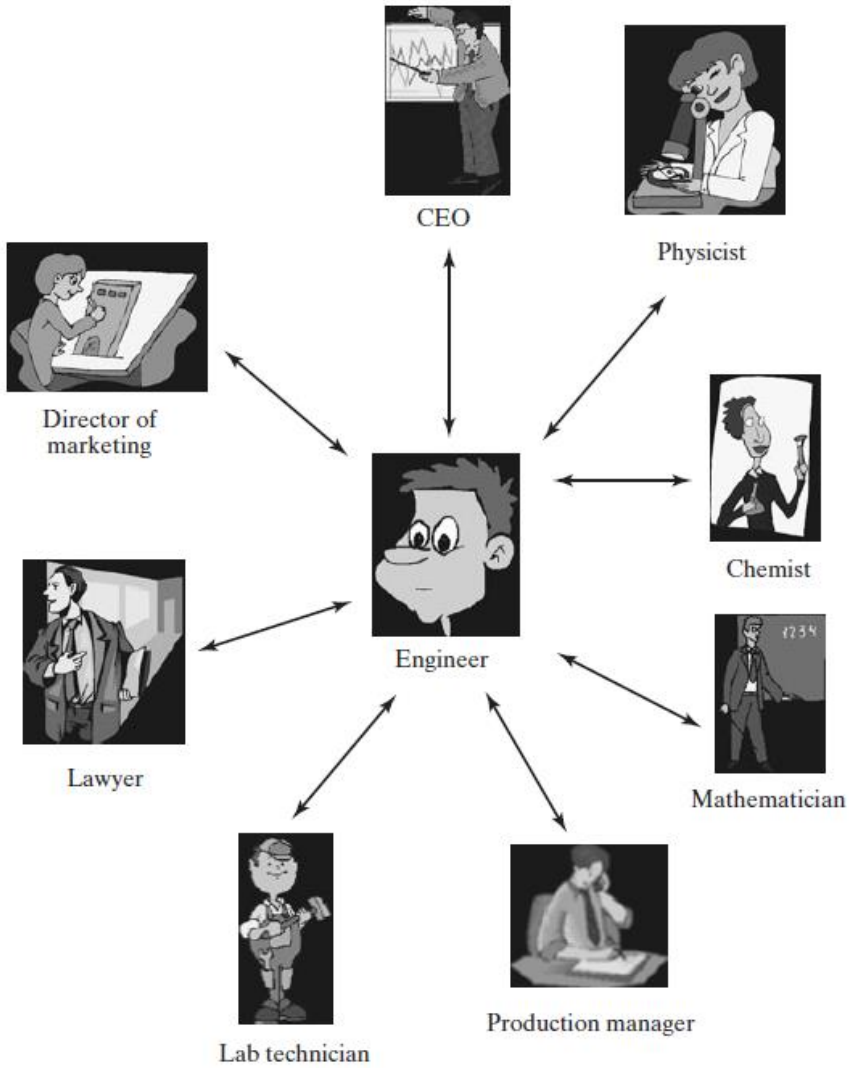
- *Role:* focusses on the legal aspects of the company products.
- To assist a lawyer, an engineer needs to communicate and share the engineering knowledge.
  - An engineer can discuss with the lawyer & apply his legal considerations into the design process.



The Engineer

The Marketing Director

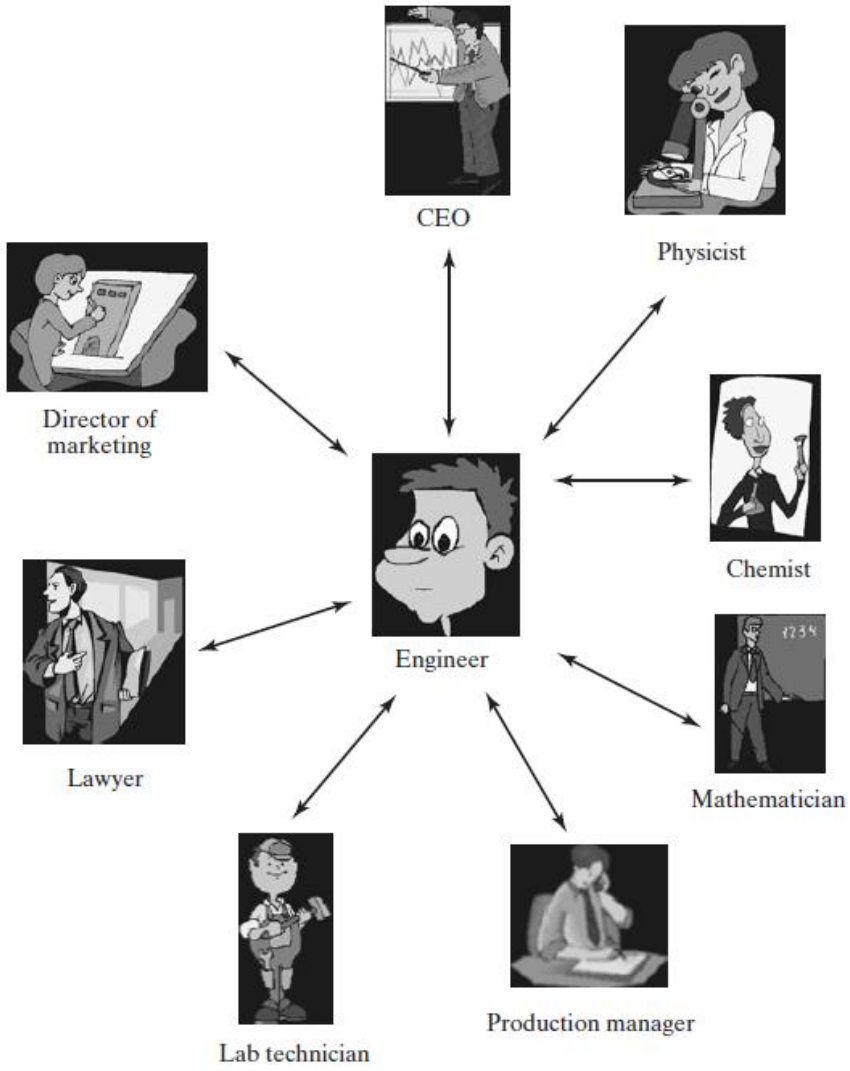
- *Role:* master of imagery & style.
- Advertise, convince the people & Selling the products
- An engineer can help marketing director understand the product & how it works.



The Engineer

The President/CEO

- *Role:* worries about economy & what future markets the company should pursue.
- Determines how to finance the project, needs to be kept up-to-date about its progress.
- An engineer can converse with CEO based on previous educational background, experience and training.



Engineering: A set of Skills

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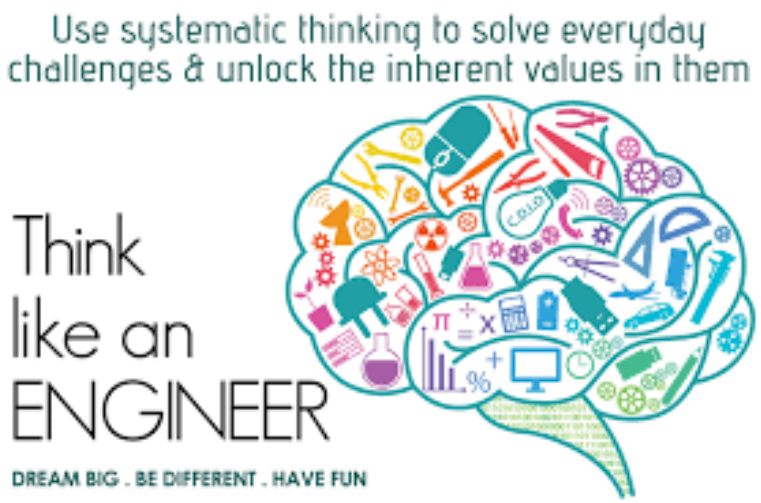
Engineers require/develop…

- **Knowledge**
- **Experience**
- **Intuition**



Engineering: A set of Skills

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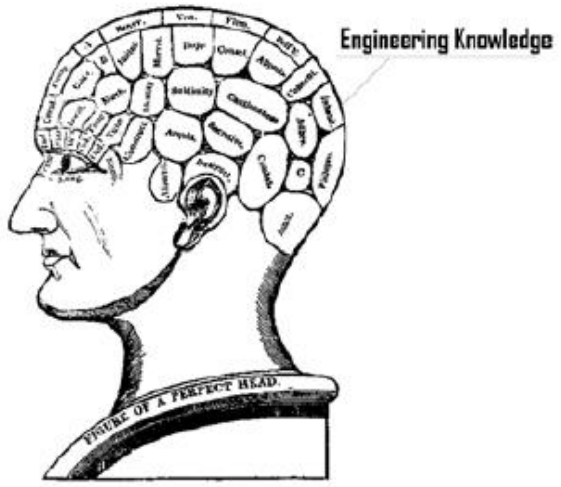
Engineer require/develop…

Knowledge is an important part of engineering

1. Knowledge

- *Knowledge* describes the body of facts, scientific principles, and mathematical tools that an engineer uses to form strategies, analyze systems, & predict results.
- knowledge can provide a deeper understanding of how something works.
- Engineers work in a multidisciplinary world where a basic knowledge of many different subject areas is critical.
- Cross-disciplinary Knowledge is critical for communication & design proficiency
- ***Sources of engineering knowledge:***
  - Formal education
  - On-the-job training
  - Life-time of study and exploration
  - Tinkering, fixing, experimenting



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Engineering: A set of Skills

Engineer require/develop…

2. Experience

- *Experience* refers to the body of methods, procedures, techniques, and rules of thumb that an engineer uses to solve problems.
- ***Sources of engineering experience for students:***
  - Cooperative assignments,
  - Assistantships in labs,
  - capstone design projects,
  - Summer jobs, and
  - Research work in a professor's lab
- ***Sources of experience for engineers***
  - On-the-job training
  - Continuing design *failure*.
  - Testing prototypes,
  - Studying failures,
  - Observing the results of design decisions.

Engineering: A set of Skills

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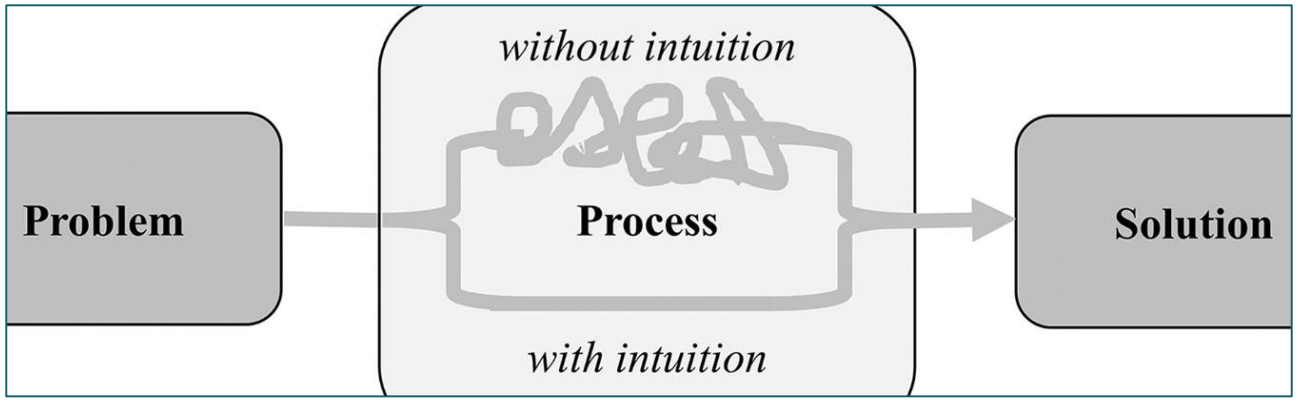
Engineer require/develop…

3. Intuition

- Intuition refers to a basic instinct about what will or will not work as a problem solution
- Developing intuition should be a key goal of engineering education, such as:
  - Will this ship float?
  - Will this spacecraft fly?
  - Will too much power overheat that circuit?
- *Keys to developing design intuition:*
  - Careful attention to details
  - Working with experienced engineers
  - Dedication

"That seems reasonable"
"That answer is acceptable"



Disciplines of Engineering

- Aeronautical
- Agricultural
- Architectural
- Biomedical
- Chemical
- Civil
- Computer
- Electrical
- Environmental
- Food
- Industrial
- Materials
- Mechanical
- Naval
- Nuclear
- Ocean
- Petroleum
- Systems

Disciplines of Engineering

- **Biosystems and Agricultural (or Biological)**
  - Concerned with **systems and devices** that have a significant biological component
- **Chemical Engineering**
  - Apply **principles of chemistry** to the design of manufacturing and production systems
- **Civil and Environmental Engineering**
  - **Design** and **construct** the world's **infrastructure**
- **Electrical and Computer Engineering**
  - **Design and build devices** that apply and use **electricity**
- **Industrial Engineering and Management**
  - Design and implement complex production systems
- **Mechanical and Aerospace**
  - **Design and build devices** that involve **mechanical motion and flight**

Disciplines of Engineering

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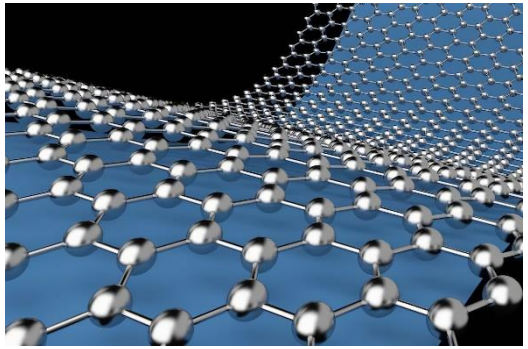
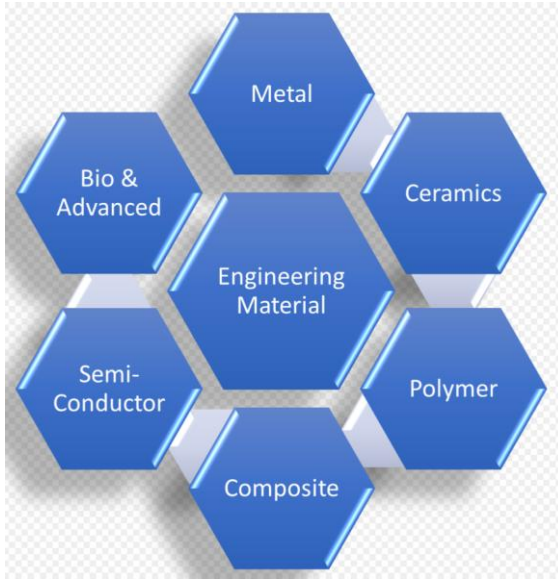
- **Materials Engineering**



- It is concerned with investigating the properties of existing materials and substances in order to create new materials and items with enhanced chemical and physical properties.
- It Combines mathematics, physics, and chemistry.
- New materials could be in the form of metal alloys, ceramics, plastics, or composites.
- Material engineers manipulate the atomic & molecular structure of materials in order to create materials that are lighter, stronger, & more durable.



Electrical, Electronics & Computer Engineering

- Electrical & electronic (EEE) is largest engineering discipline.
- *electrical engineering* is the branch dealing with "heavy current"—i.e., electric light and power systems and apparatuses.
- *electronics engineering* deals with such "light current" applications as telephone and radio communication, computers, radar, and automatic control systems.
- *Electrical and computer engineering (ECE)* is all about the design, analysis, optimization and implementation of electronic and electric circuits and systems that drive all aspects of our modern society.

  e.g. Artificial intelligent systems, power and renewable energy systems, electric vehicles, smart phones, smart homes and cities, robotics, computer systems, cyber security, augmented reality, and medical devices.

Disciplines of Engineering

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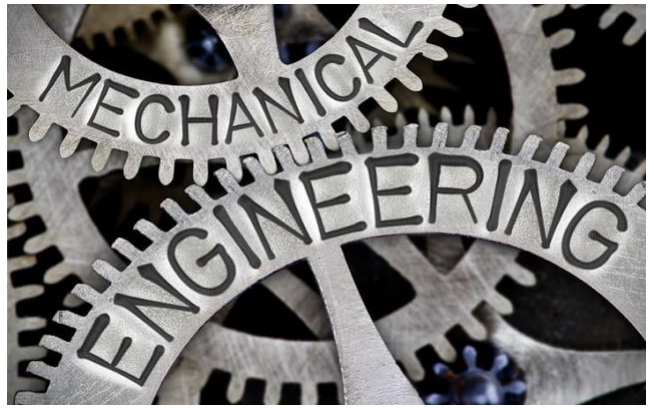
- **Mechanical engineering**
  - One of the most diverse and versatile engineering fields.
  - It is particularly concerned with forces and motion.
  - **Specializes in design and application** - includes the broad areas of **mechanical design**, **mechanical power and manufacturing**
  - *Mechanical engineers* design, develop and test machines, robots, tools, power generating equipment such as steam and gas turbines, heating, cooling, and refrigerating equipment, and internal combustion engines.



- **Aerospace engineering** concerned with the design, development, construction, testing, & operation of vehicles operating in the Earth's atmosphere or in outer space.
  - *Aerospace engineers* design, develop, test, and supervise the manufacture of commercial and military aircraft, helicopters, spacecraft, and missiles.
  - Most aerospace engineers work for aircraft and missile manufacturers, the Department of Defense, and NASA.

Disciplines of Engineering

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- **Biomedical engineering (BE)**
  - It combines biology, chemistry, medicine, and engineering to solve a wide range of medical and health-related problems.
  - Medical doctors, chemists, and biologists are involved to better understand various aspects of biological systems and the human body.
  - BE helps to design artificial limbs, organs, imaging systems, and devices used in medical procedures
  - *Examples:* biomechanics, biomaterials, tissue engineering, medical imaging, and rehabilitation.
  - Computer-assisted surgery & tissue engineering are among the fastest growing areas

Disciplines of Engineering

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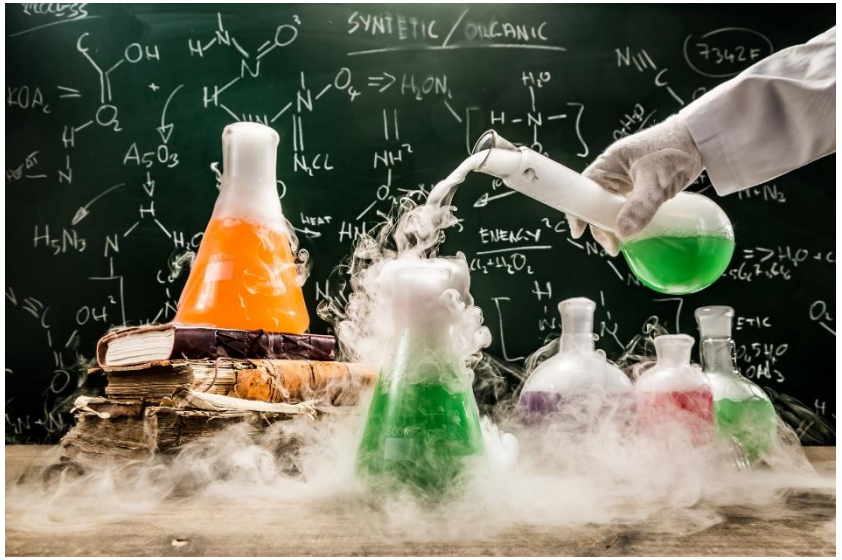
- **Chemical Engineering**
  - Apply **principles of chemistry** to the design of manufacturing and production systems
  - Chemical engineers are employed by chemical, petroleum refining, film, paper, plastic, paint, metallurgical, food processing, biotechnology and fermentation industries.



Disciplines of Engineering

- **Civil Engineering**
  - the oldest engineering discipline
  - Provides public infrastructure and services
  - Civil engineers design and supervise the construction of buildings, roads and highways, bridges, dams, tunnels, mass transit systems, airports, municipal water supplies & sewage systems.
  - **Major branches**
    - Structural
    - Geotechnical
    - Environmental
    - Transportation
    - water resources

Disciplines of Engineering

- **Architecture**
  - **design** space and **create total interior and exterior environments** according the to customer's needs
- **Architectural Engineering**
  - **design** of safe and economical **structural systems used in buildings**

Disciplines of Engineering

- **Construction Engineering Technology**

  Manage the process of **building** of **the** world's **infrastructure** –

  both vertical and horizontal

- **Fire Protection and Safety Engineering Technology**

  Focus on loss control in **fire protection**, **industrial hygiene** and **safety**, and fire service

- **Industrial Engineering and Management**

  Design and implement complex production systems

- **Civil and Environmental Engineering**

  Design and **construct** the world's **infrastructure, pollution control**

Homework

- Depending on your personal interests, prepare a brief two-page report about the goals and reasons of choosing the field of your interest.

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Thank you