

A Studio Model for Teaching Undergraduate Heat Transfer

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Before the advent of the computer, differential equations that describe physical processes were solved tediously using analytical techniques. Often the solutions were evaluated using mechanical calculators and graphed or tabulated for use in engineering design. While convenient and the only feasible approach at the time, these solutions and a few assigned homework problems making use of them rarely build any physical insight at all. Now those same equations, as well as far more complicated ones, can be approximated and solved in a matter of seconds on an inexpensive desktop computer. More importantly, relatively simple but creative graphical depictions of the solutions can aid greatly in actually understanding the physical principles underlying the process. "The students are learning the subject matter by experimentation," says Robert Ribando. "Many of these simulated experiments in fact are far more powerful than anything we could conceive of doing in our laboratories."

The course that is the focus of Mr. Ribando's TFI project was previously taught in a three-lecture-a-week format with a related laboratory taken the following semester, too late for timely reinforcement of lecture material. Under the new format, there are two lectures a week plus a two-hour studio session. In the studio session students perform a variety of computer-facilitated design and analysis activities. Some weeks they do "virtual" experiments using computational simulations of heat transfer processes, actually taking data from the screen display for later analysis. They see and use modern visualization techniques similar to what they will routinely encounter in real world engineering.

Unlike commercial software packages, which are designed for ease of use rather than for instructional value, these studio exercises generally require preliminary "pencil and paper" analysis and provide training in the verification and interpretation of results as well. Other weekly exercises demonstrate the use of computer-aided solutions in the design process, allowing plenty of "what if?" calculations in minimum time. Mr. Ribando remarked, "The most common paradigm in engineering education for the last fifty years has been largely writing equations on the board. But we don't have to do that anymore. We can't afford to go back to the laboratory- and shop-intensive curricula that once prevailed in engineering, but at least now we can visualize the physical process that's going on right in front of us on the computer screen."