# Bruce A. Finlayson Receives ASEE-CACHE Award

It is quite fitting to honor Bruce Finlayson for his long-time contributions to chemical engineering computing with this award after he recently retired from full-time teaching at UW (after nearly 40 years in that department). All of Bruce's friends and colleagues have deep respect for Bruce as someone who is a first-rate researcher but also is equally committed to chemical engineering education and the chemical engineering profession.

Bruce is an author of four significant well-written textbooks spanning four decades that emphasize computing:

1. *The Method of Weighted Residuals and Variational Principles,* Academic Press (1972)

2. *Nonlinear Analysis in Chemical Engineering*, McGraw-Hill (1980)

3. *Numerical Methods for Problems with Moving Fronts*, Ravenna Park Publishing (1992)

4. *Introduction to Chemical Engineering Computing,* Wiley (2006).

His latest contribution, *Introduction to Chemical Engineering Computing,* Wiley (2006) teaches undergraduates how to use the programs Excel, MATLAB, AspenPlus, and Femlab (Comsol Multiphysics) to solve chemical engineering problems. An earlier book, *Nonlinear Analysis in Chemical Engineering*, McGraw-Hill (1980) describes mathematical methods (including the orthogonal collocation method and the finite element method) that were used by countless graduate students to solve their problems numerically. The computer programs published in that book are still used worldwide.

Professor Finlayson is helping establish a new paradigm for chemical engineering computing, which is described by the preface in his latest book: "Chemical engineering students and chemical engineers are being asked to solve problems that are increasingly complex, whether the applications are in refineries, fuel cells, microreactors, or pharmaceutical plants. Many years ago, students wrote their own programs, first in the FORTRAN programming language, then in languages like MATLAB®. With the growth in personal computers, however, software has been written that solves many problems for students, provided they use the programs correctly. Thus, the emphasis shifted from a small group of people who were interested in writing their own programs to a large group of students who will use the programs, but don't write them. Bruce states "In my 38 years of teaching at the University of Washington, I taught those small groups of students how to use numerical analysis to solve complicated problems. Now, I teach all my students how to use the computer wisely. Only a few of the students I teach are interested in the numerical analysis (to my sorrow!), but all the students know they must be able to solve difficult problems, and they need to use the computer to do that."

"The goals of this book are to illustrate (a) the problems chemical engineers have to solve, (b) the type of computer programs used to solve them, and (c) how engineers check to be sure

they have solved the problems correctly. …The programs demonstrated here are Excel, MATLAB, Aspen Plus, and FEMLAB. …

"My teaching philosophy is that the problems engineers are solving today are usually intractable with analytical methods, but they can be solved with the sophisticated software available today. Thus, every engineer will be solving a problem that no one knows the answer to, and it is the engineer's job to ensure that the problem is posed correctly on paper and in the computer, and it is correctly solved. Engineering students must know how to determine if the computer solved the problem correctly by validating the work done by the computer. If they can do this, they can convince their instructor – or their future boss – that they have a solution that is every bit as reliable as an analytical solution, although without the analytical form and for a problem that can't be solved analytically."

Now Professor Finlayson is doing research with undergraduate researchers using computational fluid dynamics with the program FEMLAB™ (now called Comsol Multiphysics). Because of the growing importance of microreactors, the focus is on small, laminar flows, dispersion, and mixing. At the Indianapolis AIChE meeting, Finlayson described how he introduces students to the program, how they check their results, and the range of results, and a 30 page paper shows educators how to do it.

**http://faculty.washington.edu/finlayso/AIChE-155f.pdf**

His work with undergraduates and graduate students has been so successful that it is featured on a company web site.

**http://www.comsol.com/stories/finlayson/index.php**

In addition, he regularly works with students in other departments (particularly in Bioengineering) to help graduate students develop models of their thesis subjects.

After the ASEE Summer School in 1997, of which Finlayson was the Head, he organized the preparation and distribution of a CD-ROM that showed how to solve ten classic chemical engineering problems using the various software packages available at the time. The problems were generated by Mike Cutlip at the University of Connecticut, and different people prepared the solution for their favorite software; Finlayson and some of his students prepared the MATLAB™ information, prepared the entire CD, and distributed it to every department.

The Chemical Reactor Design Tool was prepared to allow undergraduates to explore different transport effects in chemical reactors, with minimal knowledge of the necessary numerical analysis. The computer would prepare the appropriate programs to solve reactors with or without radial dispersion, axial dispersion, heat effects, heat and mass transfer limitations, and pressure effects. It was written using the Unix operating system, which seemed appropriate at the time (1989), and the program was installed on over 30 computers worldwide at no cost. His presentation about it at the ASEE meeting won the Martin Award in 1994 for the best chemical engineering paper.

In addition to his research and education accomplishments and contributions, Bruce has also been a tremendous professional leader. From 1989 through 1998 he was Chairman of the Department of Chemical Engineering at the University of Washington. In 2000 he served as President of the American Institute of Chemical Engineers. He also was the Chairman of the Computers and Systems Technology (CAST) Division, and a Trustee of CACHE Corporation (Computer Aids for Chemical Engineering Education) for over 12 years. He was a member of the Board on Chemical Science and Technology of the National Research Council and the Chemical Sciences Roundtable and in 1994 was inducted into the National Academy of Engineering. Bruce also was the lead author for the section on Mathematics for the last two editions (1997, 2008) of Perry's Chemical Engineering Handbook.