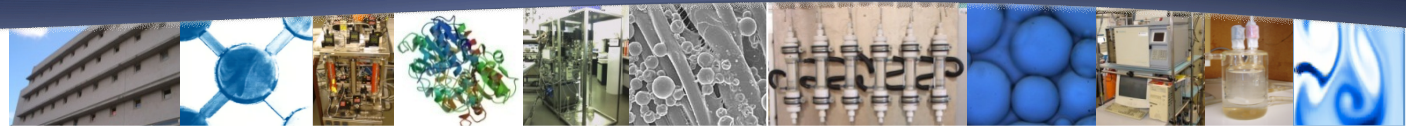

LSRE
LABORATORY OF SEPARATION AND REACTION ENGINEERING

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Teaching Product Engineering

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Associate Laboratory LSRE/LCM

Department of Chemical Engineering,

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OUTLINE

- Context- Why a Product Engineering course?

- Objectives and audience
- Methodology
- Evaluation and Transferability

- Conclusions

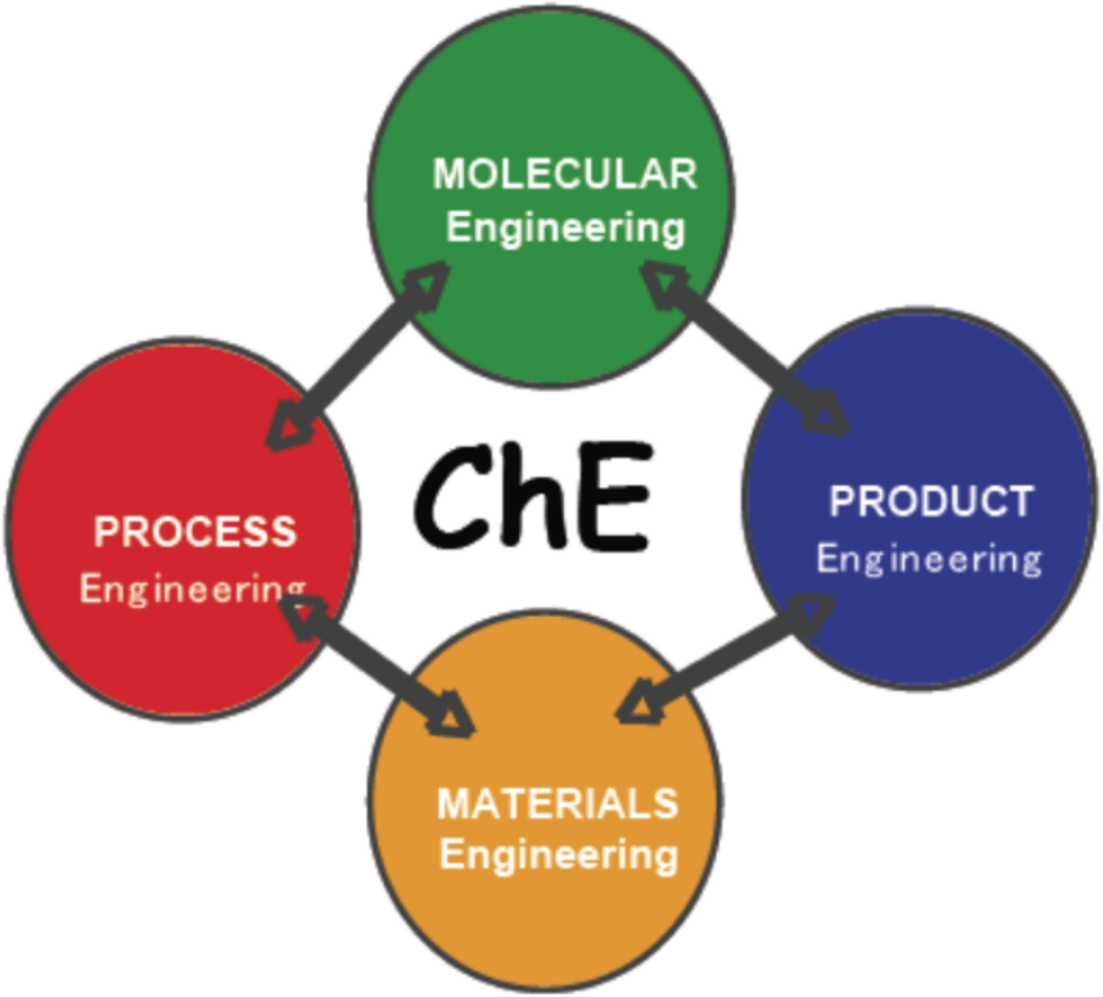
Chemical Engineering Evolution

0. Pre-paradigm – engineers with no formal education
   Descriptive treatment of specific processes (potash, sulfuric acid, soap)
1. The first paradigm – *Unit Operations*, 1923
   Processes broken into common, standard units such as heat exchange, distillation, crystallization, etc.

2. The second paradigm – *Transport Phenomena*, 1960
   Unified mathematical treatment of momentum, heat and mass transfer

3. The third paradigm – Product Design? (Wei, Cussler)
   Molecular Engineering ?Product design requires consideration of specific materials properties

Chemical Engineering today ChE=M2P2E



PRODUCT ENGINEERING COURSE

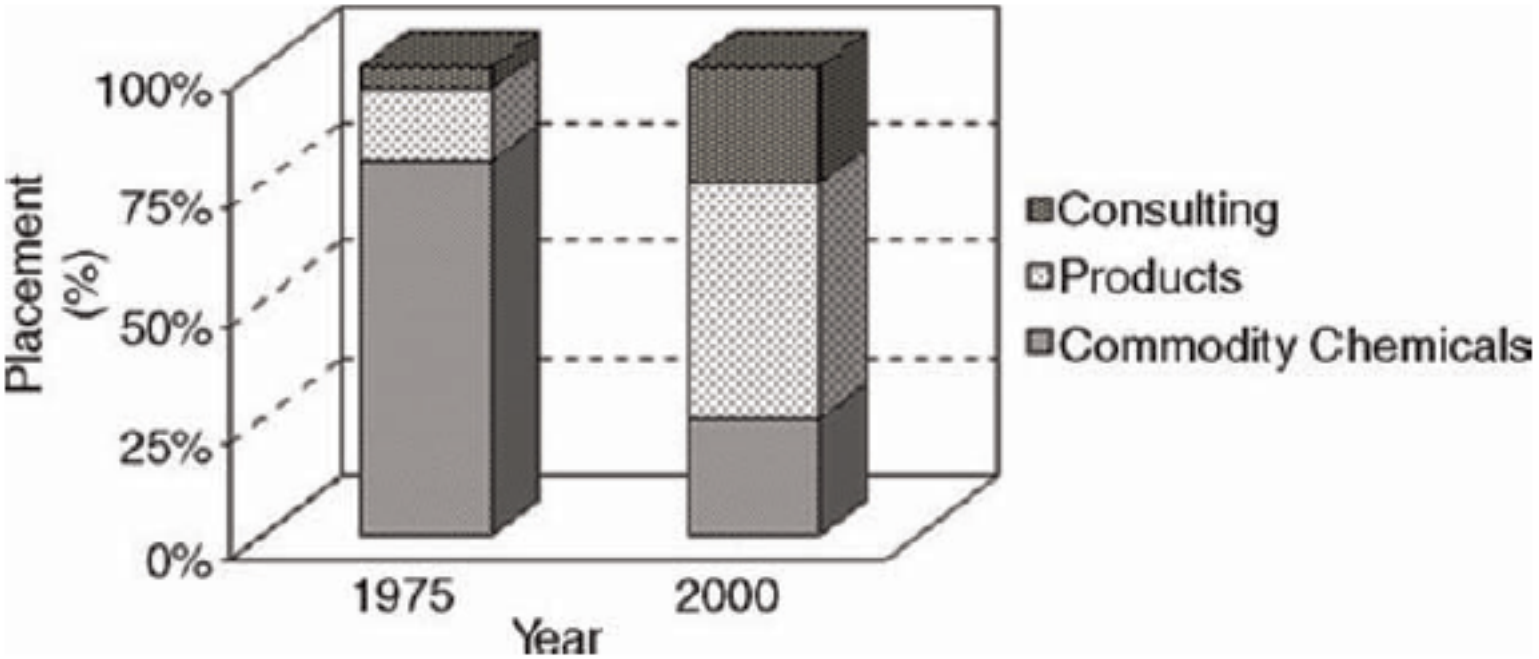
Introduced in MIEQ/FEUP in 2008 following a change in the curriculum

- three branches in the second cycle (Process and Product Engineering, Energy and Environment, Bioengineering)

I taught the course from 2007/2008 until retirement (forced) in 2013

I had the help of Viviana Silva (now at BASF, Germany) until 2011 and Miguel Teixeira (now at IFF, Holland) in 2011/2013

Response to the changing nature of jobs for Chemical Engineers



Saraiva and Costa, ChERD, 2004 based on Cussler and Moggridge book

Product engineering course at MIEQ/FEUP

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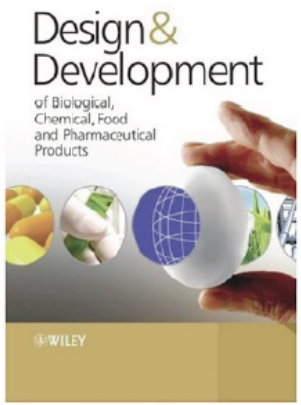
Product Engineering



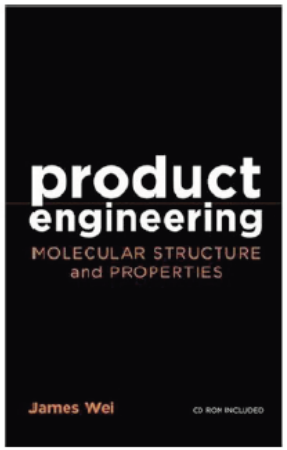
Needs

Ideas

Selection

Manufacturing

TRIZ;CONSTRUCTAL



AER

8as Jornadas do DEQ, 4 Novembro de 2008

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Products & examples from LSRE

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Product Classification

1. Commodities: propylene; Vanillin; Acetals
2. Specialty chemicals: Chiral molecules
3. Formulated products: Perfumes; Microcapsules
4. Devices: FlexSMB, NetMix
5. Virtual chemical products: SAXS, PTD
6. Bio-based products: Lactobionic acid; Dextran
7. Technology-based consumer goods: Perfumed suits

Devices: Simulated Moving Bed

Unit at LSRE: Licosep 12-26

FlexSMB at LSRE

Course Content

1. Introduction to product design
2. Needs of consumer
3. Ideas;
4. Selection of ideas;
5. Manufacturing;
6. Commodities;
7. Devices;
8. Molecular products;
9. Microstructures;
10. TRIZ;
11. Economic aspects.

Course information

Two classes of 2 hour each in a weekly basis

14 weeks

56 hours contact time

189 h of work load

7 ECTS credits

Non-conventional teaching

I just gave a couple of lectures to introduce the course content and justify its existence

Students (30-40) of 4th year of MIEQ were divided in groups of 4

In one class each group presented one chapter of reference books; the discussion was made by other groups and myself

In the other class of the week each group will present the progress of their projects

Evaluation & Transferability

Final exam 50%

Weekly presentations 20%

Report and Oral presentation of the project 30%

Limited to classes up to 50 students

Types of projects

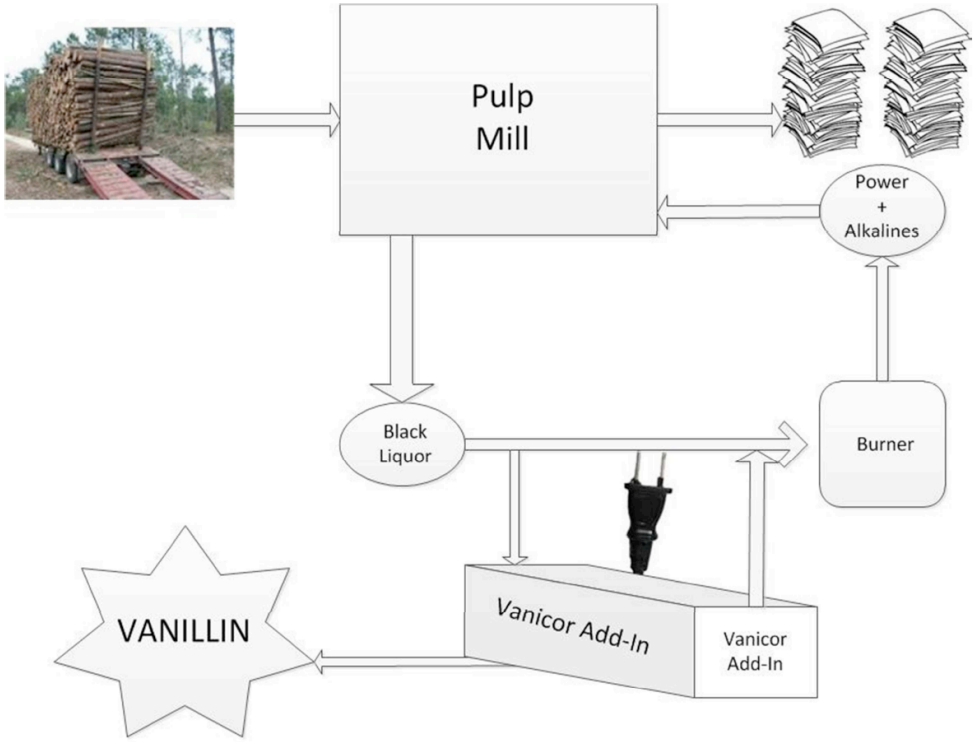

Figure 4: Vanicor Add-In plugging Scheme.

Vanillin from kraft black liquor

Aletria com sabor a baunilha

Conclusions: The future of the lecture

Lecture format: Cussler classification

Traditional- John Calvin (1509-1564)

new version MOOCs (Massive Open Online Course)

Active – Socrates (469-399 BC)

asks leading questions; then students develop ideas…

Flipped – Nancy Lape teacher of Thermodynamics at Harvey Mudd College

taped lectures + classroom discussion

Things didn't change much....

Figure 2. Henry of Germany delivering a lecture to university students in Bologna in 1233.

The behavior of students is very much the same today. Laurentius de Voltolina - The Yorck Project: 10.000 Meisterwerke der Malerei" DVD-ROM, 2002. ISBN 3936122202. Distributed by DIRECTMEDIA Publishing GmbH.

From Ed Cussler, Perspective, The future of the lecture, AIChEJ, 1472 (2015)

The teachable moment: Ed Cussler

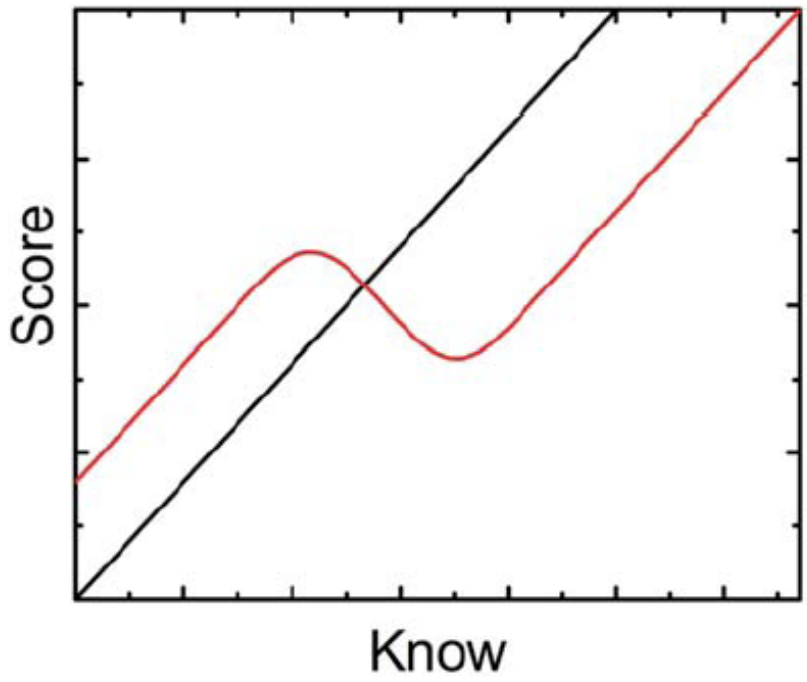

Figure 5. A schematic of exam scores vs. knowledge.

Helping students who reach the minimum, which often produces one form of "teachable moment," can give them huge gains.

TRIZ

The innovation triangle