

Computer Programming in the Chemical Engineering Curriculum: Some Empirical Observations

Thomas F. Edgar
Department of Chemical Engineering
University of Texas at Austin

In 1996 Kantor and Edgar [1] opined that computer programming (in languages such as FORTRAN, C or PASCAL) is not a vital skill for chemical engineers in industry. Surveys of industrial engineers indicated that many companies explicitly tell their engineers not to write software because of the difficulty of maintaining such programs written by individuals. On the other hand, formal courses on computer programming appear to remain a required element of many undergraduate chemical engineering programs. A more recent survey by Dahm et al. [2] shows that 83% of programs (84/160 departments responding) require a computer-programming course (taught by either computer science or engineering faculty) and 45% require programming in “several” subsequent courses; see Tables 1 and 2. Dahm et al. believe that there has been a shift away from teaching traditional computer programming. 16% of respondents indicated that their curriculum no longer contains computer programming at all, a fairly recent development. Other respondents indicated that the programming present in their curriculum does not employ traditional languages such as C or FORTRAN, but higher-level programming environments such as Maple or MATLAB. Swinnea [3] recently surveyed 160 Chemical Engineering departments and received 43 replies. Many of the respondents indicated that they were examining their computing curriculum and were interested in the survey results. Of the 43 respondents, all but five indicated that they have some sort of programming course requirement. Many of them indicated that they teach more than one programming “language”. The distribution is as follows: (see Table 3).

C/C++	17
FORTRAN	10
MATLAB	16
Excel	13
V. Basic	7
MathCAD	6
Other	4

Swinnea also inquired about coverage of numerical methods: 21 teach a separate course, but 17 teach no specific course, although several departments stated that numerical techniques are introduced throughout the curriculum. Five indicated that numerical methods are included in the programming course.

The results of Swinnea’s survey are intriguing in that there seems to be a wide range of approaches to addressing instruction in numerical methods and instruction. There are many factors that contribute to this lack of consensus: resistance to change (how many years has this requirement been in place?), lack of qualified instructors, teaching loads, overall engineering curriculum requirements (e.g., freshmen core course

requirements), a need to retain computer science credit hours in the university, etc. I believe that this aspect of the curriculum has not received as much scrutiny as has the integration of computer software into design, control, thermodynamics, and unit operations. This is somewhat surprising given the continuing pressure on the number of required hours in the B.S. curriculum. The purpose of this article is to present empirical evidence of the many different approaches used in U.S. chemical engineering departments, without reaching specific conclusions. Hopefully this will initiate discussions in different venues on how to most effectively incorporate instruction of programming and numerical methods. Please send comments to Tom Edgar (edgar@che.utexas.edu).

Table 1: Response to “Which of the following best describes your department’s use of computer programming languages?” (84 responses) [2]

Response	% Yes
One required course taught by computer science and no programming required in subsequent chemical engineering courses	13%
One required course taught by chemical engineering and no programming required in subsequent chemical engineering courses	11%
After students take the required programming course, they are required to program in one subsequent ChE course.	7%
After students take required programming course, they are required to program in several subsequent ChE courses.	45%
Students are required to program in upper level chemical engineering courses without having taken a formal programming courses.	8%
None of the above selected	16%

Table 2: Response to “Indicate the mathematical applications software required of chemical engineering undergraduates” (84 responses) [2]

Response	% Yes
POLYMATH ³⁹	37%
MATLAB	65%
Maple	24%
MathCAD	37%
EZ-Solve	5%
Spreadsheets	82%
Mathematica	13%
Other	15%

Table 3: Department Responses on Numerical Methods and Programming Instruction [3]

Institution	Numerical Methods Course	Programming Course
Arizona	3hrs Soph, 3hrs Junior	3hrs C++
Clarkson University	No	2hrs Excel, Maple, MATLAB
Colorado	3hrs MATLAB, Excel	3hrs VBA, Mathcad, Excel, MATLAB
Colorado School of Mines	2hrs	2hrs Visual Basic
Colorado State University	MATLAB	3hrs C++
Connecticut	3hrs Mathcad, MATLAB	No
Cornell University	80% Take Engineering Calculations elective (MATLAB)	4hrs MATLAB, Java
Delaware	3hrs MATLAB	No
Iowa	3hrs MATLAB	3hrs C, Fortran
Iowa State Science and Tech.	3hrs Fortran, MATLAB	3hrs Fortran Excel, Visual Basic
Kansas	No	3hr Fortran, Excel, Powerpoint
Kansas State University	Included in programming course	2hrs Fortran
Kentucky	No	2hrs C++ Maple, MATLAB, Aspen
Lehigh University	No	No
Maine	None indicated	3hrs Mathcad
Massachusetts Inst of Tech.	Included in Programming course	6hrs C MATLAB, 3hrs Visual Basic, MATLAB
Michigan State University	No	3hrs Fortran, Visual Basic, Mathcad, Excel
Minnesota at Duluth	3hrs	3hr C++ or Fortran
Missouri-Rolla	No	No
Nevada, Reno	3hrs Mathcad, MATLAB, Excel, Polymath, Maple, ChemCad	4hrs C
New Hampshire	Applied Math Course using C, Excel, Mathcad introduced in other courses	No
North Dakota	No	2hr Excel, MATLAB, 4hr C++
Northeastern University	No	3hrs MATLAB
Notre Dame	3hrs MATLAB	3hrs MATLAB, Excel
Ohio University	3hrs MATLAB	1hr Mathcad, Excel
Oklahoma	3hr Mathcad, Fortran, Excel	2hrs Fortran
Oklahoma State University	No	4hrs C Excel, MATLAB
Purdue University	No	3hrs Unix, MATLAB, Maple, Fortran (self paced)
Rice University	3hrs Fortran, MATLAB	2hrs C++
Rose-Hulman Inst. of Tech.	No	4hrs C++
Rowan Univ.	No	3hrs MATLAB, Excel
San Jose State Univ.	3hrs MATLAB Excel	Visual Basic, Excel, Mathcad, Aspen
South Alabama	No	3hrs C++
State New York at Buffalo	No	3hrs C
Syracuse Univ.	Adding Excel/MATLAB course	3hrs Fortran
Tennessee Tech Univ.	3hrs	3hrs Fortran or C
Texas	4 hrs MATLAB, some programming	No
Texas A&M Univ.-Kingsville	No	3hrs C or Visual Basic
Tri-State Univ.	2hrs Mathcad, Excel	3hrs MATLAB
Vanderbilt Univ.	No, teach Aspen to sophmores	3hrs Excel Mathcad , MATLAB, Pro/II, HYSYS
Washington State Univ.	Included in programming course	3hrs C++, MATLAB, Excel
West Virginia Univ.	3hrs Polymath, Excel, Mathcad	3hrs Fortran or C
Wyoming	Same course	No

REFERENCES

1. Kantor, J.C. and T.F. Edgar, "Computing Skills in Chemical Engineering Curriculum" pp. 9-21, *Computers in Chemical Engineering Education*, CACHE Corp., Ann Arbor, MI, 1996.
2. Dahm, K.D., R.P. Hesketh, and M.J. Savelski, "Is Process Simulation Effectively Utilized in Chemical Engineering Courses?", *ASCE Annual Meeting*, Albuquerque, NM, June, 2001.
3. Swinnea, S.L., Personal communication, University of Texas, Austin, TX.