


# New Frontiers in Chemical Engineering: Impact on Undergraduate Education

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# Outline

- History of Chemical Engineering
- Strength-Weakness-Opportunity-Threat Analysis
- Chemical Engineering Workforce Data and Trends
- CHE Frontiers activities/documents
- CHE relative to other disciplines
- New Curriculum

# History of Chemical Engineering

## ➤ 1900

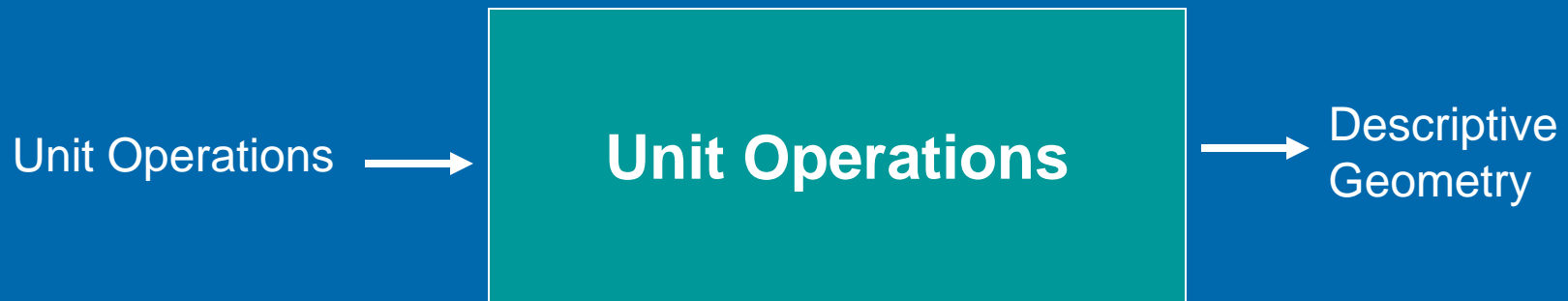
- Initial curriculum consisted of separate courses in chemistry and conventional engineering

## ➤ Decade I (1905-1915)

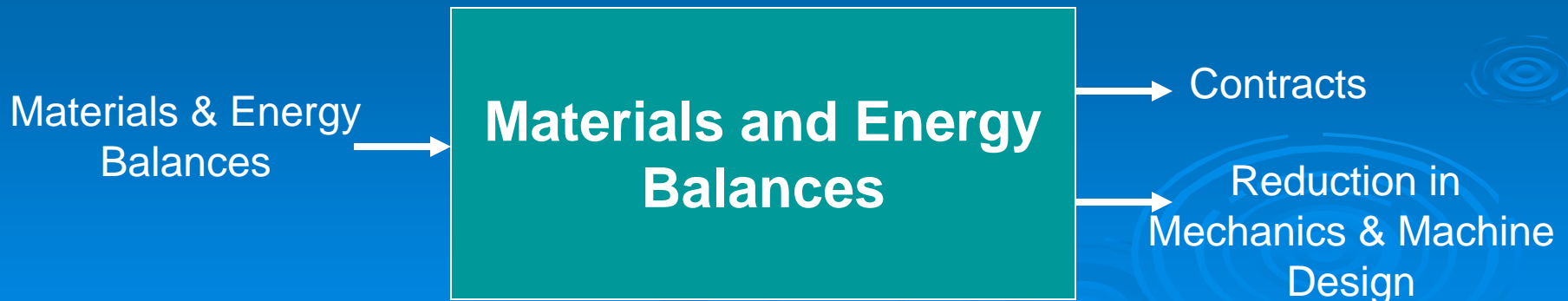


# History of Chemical Engineering

## ➤ Decade II (1915-1925)



## ➤ Decade III (1925-1935)



# History of Chemical Engineering

## ➤ Decade IV (1935-1945)

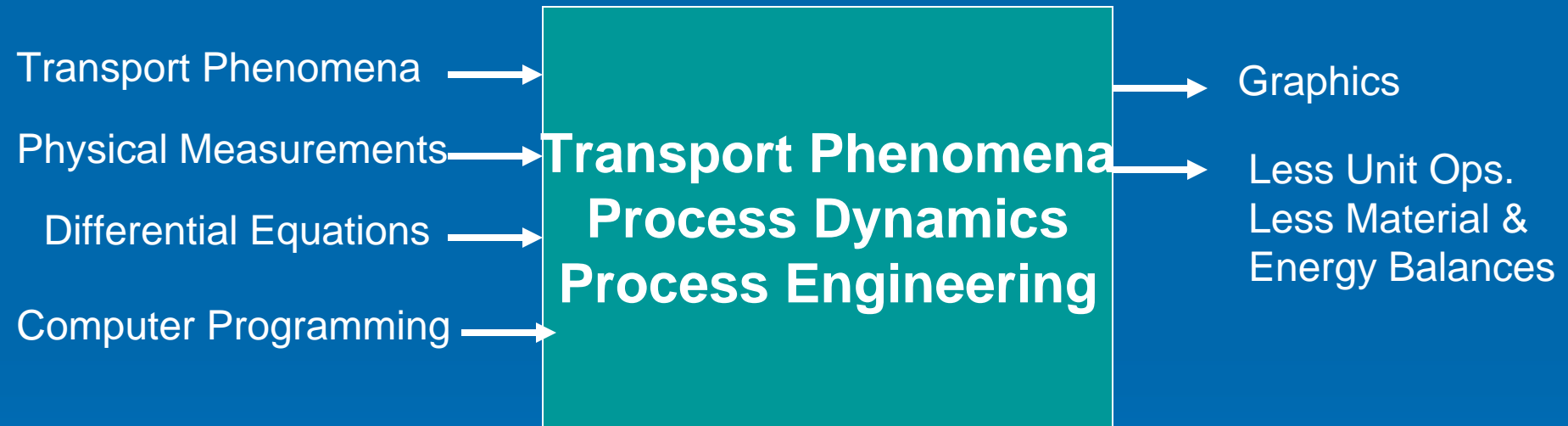


## ➤ Decade V (1945-1955)



# History of Chemical Engineering

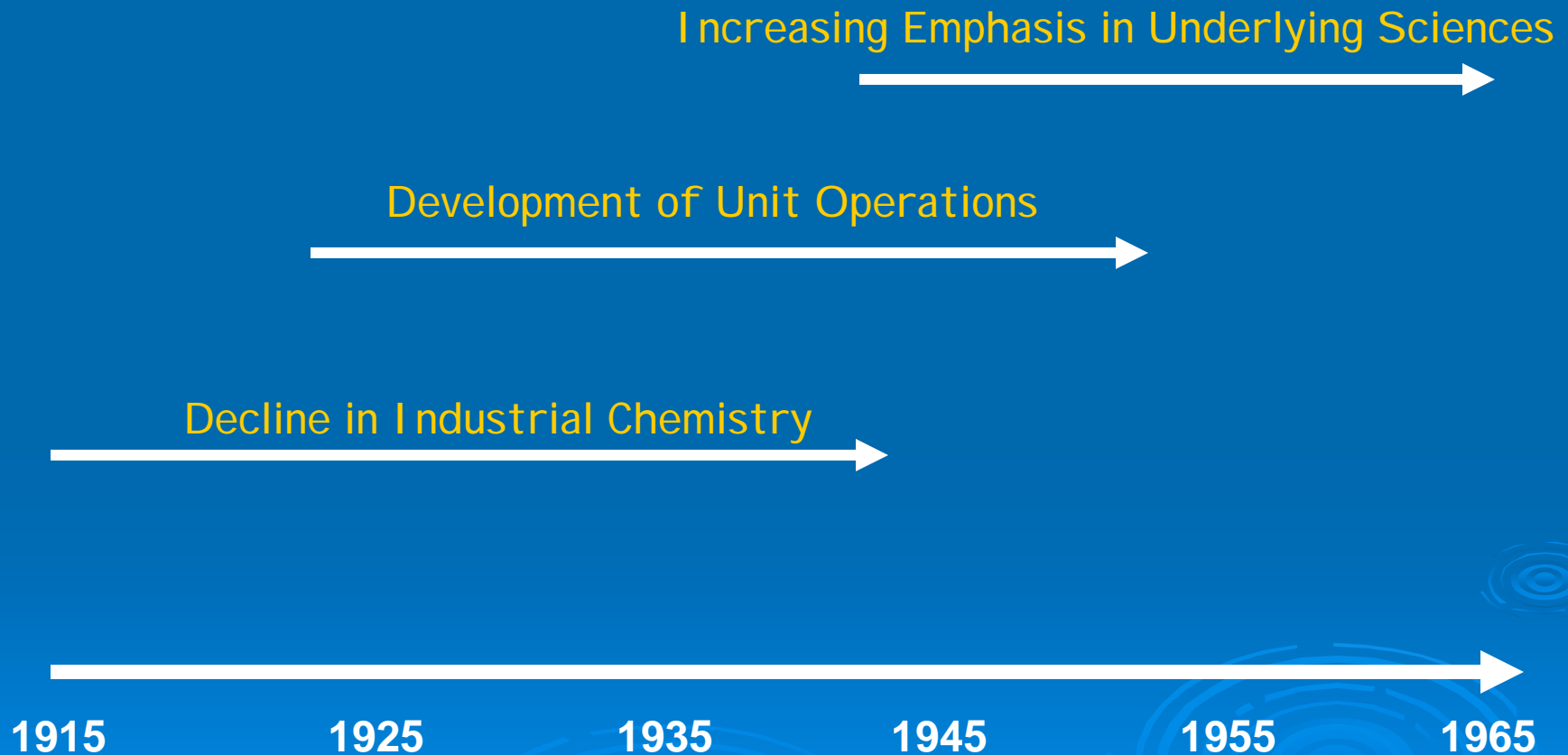
## ➤ Decade VI (1955 -1965)



## ➤ Decades VII – X (1965 -2005)

Minor changes

# Evolution of CHE Curriculum



# Current Landscape of CHE

## ➤ Strength:

- Knowledge of processes on both molecular to macroscopic scales allows CHEs to work on the most exciting technology areas.

## ➤ Weakness:

- While CHE practice has evolved dramatically, the core curriculum has undergone minor changes in the past 40 years.

# Current Landscape of CHE

## ➤ Opportunity:

- To convey the excitement of CHE practice to students, to equip them to be versatile problem-solvers, to give them solid grounding in fundamentals and tools for engineering analysis and synthesis, illustrated by examples drawn from the breadth of industry and practice
- Biology has become a more molecular and quantitative science.
- There are new methods of incorporating new technology for education.

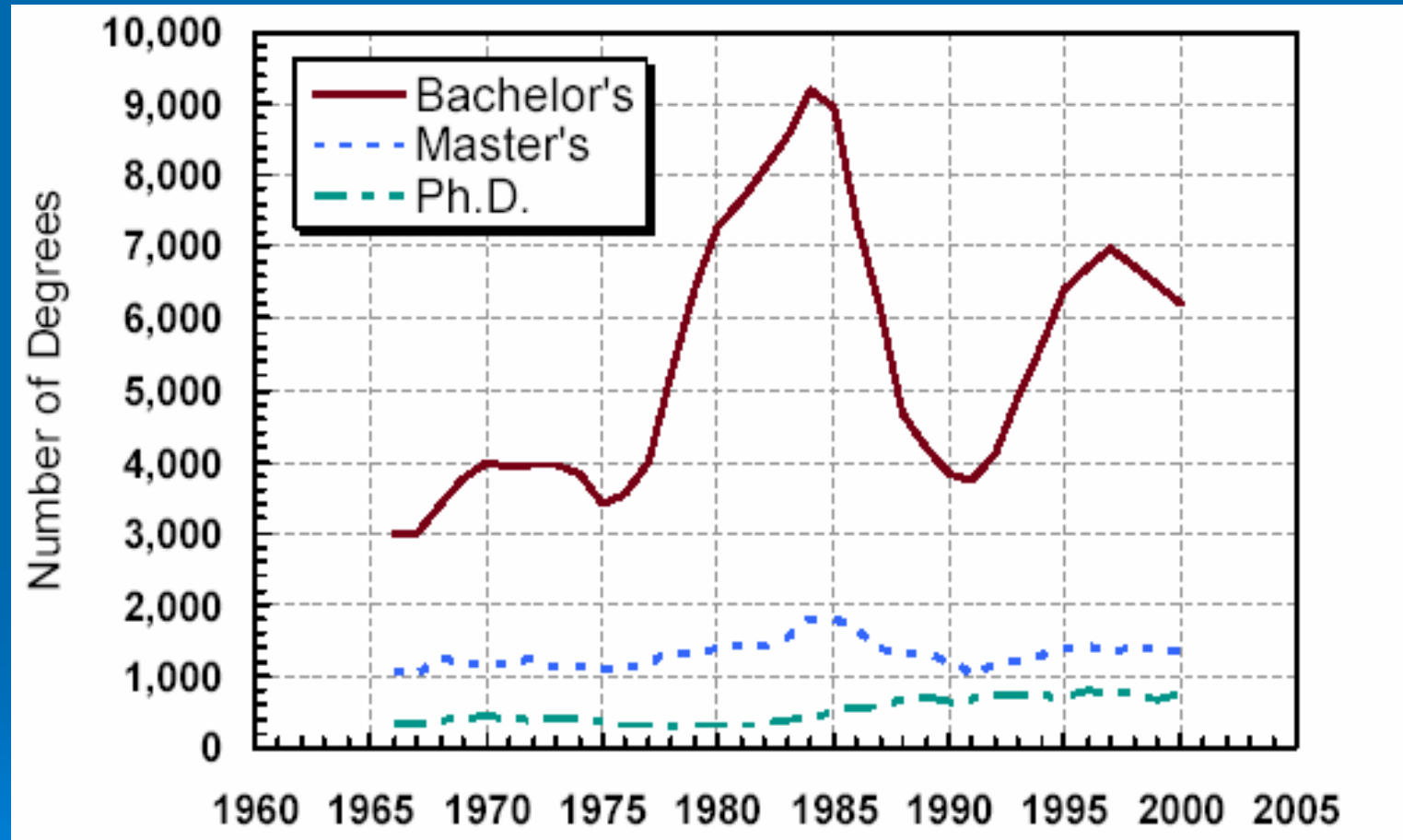
# Chemical Industry (CI) Trends

- The CI is cyclical.
- The CI is increasingly global.
- Mergers of companies and product lines happen often.
- Chemical companies are becoming life science companies and spinning off chemical units.
- Virtual companies provide out-sourced services including research.
- Time-to-market for new products has dramatically decreased.
- New CHE workforce can expect to have multiple jobs in their careers.

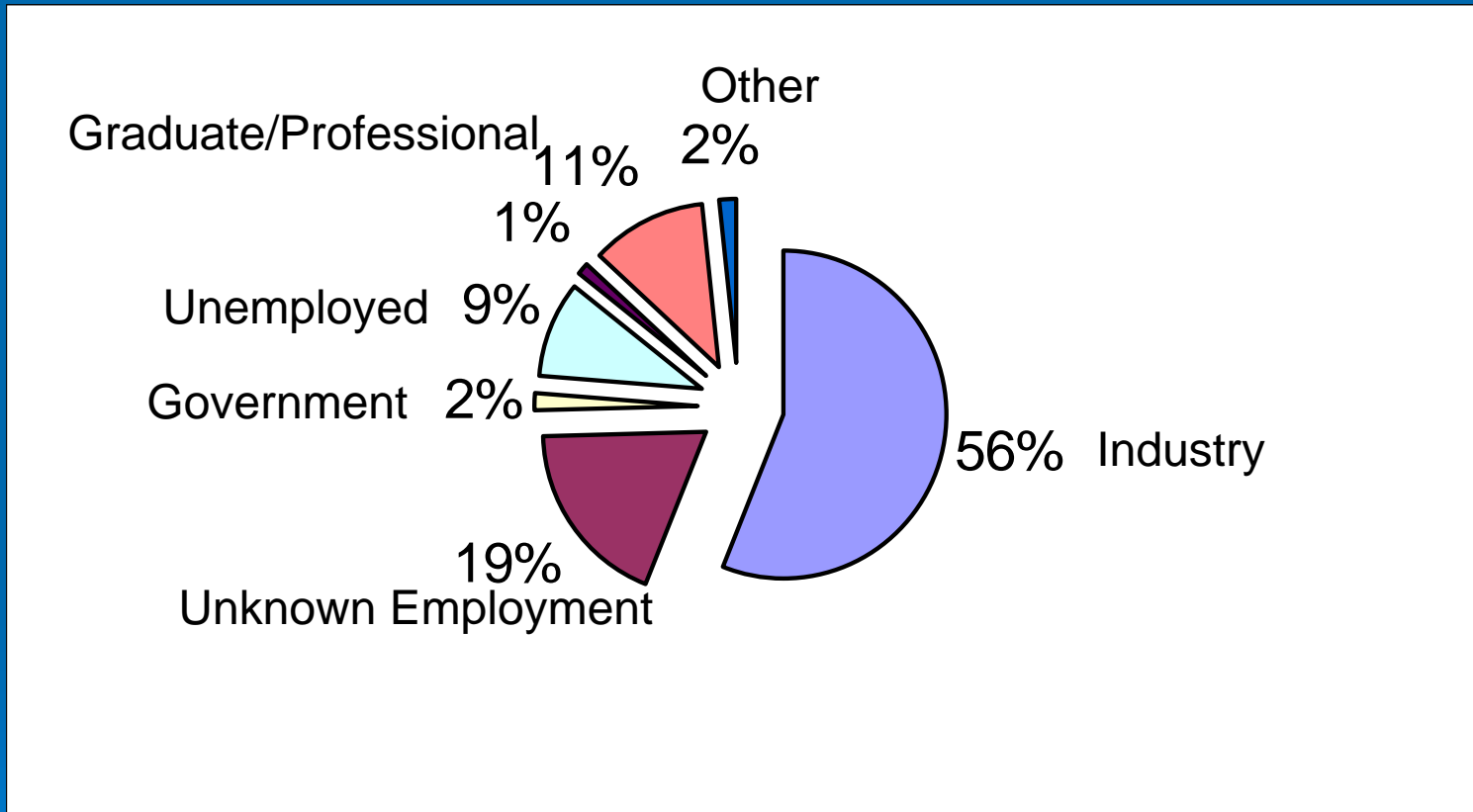
# Workforce Issues

- Public perception of “chemical” is negative.
- Potential students don't know the role and contributions of CHEs in emerging technologies (biotech., nanotech., infotech.)
- Enrollments are small relative to other engineering disciplines
- Enrollments appear to be cyclic.
- Employment opportunities are diverse.
- Other disciplines are embracing molecular engineering.

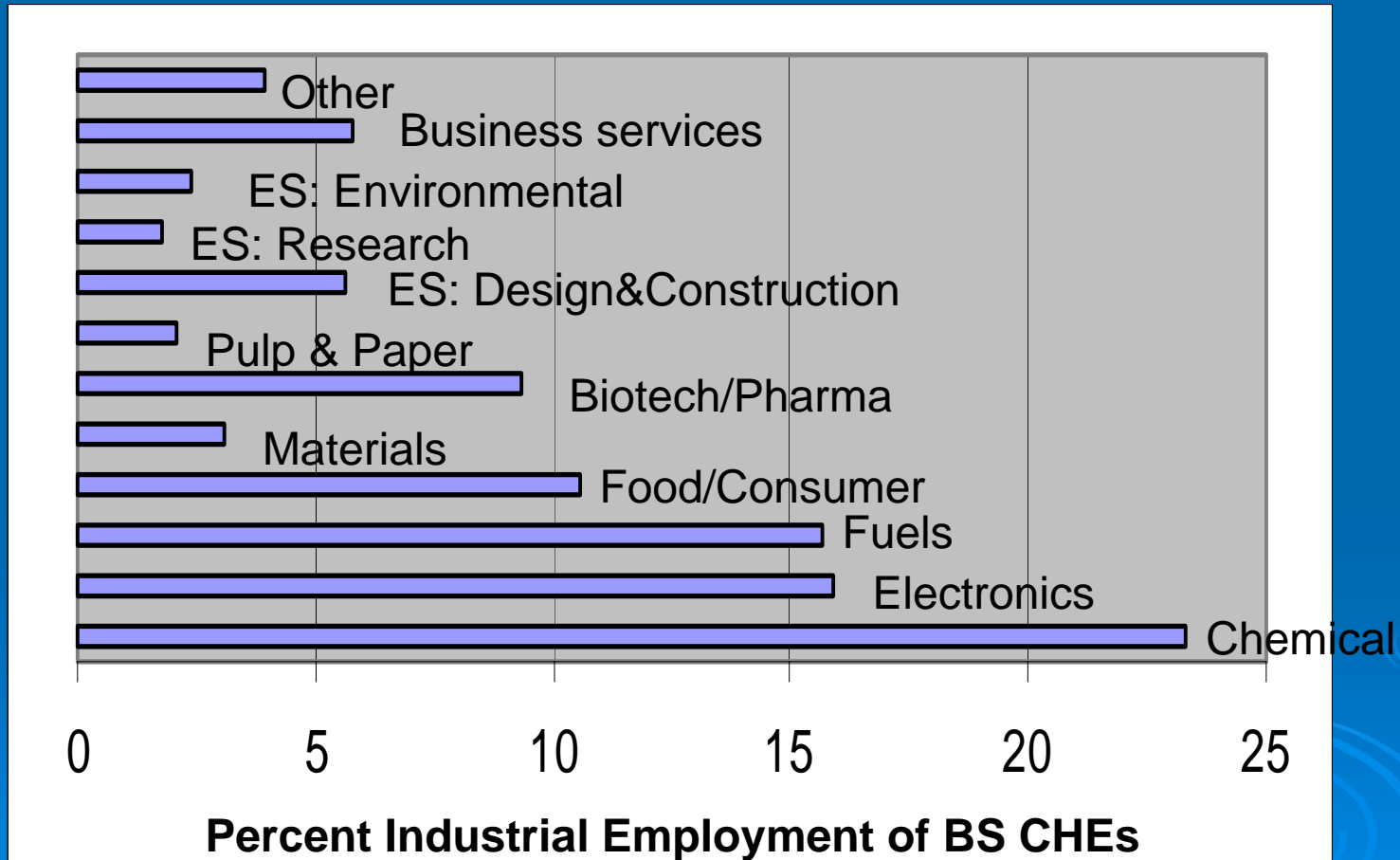
# U.S. CHE Degrees 1966-2000



# Initial Placement for BS 00-01












# Industrial Employment of BS



# BS Starting Salaries

CHE leads all fields

Field	Starting salary	Pct change from 2002
Business administration	\$36,515	3.7 
General accounting	\$41,360	2.6 
Marketing	\$35,822	1.3 
Computer science	\$46,536	- 7.6 
Information science and systems	\$39,800	- 3.9 
Civil engineering	\$41,067	0.5 
Electrical engineering	\$50,566	0.4 
Chemical engineering	\$52,169	1.8 
Liberal arts	\$29,543	3.1 

Boston Globe, April 25, 2003

# Chemical Engineering Frontiers

(Graduate Education and Research)

## ➤ Beyond Molecular Frontier: Challenges for Chemistry and Chemical Engineering

[Structures and Cultures of CHEM & CHE Disciplines: The Common Chemical Bond]

- NRC Report with six workshop documents
  - The Environment
  - National Security and Homeland Defense
  - Materials Science and Technology
  - Energy and Transportation
  - Information and Communications
  - Health and Medicine

# Chemical Engineering Frontiers

(Undergraduate Education and Curriculum)

## ➤ CCR/NSF Curriculum Workshops

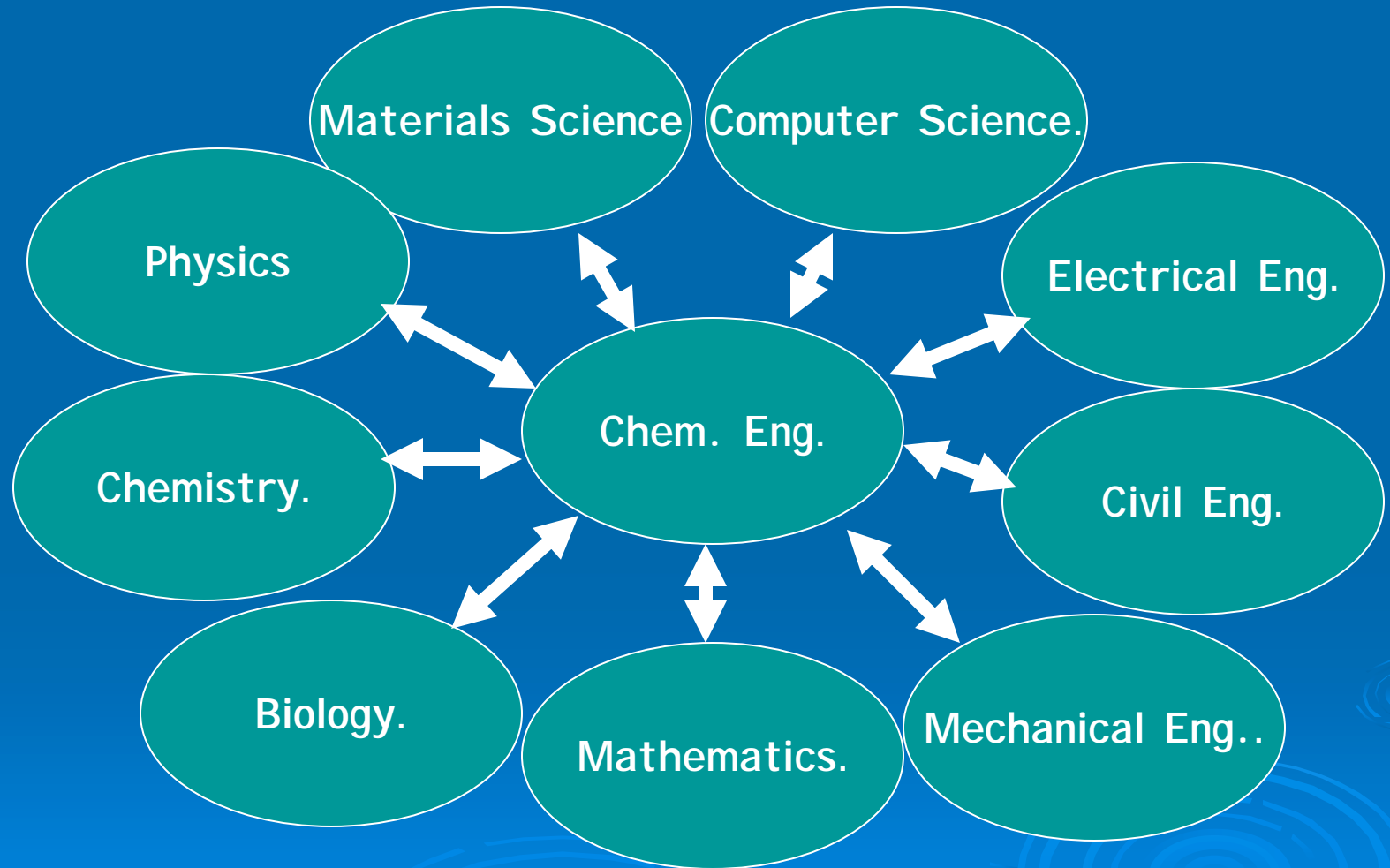
- 2002 Council of Chemical Research Annual Meeting, CHE Department Chairs Session
- Three planning workshops, "New Frontiers in CHE" supported by NSF
  - Workshop I: Orlando, Jan., 2003
  - Workshop II: Austin, April 2003
  - Workshop III: Cape Cod, June 2003

[Led by Bob Armstrong, CHE Dept. Chair, MIT]

<http://www.ccrhq.org/>

Chemical Engineering Curricula

# Chemical Engineering at the Center



Chemical Engineering is connected to many disciplines

# Opportunities for New Curriculum

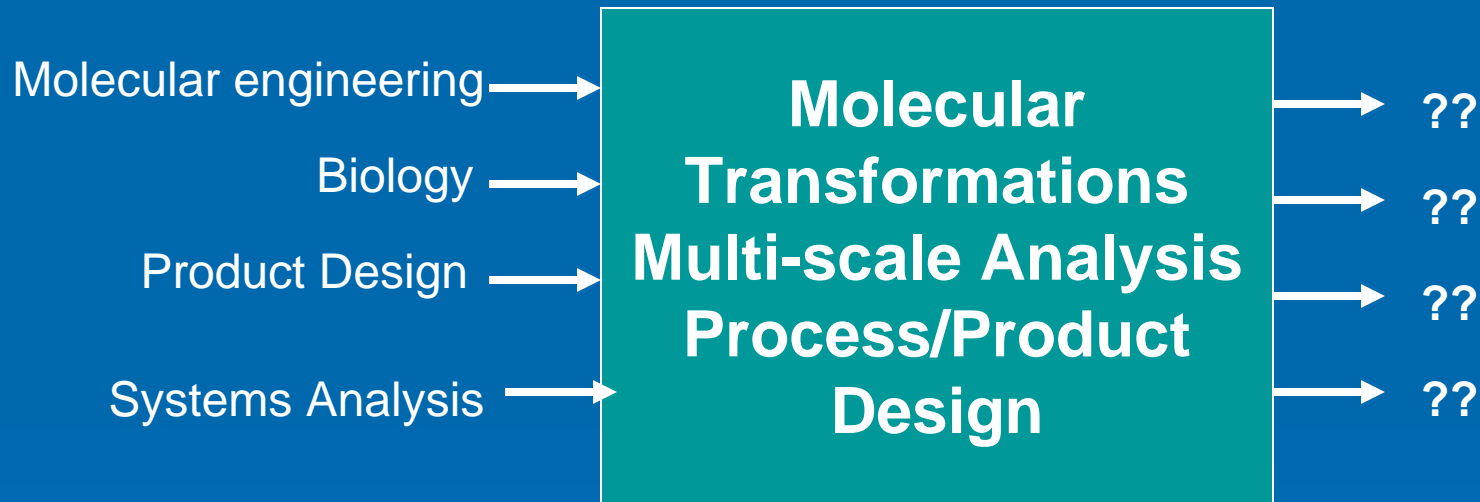
- CHE is uniquely positioned at the interface between molecular sciences and engineering. It can significantly contribute to emerging technologies:
  - Alternate/renewable energy
  - Better health
  - National security
  - Improved environment

# Elements of New Curriculum

- The enabling sciences are:
  - Chemistry, Biology, Physics, Mathematics
- Core chemical engineering principles:
  - Molecular transformations
  - Multi-scale analysis
  - Systems approach to solving problems
- Chemical engineering design contains:
  - Process design
  - Product design

# The Frontier CHE Curriculum

## ➤ Decade XI (2005 -2015)



Increasing emphasis in biology and integration

2005

2015