# ChE 111
# Elements of Chemical Engineering

**February 2015**

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# Syllabus

## ChE – 111: ELEMENTS OF CHEMICAL ENGINEERING

Scope of chemical engineering, Principles of chemical engineering calculations: systems of units, basic concepts of dimensional analysis, process variables, basis of calculation, conservation of mass and energy. Material balance: overall component balance, recycle and bypass, simple reactive systems and combustion reactions. Energy balance; forms of energy and the First Law of Thermodynamics, thermodynamic data and tables, energy balance on closed and open systems. Application of mass and energy balance to real processes. Measurements of process variables; fluid statics and manometry, flow measurement, temperature measurement.

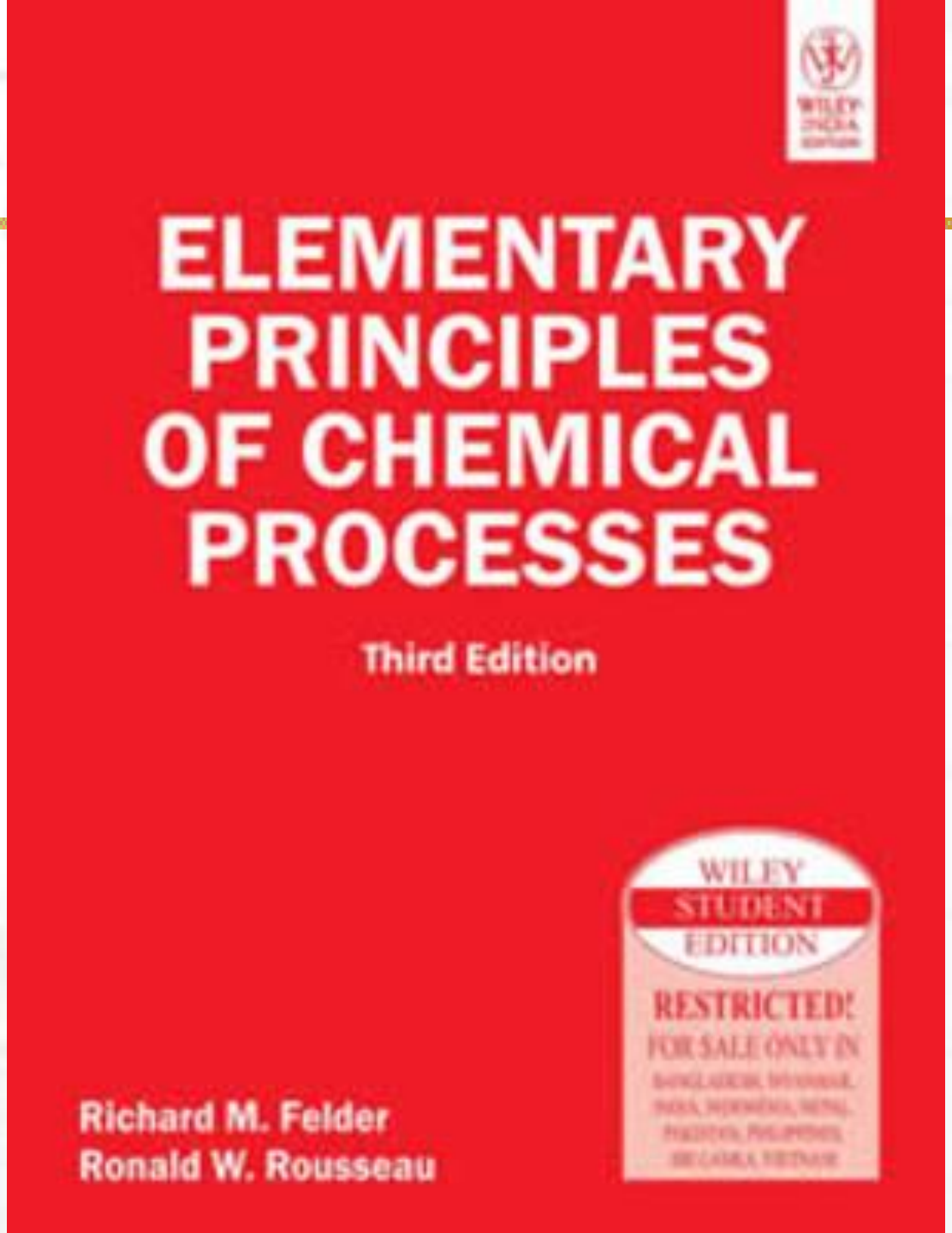
# Books:

**Text book:**

**Felder, R.M. and Rousseau, R.W. (2005), Elementary Principles of Chemical Processes, 3rd ed., John Wiley and Sons, Inc. New York**

**Reference books:**

1. **Reklaitis, G.V. (1983), Introduction to Material and Energy Balance, John Wiley and Sons, Inc. New York**
2. **David M. Himmelblau and James B. Riggs, Basic Principles and Calculations in Chemical Engineering, 8th ed., Prentice Hall**


ELEMENTARY PRINCIPLES OF CHEMICAL PROCESSES
Third Edition
WILEY STUDENT EDITION
RESTRICTED!
FOR SALE ONLY IN
Richard M. Felder
Ronald W. Rousseau

**Course Teachers:** **1.** Dr. M. A. A. Shoukat Choudhury
2. Dr. Nahid Sanzida

**Course Website:** **http://teacher.buet.ac.bd/shoukat/**

**courses → Elements of Chemical Engineering**

# Richard Felder

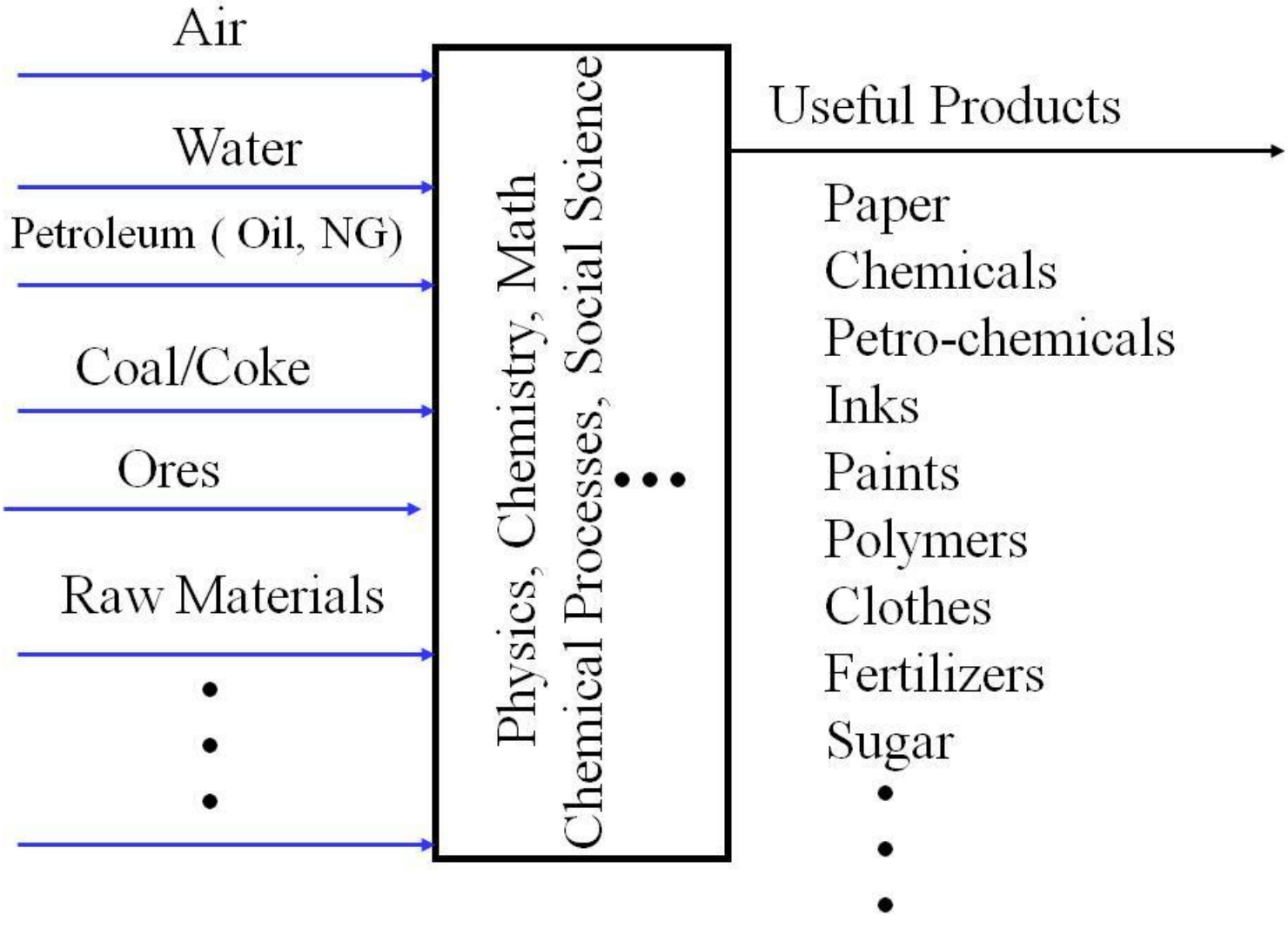

- http://www4.ncsu.edu/unity/lockers/users/f/felder/public/
- North Carolina State University

# What is Chemical Engineering?

**Chemical engineering** is the branch of engineering that deals with the application of physical science (e.g., chemistry and physics), and life sciences (e.g., biology, microbiology and biochemistry) with mathematics, to the process of converting raw materials or chemicals into more useful or valuable forms. In addition to producing useful materials, modern chemical engineering is also concerned with pioneering valuable new materials and techniques - such as nanotechnology, fuel cells and biomedical engineering.[1] Chemical engineering largely involves the design, improvement and maintenance of processes involving chemical or biological transformations for large-scale manufacture. Chemical engineers ensure the processes are operated safely, sustainably and economically. Chemical engineers in this branch are usually employed under the title of process engineer. **A CHEMICAL ENGINEER converts scientific discoveries into marketable products.**

**Source: Wikipedia**

# What is Chemical Engineering?



# Chemical Engg. Products

## Consumer Products

Food, water, clothing, medicines, health & beauty aids, soap and detergents, fuels, lubricants, pulp and papers

## Commodity Chemicals

Oxygen, water, sulfuric acid, ammonia, chlorine, plastics, rubber, fertilizers, inks, polymers, pesticides, insecticides

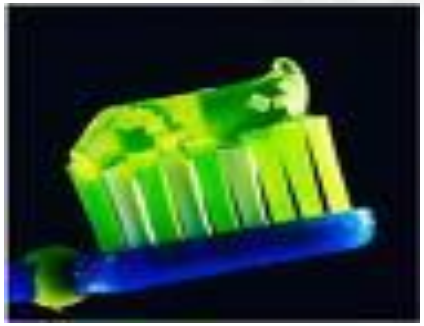
## Special materials

Biomaterials, Nylon, Teflon, nanomaterials

## Electronic/Optical Materials

High purity silicon, compound semiconductors, thin films, optical polymers

# Chemical Products



From Potato chips




To computer chips

# What Can a Chemical Engineer Do?

Inception

Feasibility Study

Site Selection

Design and construction

Built and commission

Manage, operate and troubleshoot


Make Money

# Activities of Chemical Engineers

- Process Development
- Process Evaluation
- Process Design
- Plant Equipment Procurement
- Plant Construction
- Plant Operation and Maintenance
- Research and Development
- Technical Services
- Entrepreneurships
- Management
- Marketing and Product Sales
- Teaching

# Activities of Chemical Engineers

- Bangladesh Situations
  - Mainly Operation and Maintenance
  - Management
  - Entrepreneurships
- Process Engineering
  - involves research and development of Chemical processes, design of Chemical Plant, Project Engineering
- Professional Bodies in Bangladesh
  - Chemical Engineering Division, Institute of Engineers Bangladesh (IEB)
  - Chemical Engineering Alumni Association
  - BUET Chemical Engineering Forum
  - ChemicalBUET

Source: Chemical Engineering Education in Bangladesh by Dr. Nooruddin Ahmed, ICCHE conference 2003, pp. 8-11

# What is the difference Between a Chemist and a Chemical Engineer?

Preparation $H_2$ gas in the laboratory. Zn reacts with $H_2SO_4$ to produce $ZnSO_4$ and

$$Zn\ (s) + H_2SO_4\ (l) \longrightarrow ZnSO_4\ (s) + H_2\ (g)$$

Produce 1 kg or 20 kg ZnSO4 per day

- Probably a chemist can make it

Produce 100 ton (100,000 kg) ZnSO4 per day

- A chemist cannot handle or deal with it.
- Here comes, Chemical Engineering

# Chemical Plants

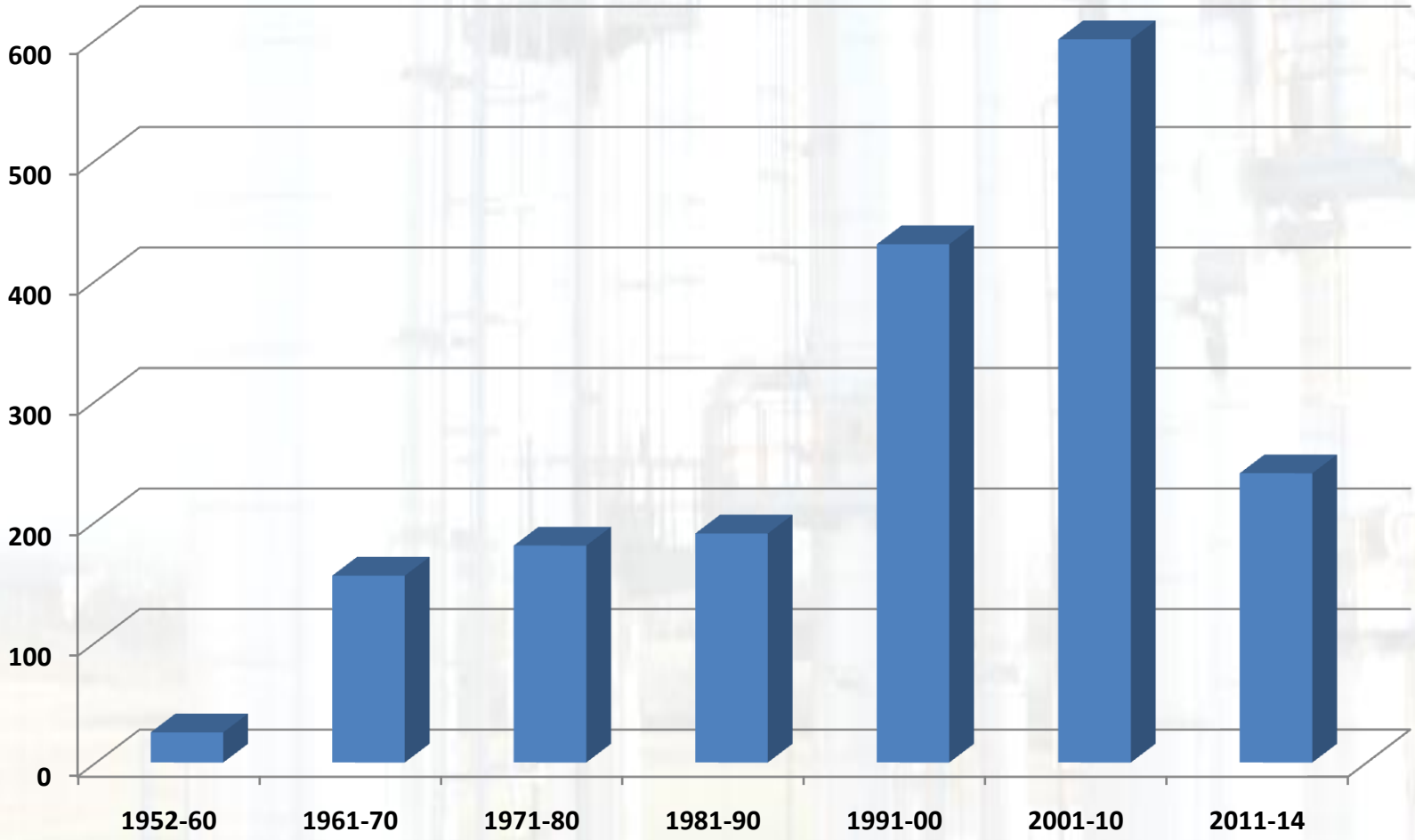
# Difference Between a Chemist and a Chemical Engineer

- A Chemist is good in running a laboratory
- He feels comfortable working in a laboratory
- He does not know how to transfer a technology from Laboratory scale to Industrial scale
- He can’t design and build an industrial plant

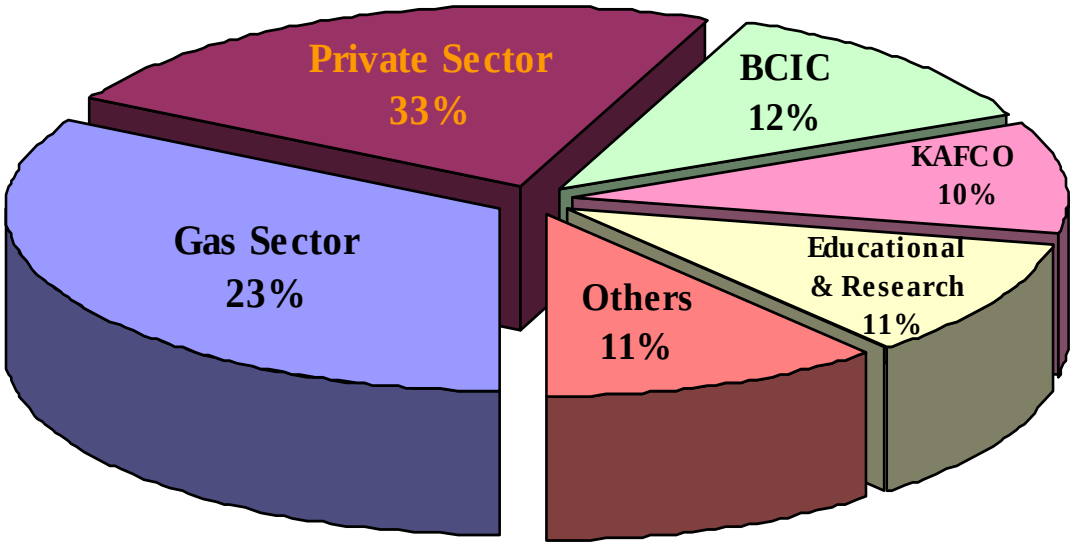
- A Chemical Engineer is capable of running a laboratory
- He is comfortable working in an industrial environment
- He knows how to transfer a technology from laboratory to industry
- He CAN design, build, operate and run an industrial process

# Graduates of ChE, BUET

## Total number of graduates from 1952-2014: 1820



# National Employment Profile




A Graphical View of the
Employment Profile of Chemical Engineers in Bangladesh, December 2006

# ChE Job Profile at USA

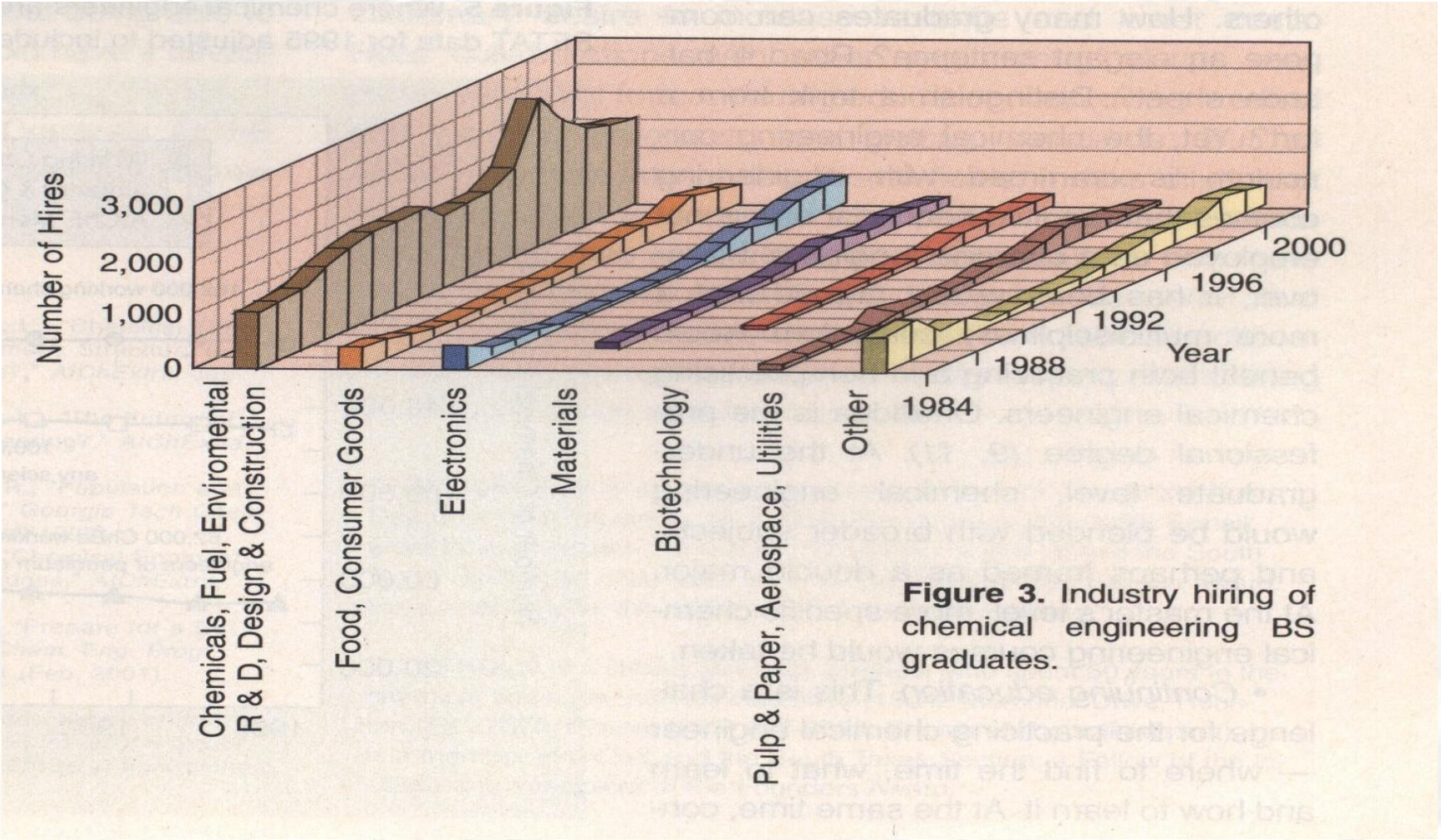



**Figure 3.** Industry hiring of chemical engineering BS graduates.

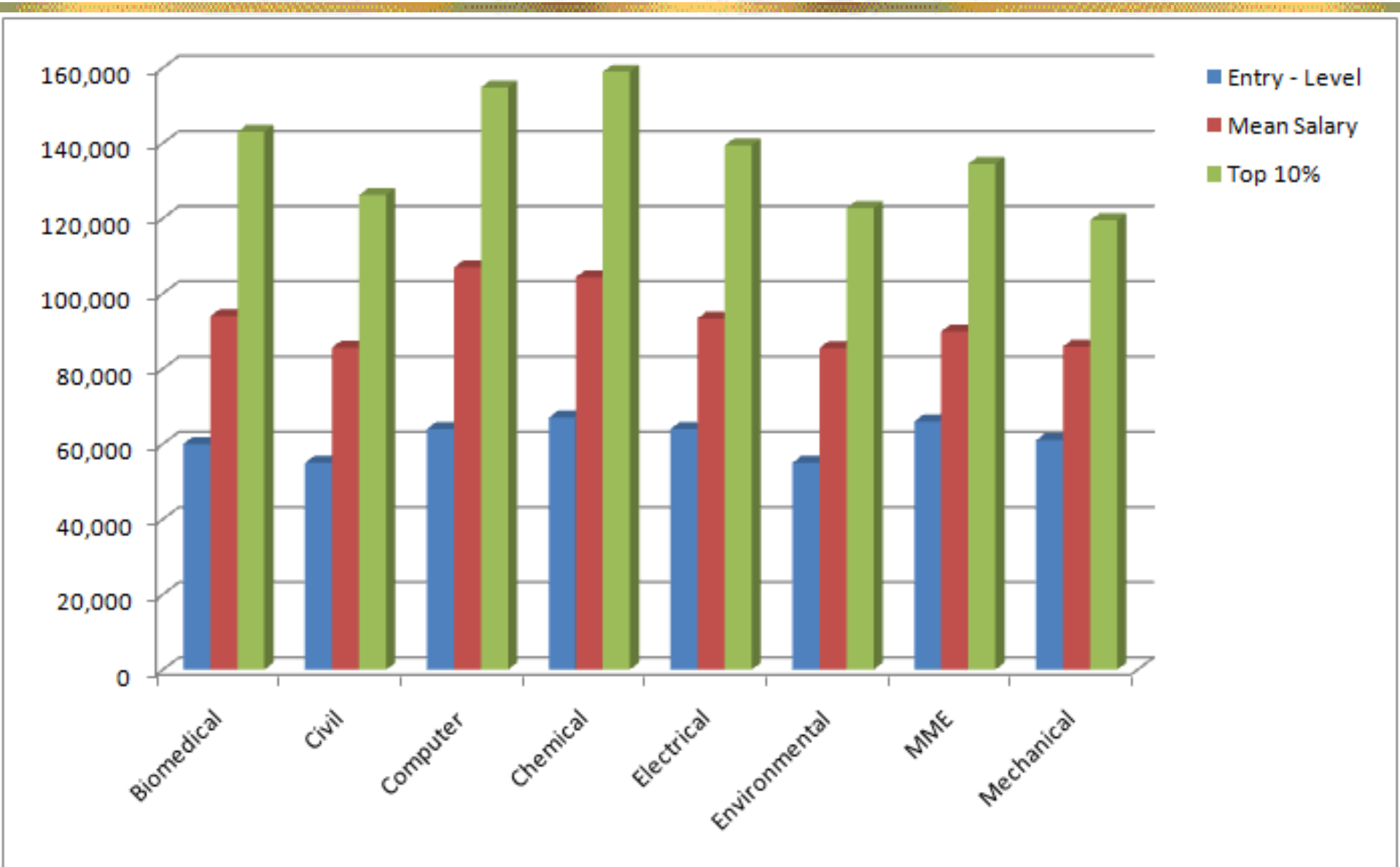
*Source: Chemical Engineering Progress, January 2002, pp.23*

# ChE Employment

**Table 1.1 Chemical Engineering Employment by Sector (from AIChE Surveys)**

| | 1996 | 2000 | 2002 | 2005 | 2007 |
|---|---|---|---|---|---|
| Chemical, industrial gases, rubber, soaps, fibers, glass, metals, paper | 33.3 | 32.5 | 25.2 | 28.1 | 25.5 |
| Food, ag products, ag chemical | 4.5 | 5.1 | 5.6 | 5.7 | 5.0 |
| Energy, petroleum, utilities | 14.1 | 1.9 | 5.1 | 4.5 | 3.7 |
| Electronics, materials, computers | 1.4 | 1.9 | 5.1 | 4.5 | 3.7 |
| Equipment design and construction | 13.8 | 12.6 | 10.6 | 12.6 | 14.3 |
| Environmental, health, and safety | 6.4 | 4.7 | 4.4 | 4.2 | 3.4 |
| Aerospace, automobile | 1.1 | 0.9 | 1.8 | 2.0 | 2.1 |
| Research and development | 3.9 | 3.8 | 4.4 | 4.2 | 3.4 |
| Government | 3.6 | 3.6 | 3.5 | 3.7 | 4.4 |
| Biotechnology | 1.5 | 2.2 | 2.4 | 4.4 | 3.7 |
| Pharmaceutical, health care | 4.2 | 6.5 | 6.1 | 8.4 | 7.6 |
| Professional (including education) | 4.7 | 4.5 | 8.6 | 7.0 | 8.4 |
| Other | 7.4 | 8.6 | 9.6 | - | 1.5 |

# 2014 Annual Salary of USA Engrs



# Achievements of ChE, BUET Graduates

- **Chemical Engineers:** Successful at home and abroad
- **Administrators:** Vice Chancellors (4 **Vice Chancellors - 3 at BUET and one at DUET),** Chairman/Managing Directors/CEO (**Zia Fertilizer Co. Ltd. , Urea Fertilizer Factory Ltd, Padma Oil Company Limited, Barapukuria Coal Mining Company Ltd. Bakhrabad Gas Systems Ltd.), Unilever Nepal, Sylhet gas fields, BCIC, BCSIR**
- **University faculties:**
  **Singapore, Malaysia, Denmark, UK, USA, Oman, Saudi Arabia, Qatar, Bangladesh**
- **Working in reputed Companies: Honeywell, Saudi ARAMCO, ASPEN, Unilever, BOC, Shell, Chevron, Cairn-Energy, AES, Alfa-Laval, Exxon-Mobile, IBM, Microsoft and ……**
- **As Graduate Students – All our graduates are performing superbly all over the world**

# Achievements of ChE, BUET Graduates

- **Consultants:** UNDP, UNESCO, WB, BCIC, SABIC
- **Entrepreneurs:** Ceramics, Basic chemicals, Plant equipment , supply/erection, Textile industries, Garments industries, ETP
- **Gov't officers:** magistrate, TNO, Income Tax
- **Politicians:** Ministers
- **Software engineers:** Microsoft and IBM
- TV, Bank, School

***Rather ask the easier one:***
***Where does a chemical Engineer not work?***

# Type of Chemical Industries

US Bureau of Census defines chemical and allied products as per the Standard Industrial Classification (SIC Index):

**Three general categories of products:**

- 1) basic chemicals: such as acid, alkalis, salts and organic chemicals
- 2) Intermediate chemicals: to be used in further manufacture such as synthetic fibers, plastic materials, colors and pigments
- 3) finished chemicals: to be used for ultimate consumption as drugs, cosmetics and soaps or to be used as materials or supplies in other industries such as paints, fertilizers and explosives, etc.

# Type of Chemical Industries

Large tonnage plants: 2000 — 5000 t/d

Small capacity plants: 5-10 kg/day or batch

US Industry spends *5* cents/$ of product in R& D effort

Development of CPI characterized by:

- entrepreneurship
- effort and initiative to transfer lab work to industry
- competition
- technological innovation and quality
- continuous development and faster adoption of changes
- meeting the market needs and creating new markets

# Chemical Products and Companies

**Chemical and Allied Products**: **A long list**

**Food & beverages**

**Textiles**

**Paper**

**Chemicals**

**Petroleum**

**Rubber and Plastics**

**Stone, clay and glass**

**Nonferrous metals**

⋮

**Well known chemical companies include:**

**du Pont, ICI, Union Carbide, Montecatani, Bayer, Hoechst, BASF, Dow, Rhone-Poulenc, Standard Oil, Sumitomo Chemical, Mitshubishi Chemical**

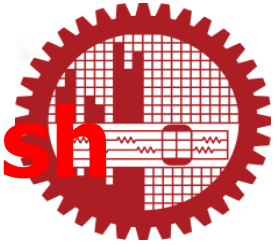
# Development of Chemical Industries in undivided Bengal

CPI in undivided Bengal

| | |
|---|---|
| Paper | 1870 |
| Rubber products | 1920 |
| Lead Acid storage battery | 1931 |
| Antibiotics | 1934 |
| Caustic soda | 1941 |
| Contact Sulfuric Acid | 1943 |
| Soda Ash | 1943 |

Bengal Chemical and Pharmaceutical Works started by Acharya Praflulla Chandra Ray in 1892 in Calcutta.

# Development of CPI in Bangladesh



- Sugar 1933
- Distilleries 1938
- Portland cement (Chhattak) 1941
- Pulp & Paper *(KPM)* 1953
- $H_2S0_4$, NaOH, $Cl_2$ etc. 1953
- Urea-Ammonia *(Fenchuganj)* 1961
- Refinery(ERL, Chittagong) 1968
- NG Processing plant 1969
- TSP *(*Chittagong*)* 1972
- Insulators *(BISF)* 1980
- Visbreaking *(ERL)* 1995
- 1960: NG used as fuel in Chhatak Cement Plant
- 1961: NG used a raw materials and fuel at NGFF

# History of the Development of Chemical Engineering Courses

- 19th Century: Industrial Chemistry. An industrial Chemist specialized in each area. For example, manufacture of Sulfuric Acid, Manufacture of Soda, etc.
- 1920s: Unit operations at MIT, USA
- 1950s: Transport Phenomena (Chemical Engineering Science)
- 1970s: Mathematical Modeling and use of computer in Process Control
- 1980s: Biochemical Engineering, Biomedical Engineering, Material Science
- 1990s: Nanotechnology, Biotechnology

***Source: Chemical Engineering Education in Bangladesh by Dr. Nooruddin Ahmed, ICChE conference 2003, pp. 8-11***