

Process Systems Engineering

Past, Present and Future

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Process Systems Engineering

OUTLINE

- Historical Perspective
- A Time of Change
- ESCAPE - 11
- Conclusions

Historical Perspective

KEY IDEAS

- **Unit Operations** (1900 -)
- **Chemical Engineering Science** (1945 -)
- **Process Systems Engineering** (1960 -)

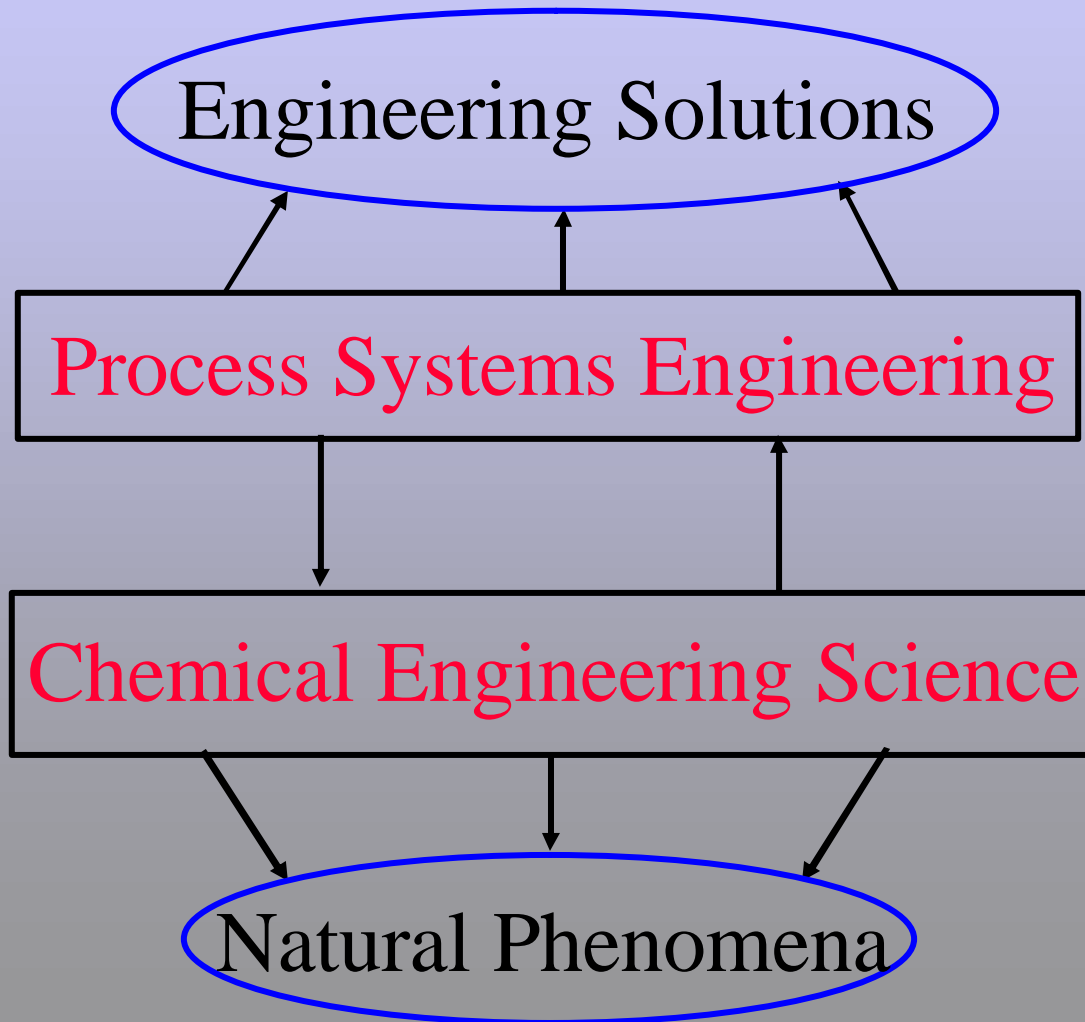
‘Scientific Engineering’

‘Since World War II, engineering education has moved strongly toward analysis, with courses dealing with individual process operations and phenomena. Transport Phenomena, Unit Operations, Process Control, Reaction Engineering, and other engineering science courses greatly strengthened engineering education by showing how things are and how they work.

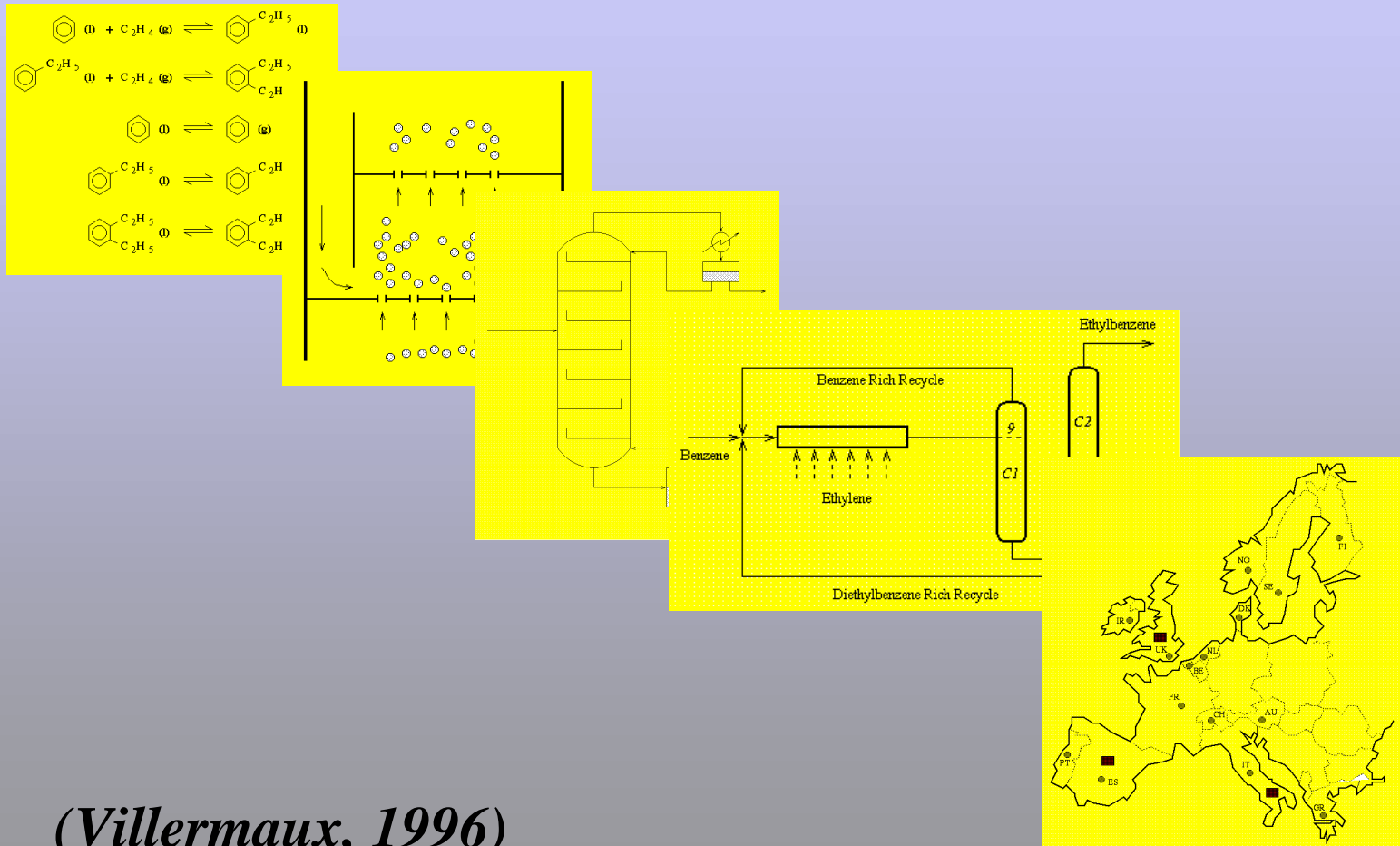
Unfortunately, there was not a parallel development of courses dealing with synthesis ... This deficiency has been recognized for years, but the remedy awaited the development of sufficiently general principles of synthesis about which to organize educational material.’

(Dale F. Rudd 1973)

What is Chemical Engineering?

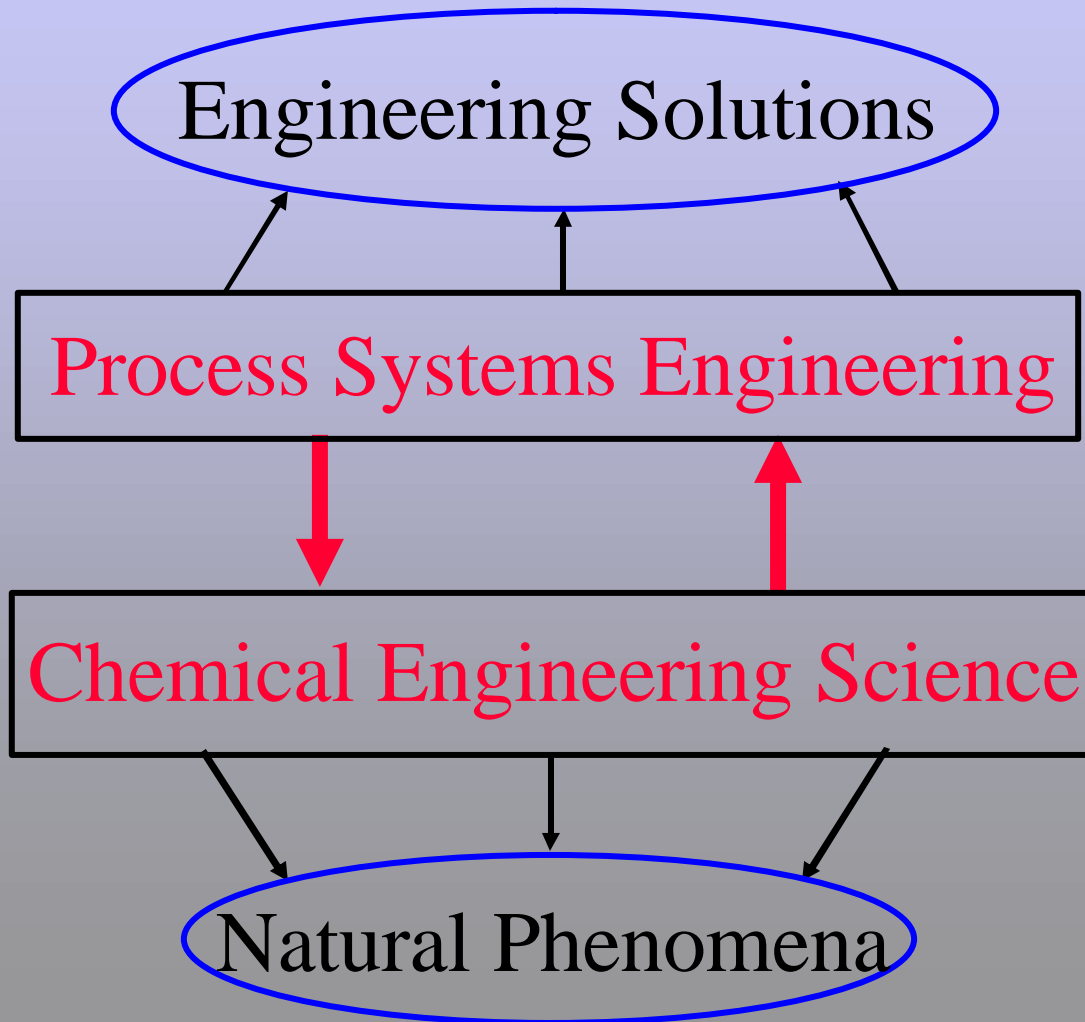


Multiscale Nature of Chemical Engineering



(Villermoux, 1996)

What is Chemical Engineering?



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A Time of Change

INDUSTRY TRENDS

1970

2000's

Homogeneous Materials
Inexpensive, low performance
Commodity Chemicals
Synthesis
Macroscopic
Large-scale processing
Continuous processing
Process emphasis
Cost competition
Efficient
Capital intensive
National
Manufacture
Short term payoff
Intradisciplinary
Understanding of macroscale and mesoscale

Composite and Structured Materials
High value, High performance
Specialties & Biochemicals
Formulation by design
Microscopic
Smaller scale and flexible
Batch and flexible/continuous and flexible
Product and Process emphasis
Quality competition
Rapid innovation and commercialisation
Information intensive
Global
Service and Manufacture too!
Longer term investment
Interdisciplinary
Understanding microscale and nanoscale

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Themes of ESCAPE - 11

- **Computer Aided Systems for**
 - **Synthesis and Design**
 - **Control and Operation**
 - **Modelling**
 - **Manufacturing**
- **Process and Tools Integration**
- **New Frontiers for CAPE**

ESCAPE - 11

Synthesis and Design

Ka Ng **Multiscale approach to synthesis needed**

Ka Ng **Importance of meaningful industrial collaboration**

Ka Ng **Contribute to business process analysis**

ESCAPE - 11

Synthesis and Design

Joan Cordiner **22% of project costs
on process**

Joan Cordiner **Seek out *niche*
applications**

Joan Cordiner **More chemistry please**

ESCAPE - 11

Control and Operation

Manfred Morari Hybrid systems as
an important enabling technology

Tariq Samad Autonomy implies
appropriate responses to unforeseen
circumstances

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Modelling

Costas Pantelides **Impressive
progress in last decade**

Costas Pantelides **Challenges to
support more rigour, multiscale
modelling, and model validation**

Costas Pantelides **Integrated systems
for laboratory experimentation?**

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Modelling

Jan Willem Verwijs **FAST project cycles to help manage risk**

Jan Willem Verwijs **Opportunity for PSE in discovery phase**

Jan Willem Verwijs **... but need for improvements in parameter estimation/experimental design**

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Manufacturing

Gert Mølgaard **Time to market**
implies *new* paradigms

Gert Mølgaard **Avoid *haute couture***
solutions

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Process and Tools Integration

Stratos Pistikopoulos **Parametric programming to analyse uncertainty**
Hans Pingen **Life cycle process models; integrated engineering**
Venkat Venkatsubramanian **Batch process development**

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New Frontiers for CAPE

Peter Cummings More sophisticated
chemical models please

Greg Stephanopoulos More 'systems
biology' please

Costas Maranas Discovery process
systems engineering

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CONCLUSIONS

- More sophisticated chemistry
- ... and biology!
- Develop *new* paradigms/explore *new* areas
- Tradition of effective collaboration
- ... necessary if we are to meet challenge
- ‘Opportunity overload’