# University of Kentucky

The incorporation of computing through the curriculum is being addressed at the University of Kentucky with a goal of achieving the following objectives:

- Student proficiency in computing skills representative of the breadth of computing tools encountered in industrial practice.
- Demonstration of student's ability to for in-depth analysis using selected individual computing tools.
- Demonstration of student confidence in their ability to employ computing tools and to learn new tools
- Cohesive and efficient approach to introducing and using computing tools through the curriculum.

These objectives are being achieved through changes in the delivery of current courses as well as proposed curriculum reform. Through surveys of current students, alumni, co-op employers, and our faculty, the department clearly identified deficiencies in our previous approach to introducing and using computing tools. Namely, our required programming language course (Fortran or C++), which is taught outside our department, was not preparing students for engineering analysis. In addition, the programming language was not being sufficiently utilized and reinforced in the subsequent core chemical engineering courses for which it was a prerequisite. Numerical methods packages were being utilized in core chemical engineering courses, but the use of multiple software packages (e.g, Maple, MATLAB and Mathematica) limited the students' perceived proficiency in the use of computing tools. Further, students were not well-prepared to use chemical engineering simulation packages (e.g., Aspen or Chemcad) at the level required in senior-level design projects. Finally, knowledge of Excel was required for a broad range of core classes but was not introduced in a systematic manner.

These survey results led the faculty to carefully evaluate the choice of computing tools and the implementation of these tools in our curriculum. The following steps have been undertaken to incorporate computing tools through our curriculum:

1. A clear description of the objectives relating to computing in our curriculum was developed (as stated above).
2. A limited number of computing tools were selected and a plan for their introduction and implementation in the curriculum was formulated.
3. The relevance of a programming language in our curriculum was formally assessed.
4. The development of a new computing tools course within our chemical engineering curriculum was examined.

As a department, we have chosen to focus on three computing tools (a numerical methods package, a chemical engineering simulation package, and a spreadsheet program) and the implementation of these tools through the curriculum (Table B.1). Maple was chosen

over other commercial numerical packages such as MATLAB because it is widely available, sufficient for most undergraduate problems, and instills the basis for learning more powerful numerical packages. In addition to being used by our chemical engineering faculty, Maple is also introduced in the freshman and sophomore-level calculus courses at the University of Kentucky. Aspen has been our primary unit operations simulation package, and continues to be supported in recent textbooks examples. Computer-based tutorials (D.R. Lewin, W.D. Seider, J.D. Seader, E. Dassau, J. Golbert, D. Goldberg, M.J. Fucci, and R.B. Nathanson, "Using Process Simulators in Chemical Engineering: A Multimedia Guide for the Core Curriculum" Distributed by John Wiley & Sons, Inc,. Version 2) has greatly enhanced the ability to incorporate unit operations simulation packages into our core courses. Recognizing its importance in industrial practice and its practical value, Excel is now emphasized as a primary computing tool in our curriculum. Training in Excel in our unit operations laboratory is coupled with statistical analysis, thereby addressing two educational needs of our program. The overall goal of this implementation is to provide students with fewer computing tools, but to increase their proficiency and confidence in these tools by reinforcing their use throughout the curriculum. The exception to our "preferred list" of computing tools occurs in Process Control, where Simulink, a MATLAB tool, is a standard tool for the simulation and analysis of control systems.

Table B.1. Current implementation of computing tools at the University of Kentucky

| Year | 1st Semester | 2nd Semester |
|---|---|---|
| **Freshman** | Calculus I: Maple | Calculus II: Maple<br>CS Programming Language |
| **Sophomore** | Calculus III: Maple<br>CME Process Principles: ASPEN | Calculus IV: Maple<br>CME Thermodynamics: ASPEN |
| **Junior** | CME Separation Processes: ASPEN and Excel | CME Process Modeling: Maple |
| **Senior** | CME Unit Ops. Lab: Excel<br>CME Reactor Design: ASPEN<br>CME Process Design I: ASPEN and Excel | CME Process Control: Simulink<br>CME Process Design II: ASPEN and Excel |

Our current plan of implementation of computing tools reflects our department's choice to move away from a formal programming language course. Thus, we are piloting a 2 credit hour CME course (CME 1xx *Computational Tools for Chemical Engineers*, Spring 2004) aimed at freshmen-level students. Our purpose for the course is the meaningful introduction of computing tools (Excel, Maple, and ASPEN) which will be used throughout the curriculum. One goal of the new course is proficiency in Excel, including mastery of the basic interface, graphing, regression, and optimization. Knowledge of the tools of Maple is the goal for the second section of the course. We will focus on simple methods used to numerically solve problems (symbolic math with Maple is covered in our Calculus sequence) and avoid a "black box" treatment. In this freshman-level course, only a basic introduction of ASPEN for the solution of simple problems is an appropriate goal. In addition to developing proficiency with the user

interfaces of these packages, the focus will be on numerical methods (Newton-Raphson, solving linear equation sets, numerical differentiation and integration) used across all packages. This course will incorporate *chemical engineering* problems that the students will see again in future core courses (e.g., flash calculations). *Computational Tools for Chemical Engineers* will be offered as an optional course during its pilot period, to be substituted for our 2 hour programming language course. As we move toward the full implementation of the freshman-level Computational Tools course as a required course, we anticipate that our integration of computing tools in our curriculum will be described by Table B.2. The placement of this course in the freshman year will allow us to increase our reliance on computing tools, particularly Excel, in the sophomore year.

Table B.2. Proposed implementation of computing tools at the University of Kentucky

| Year | 1st Semester | 2nd Semester |
|---|---|---|
| **Freshman** | Calculus I: Maple | Calculus II: Maple<br>CME Computational Tools: Maple, ASPEN, and Excel |
| **Sophomore** | Calculus III: Maple<br>CME Process Principles: ASPEN and Excel | Calculus IV: Maple<br>CME Thermodynamics: ASPEN and Excel |
| **Junior** | CME Separation Processes: ASPEN and Excel | CME Process Modeling: Maple |
| **Senior** | CME Unit Ops. Lab: Excel<br>CME Reactor Design: ASPEN<br>CME Process Design I: ASPEN and Excel | CME Process Control: Simulink<br>CME Process Design II: ASPEN and Excel |