The Practical Problems of Practical Problems

Industrial Perspectives on Teaching Process Design

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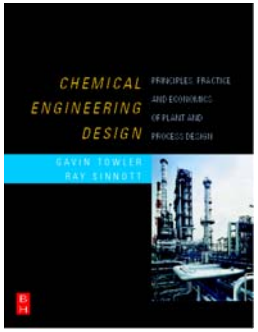
Overview

- Qualifications & disclaimer
- Design in industry
- Ways to make design teaching realistic

Qualifications & Disclaimer

- I have managed engineering design groups for over 10 years
- I run UOP's summer intern program
- I used to be on the faculty of Manchester University
- I have been teaching design at Northwestern since 2003 and recently co-authored a book on design



- Having said which, all of the following opinions are entirely my own and do not represent the official policy of UOP, Honeywell, AIChE, CACHE, Elsevier or Northwestern University

Design in Industry

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Designs For Studies:

- Make-or-buy scenarios
- Competitor analysis
- R&D “what if” designs
- Designs by consultants

Designs That Get Built

- Debottlenecking 30%
- Revamp/reuse 15%
- Off-the Shelf plants 10%
- Licensed designs 20%
- Clones 20%
- Commercialization of new technology 5%

Percentage of all design activity

40% **60%**

Standard Designs

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- “Cookie cutter” approach reduces technical risk of new plant
- Pharmaceuticals & biotechnology:
  - Time to market and successful scale up are critical
- Petrochemicals, polymers and fuels:
  - Scale of investment drives conservative design
- Well established design rules, clear manuals, proven unit operations and strong vendor relationships make design and EPC phase quicker and lower risk

Non-standard Designs

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- Debottlenecking and revamp designs require a lot of effort to benchmark current performance
- Technical risk of expanding current plant is lower
- Obtaining permits can be a large part of the effort

- Commercialization of new processes is a relatively rare occurrence in industry
- Successful commercialization is even more rare
  - First of a kind units often run below design capacity
  - Few organizations have deep skill in scale-up and risk mitigation

Problems of Practical Problems

- Revamps, debottlenecking & clones
  - Need lots of current plant data, which is usually proprietary
- Standard designs
  - Manuals are proprietary, design is too “recipe book”
- Fine chems and pharma
  - Multi-step syntheses
  - Scale-up from lab data
  - Prices are not easily found

- All of which has caused many instructors to favor “research” designs
- Not necessarily a bad thing if the students learn a few key things

Safety

The safe design and operation of facilities is of paramount importance to every company that is involved in the manufacture of fuels, chemicals and pharmaceuticals!

- **AIChE Code of Ethics:**
  - Members will hold paramount the safety, health and welfare of the public and protect the environment in performance of their professional duties.
- **Students should understand:**
  - **Major safety & environmental legislation**
    - OSHA, TSCA, EPCRA, RCRA, CAA, CWA, EPA, etc.
  - **Materials & process hazards**
    - Toxicity, flammability, incompatibility, overpressure, temperature deviations, fires, explosions, loss of containment, noise, MSDS
  - **Safety codes and standards**
    - OSHA, NFPA, API, ISA, IEC, etc.
  - **Safety analysis methods**
    - HAZOP, FMEA, Quantitative risk analysis
- **Students should be able to identify safety issues in**
  - **Their own & others' designs**
  - **Plant operations, maintenance, change procedures**
  - **Laboratories and research centers**

Codes and Standards

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- Conformance with codes and standards is a very important professional ethics issue

- Students are often not even aware of the existence of design codes
- Conformance to code can be a legal requirement or source of liability
- Codes are one of the main ways that industry ensures designs meet acceptable safety criteria
- Codes should be introduced throughout the curriculum

Computation

- These days very few problems are solved as pen & paper analytical solutions
- There should be way more use of spreadsheets
  - “Excel: the universal language of engineering”
  - Use spreadsheets for sensitivity analysis
  - Graph results to understand them
  - Don’t just find a number – explore the solution!
- Use real engineering tools
  - These are often cheap or even free
  - UniSim, HTFS, FloWizard, Compress, …
- Introduce process simulators early and often
- Introduce practical design issues throughout the curriculum

Chemical Engineering Design Supporting Lectures in MS PowerPoint

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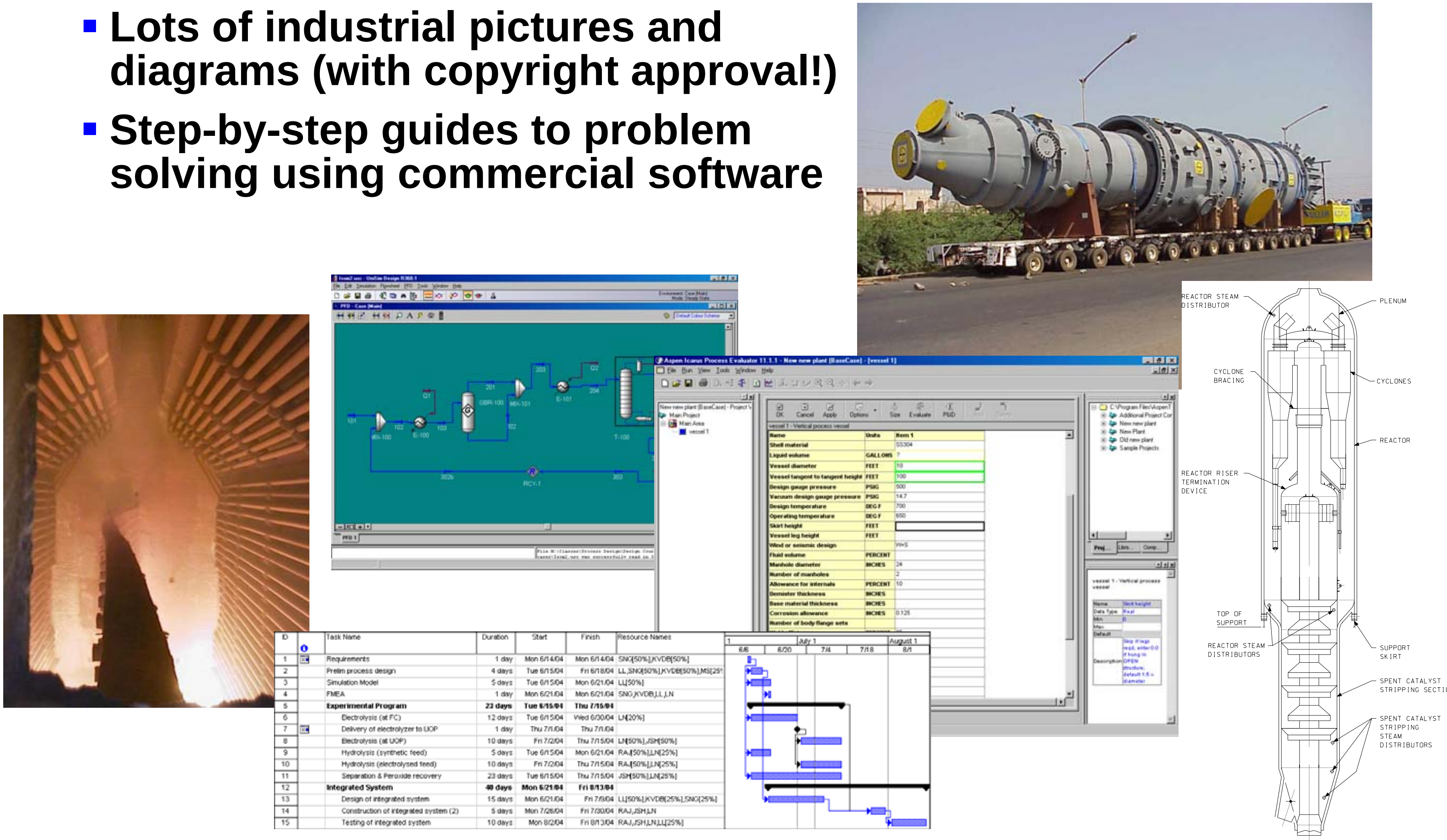
- 22 presentations with 1170 slides
- Lots of industrial pictures and diagrams (with copyright approval!)
- Step-by-step guides to problem solving using commercial software



Conclusions

- **Giving seniors a realistic experience of industrial design is not trivial**
  - **Most industrial problems are hard to simulate in a short time with minimal data and inexperienced engineers**
- **Using real engineering tools requires some set up time, but adds a lot of value**
- **Emphasizing safety, design codes and computation makes the work process more realistic, even if the problem is “researchy”**
- **Industry is really interested in helping universities to do these things better**

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