Stephen Thompson: Call Him Czar of Small-Scale Chemistry

Bulky beakers, rusty ring clamps, test tubes, and Bunsen burners aren't part of Stephen Thompson's lab. Instead, his chemistry students use "tubular integrated containers," "environmental chambers," and "sci-plexes." But don't think these tools are the latest in high-tech equipment. Tubular integrated containers, which serve as everything from clamps to filtration columns to ring stands, are really soda straws, and the environmental chambers in which chemical reactions occur are Petri dishes. Magnifying glasses are microscopes. Styrofoam cups are integral parts of a gas thermometer, and trays with microtiter wells, the mainstay of molecular biologists, hold chemicals for spectroscopic analysis.

Crude tools, yes, but each year 2800 students at Colorado State University in Fort Collins use them to analyze vitamin C concentrations, develop a chemical test for intoxication, perform redox reactions, and study acid-base equilibria. For Thompson, who directs the undergraduate chemistry laboratories at Colorado State, the methods in his madness began a few decades ago and are spelled out in his textbook, *Chemtrek*. And they serve several purposes.

Small-scale chemistry is cheaper, for one: Indeed, Colorado State's costs for "consumables" in student labs has dropped, Thompson says, from more than $50,000 a year to less than $5000. "Molecules are extremely small, and 50 billion of them do the same as 5000 billion," he says. Then there's the waste disposal advantage: Small amounts of chemicals mean there's less to be rid of. And best of all, according to Thompson, students forced to work with small-scale equipment draw large-scale lessons they won't forget.

Thompson is convinced the small-is-beautiful approach moves students away from following recipes and toward thinking about how chemists know what they know. It "allows people to play," he says, which, in turn, allows people to learn. Moreover, in Thompson's small world, students must build most of the instrumentation they use. "I want students to see the relationship between form and function," Thompson says. "There's a tremendous difference between the tools and instruments needed for research and the tools and instruments needed for *teaching* research."

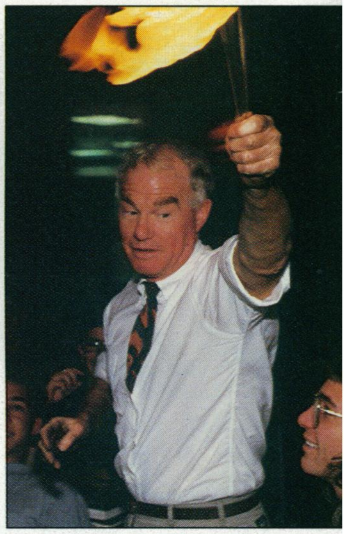
For example, Thompson's students analyze a chemical not with a $15,000 gas chromatograph but with a 25-cent contraption that they build themselves using such low-tech gear as clothes pins and syringes. "Steve is trying to take the black-box mentality out of science and show that it's what's inside the black box that matters," says Frederick Stein, a physical chemist who directs Colorado State's Center for Science, Mathematics, and Technology Education. The center carries the small-scale gospel to middle school and high school teachers throughout Colorado.

In fact, Stein believes so strongly in the concept that he has helped raise money for Thompson to purchase "sci-plexes" for his undergraduates. These are computer workstations, shaped like boomerangs, where small-scale experiments are carried out on screen. The two advantages: Students can load their lab notebooks on the machines and directly enter data, and the light from the screens can be used in experiments to, say, illuminate the scattering of gas molecules that are in a Petri dish.

An impish man with bushy white eyebrows and a lilting British accent, Stephen Thompson is a born entertainer: He put himself through graduate school by working as a fire eater in the circus. Ever since, Thompson has been breathing fire into the sometimes all-too-tepid traditions of undergraduate chemistry.

–Jon Cohen

PHOTOS BY WILLIAM A. COTTON



Edutainer. This Colorado State chem lab director passes up high-tech for magnifying glasses, styrofoam cups, and soda straws.

Ocean Engineering? New Wave In Teaching Marine Biology

Alex Vetrovs came to the University of New Hampshire (UNH) to obtain a Ph.D. in biology and to become an academic scientist. But an unusual undergraduate course in ocean engineering gave him a taste for the real-world intersection of science and commerce, and in 1985 he left school after completing a master's degree to start Aquatic Research Instruments, a small Seattle company that makes electronic equipment for marine researchers. "Biology students are usually interested in learning things," says Win Watson, a UNH biologist who often oversees the course, begun in 1969. "But this teaches them how to solve a problem in the real world."

Vetrovs was part of a team of a half-dozen undergraduates in marine biology and engineering who designed, built, and operated a system to monitor the behavior of ocean-dwelling horseshoe crabs. The system detected electrical impulses in the crabs' muscles and relayed the signals to a recorder in a floating buoy. It was a rare opportunity: Few classes give students the chance to go beyond turning knobs on a research project, and even schools offering research opportunities for undergraduates seldom give students as much independent and hands-on experience as does the ocean engineering course, which is supported by the National Oceanic and Atmospheric Administration's Sea Grant program. "That project showed me the possibilities," says Vetrovs. "It's how I first learned to work with engineers to get a product out."

Unlike the typical undergraduate marine biology course, ocean engineering judges students not just on what they know but also on how well their ideas work. Take the Automatic Monitoring Systems to Evaluate Lobsters (AMSTEL), a project designed to test the theory that lobster traps snare only a tiny percentage of the crustaceans they attract. AMSTEL was created by an undergraduate team of a marine biology major and