

**Replacing the Traditional "Computer Programming"
Course by a Course in "Computer-Based Problem Solving
for Engineers"**

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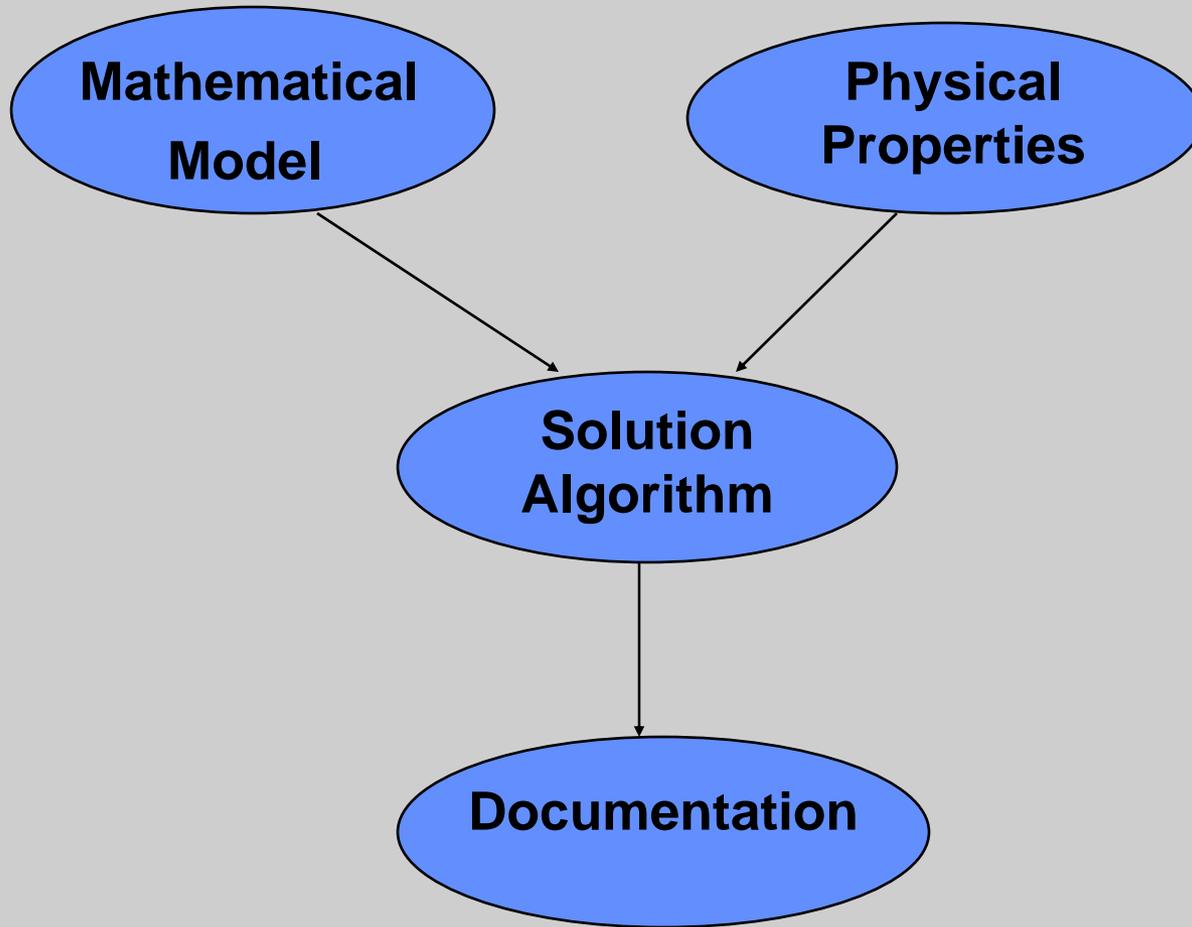
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Description of the Engineer's Main Tasks*

Engineers are fundamentally problem solvers, seeking to achieve some objective or design among technical, social economic, regulatory and environmental constraints.

*Edgar, T. F., ASEE Presentation, Salt Lake City, UT, 2004

Problem Solving in Chemical Engineering



Teaching Computer Programming (Edgar, 2004)

- Taught in engineering departments starting the early 1960.
- In the US, most of engineering degree plans changed in the 1980s to a “CS (Computer Science) 101” course.
- Has migrated through several incarnations (Algol, PL/1, Fortran, Pascal, C, C++)

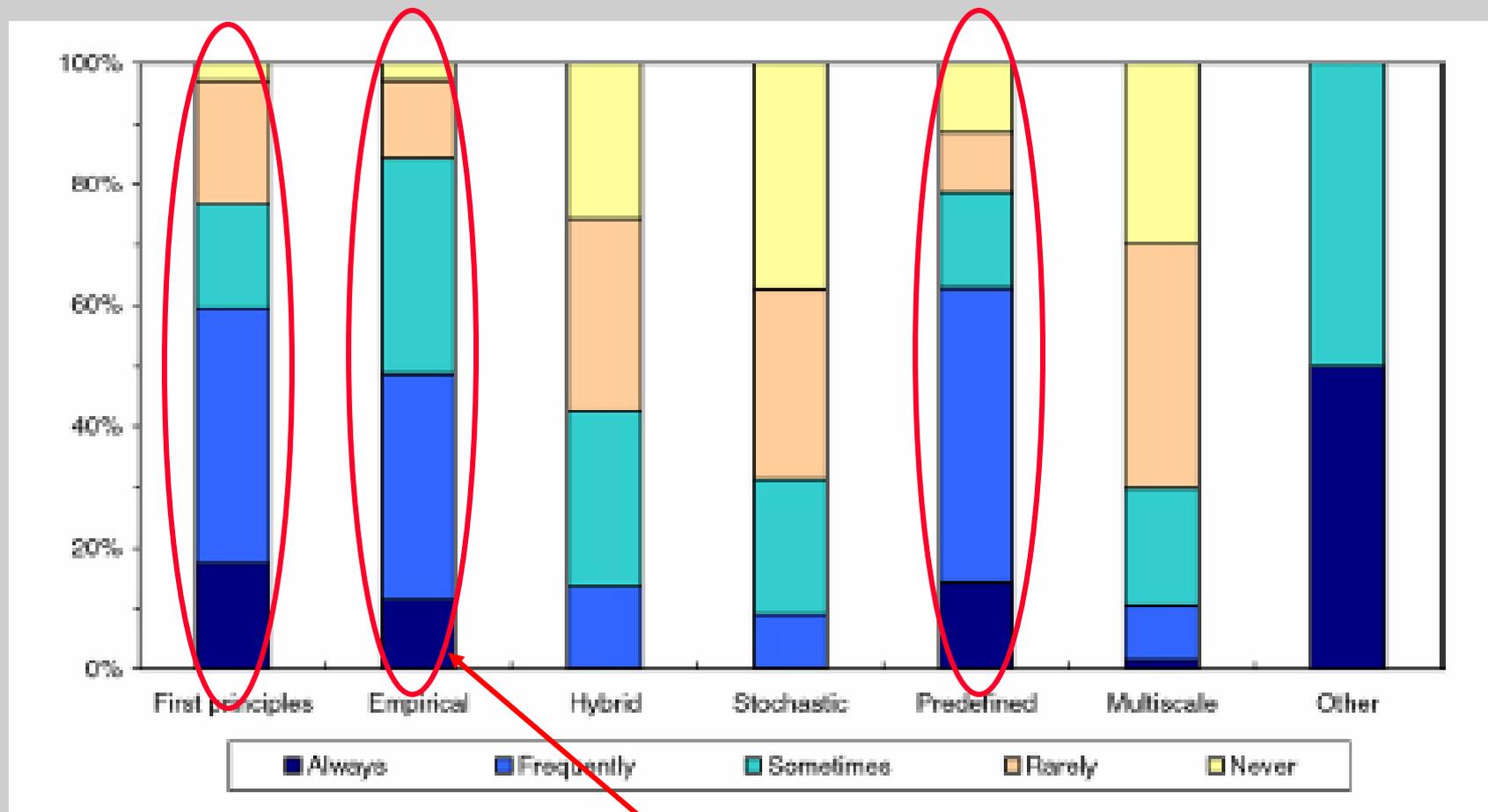
“CS 101” Advocates

- Engineers should learn fundamental concepts of programming and computer science.
- Computing should be taught by computer scientists, not engineers.

Computational Needs – Forty Years Later

- **What are the computational needs of practicing engineers?**
- **What fraction of undergraduate students should acquire programming abilities?**
- **What are the computational needs of graduate students?**

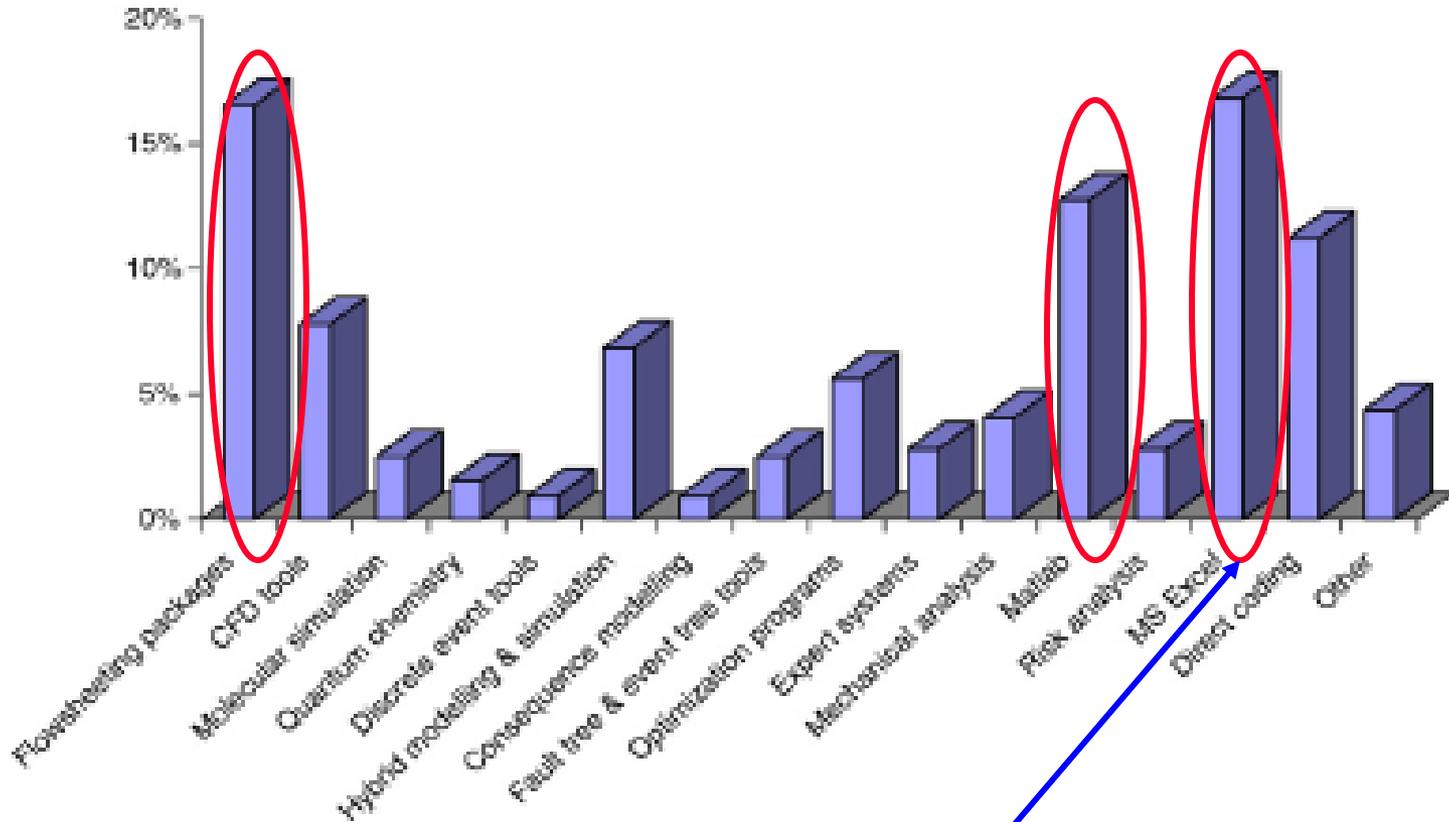
What Industry Needs: Types of Modeling Undertaken*



Emphasis on validation of regression models

*Cameron and Ingram, Comp. Chem. Engng, 2008

What Industry Needs: Tools Used for Modeling and Simulation*

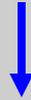


The “computer programming” course covers a small part of what is used in practice.

*Cameron and Ingram, Comp. Chem. Engng, 2008

The Reality Behind the Computer Programming Course

- Computing is taught by computer scientists, not engineers.
- Programming is learned before the student encounters any engineering problems that really require programming.



➤ **Student lose interest and are not motivated to study programming.**

- Programming is unforgiving for ambiguities and errors.



➤ **Many students lose, at an early stage, confidence in their ability to write a “working” program.**

➤ **Many students pass through the programming course with possible use of cheating.**

“Contract Cheating”

Do I Hear \$20?

STUDENTS WHO CHEAT can be very innovative and imaginative in finding ways to beat the system. Indeed, if they applied those same skills to their coursework, they probably wouldn't have to resort to cheating.

So what is their latest gambit? A new study by British researcher Thomas Lancaster indicates that students have found a new way to use the Internet to scam their teachers: putting their homework out to tender. Lancaster, a computer scientist at the University of Central England, calls the disturbing trend “contract cheating” and says it could be going on at such a scale that it risks devaluing university degrees. Students are using legitimate Web sites used mainly by businesses to contract out project work to

freelance code writers, translators and Web designers. But the students are instead asking code writers to write their homework assignments, then opting for the lowest bidder—usually someone from a developing country whose first

language isn't English. Lancaster found the rates ranged from \$5 to \$50, with \$20 being the average price paid. That, he notes, “is not a great deal of money for such a task.”

On one site he monitored, *renta-coder.com*, he determined that 1 in 10 tenders were from students. Moreover, Lancaster found that most cheating students had used the site two to seven times before. “This form of cheating is becoming habitual,” he warns. And it's not just in the United Kingdom. He found students from the United States, Canada and Australia using tender sites. Lancaster stumbled upon the ploy by happenstance. He was looking at one of the Web sites when he spotted a description of an assignment he had given his class. Lancaster worries that contract cheating is so far under the radar that most profs and schools don't even know it exists. He's sounding the alarm. —TG



“Contract Cheating” - An Unfortunate Possibility in Computer Programming Courses

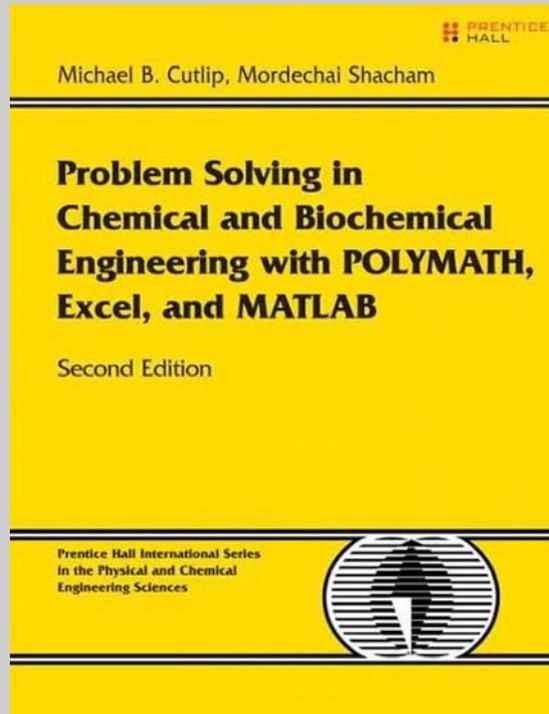
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Development of a Computer Based Problem Solving Course in Chemical and Biochemical Engineering

- A CBPS course has been developed using commonly used and available software packages: POLYMATH, Excel, and MATLAB.
- POLYMATH was selected because of its ease-of-use, availability at low cost, and new capabilities to automatically generate working Excel spreadsheets and MATLAB code.
- Excel was selected due to its wide use in industry, and MATLAB was utilized for the many programming options that are available.

Problem Solving in Chemical and Biochemical Engineering



Chapters

CBPS Course

1. Introduction
2. Basic Principles and Calculations
3. Regression and Correlation of Data
4. Problem Solving with Excel
5. Problem Solving with MATLAB

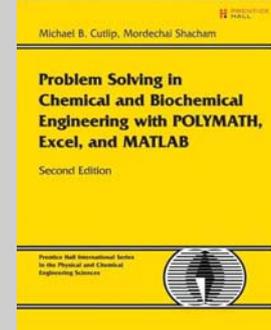
6. Advanced Techniques in Problem Solving.

Subject Matter Specific Examples

7. Thermodynamics
8. Fluid Mechanics
9. Heat transfer
10. Mass Transfer

11. Chemical Reaction Engineering
12. Phase Equilibria and Distillation
13. Process Dynamics and Control
14. Biochemical Engineering

Contents of the Computer-Based Problem Solving Course



1. Introduction

Historical perspective on problem solving

Categorizing problems according to the solution technique used

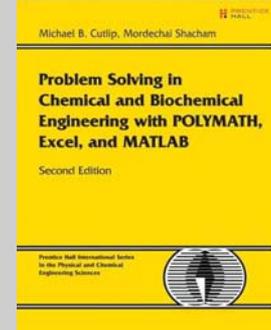
2. Basic Principles and Calculations

Solution of simple problems involving linear and nonlinear algebraic equations, ordinary differential equations and multiple linear and polynomial regressions using POLYMATH

3. Regression and Correlation of Data

Correlation of various properties with strong emphasis on validation and comparison of different regression models

Contents of the Computer-Based Problem Solving Course



4. Problem Solving with Excel

- Exporting the POLYMATH model to Excel.
- Exploiting Excel's capabilities for parametric runs, tabular and graphical presentation of the results and well organized documentation of the model, the data and the results.

5. Problem Solving with MATLAB

- Exporting the POLYMATH model to MATLAB.
- Programming in MATLAB to enable carrying out parametric runs, storage of the results in appropriate arrays and tabular and graphical presentation of the results.

Enhancing the Quality of Learning in the New Course

- ❖ *The starting point is a realistic problem to be solved – knowing what is the purpose of the use of the various software packages considerably increases the student's motivation to learn the subject matter.*
- ❖ *Gradual progress toward the more difficult tasks - the model is built using the user friendly, easy to use POLYMATH package. The MATLAB program generated by POLYMATH is used as the basis for modification to achieve the required goals through programming. Starting from a “working program” provides confidence in the students ability to complete the assignment, successfully.*

Main Features of the New Course

- *Use of self-tests for practice* - students check and grade their own homework assignments. The self-test program provides feedback on the errors made.
- *Exams in a computer lab* – in the exams the students have to provide the complete solution to a problem including preparation of the model with POLYMATH and carrying out various studies using Excel or MATLAB.

Experience with the Computer-Based Problem Solving Course*

- ❖ A preliminary version of the introductory CBPS course was introduced into the ChE curriculum in Ben-Gurion University in 1995.
- ❖ The particular structure of the course has evolved over several years.
- ❖ MATLAB was added to the course in 2003 and at the same time the required, 3 hr/week FORTRAN programming course was removed from the ChE curriculum.

*Shacham, M., *Comput Appl Eng Educ* 13: 137-145, 2005

Advantages of the Proposed CBPS Course

- ❖ The course is better tailored to the present needs of the undergraduate and graduate students and practicing engineers than the traditional programming course.
- ❖ Students are able to select the most appropriate computer based tool/s for a particular task from among the widely used Polymath, Excel and MATLAB packages.
- ❖ Successful students, a great majority, demonstrate MATLAB programming ability.
- ❖ Problem solving abilities with Excel spreadsheets, which are widely used in the industry, are significantly enhanced.
- ❖ The basis for empirical modeling, which is widely used in industry, is provided by inclusion of the subjects associated with analysis, modeling, and regression of data.