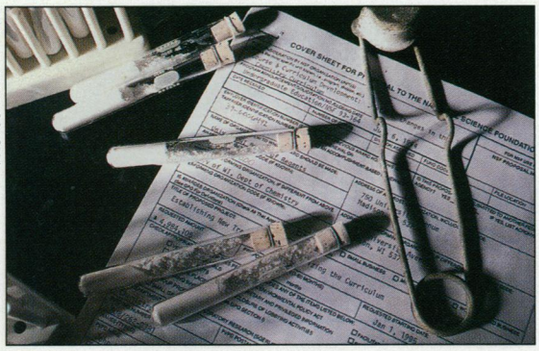
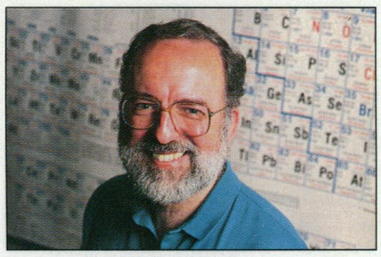
Novel Course II: 21st-Century Chemistry

One of John Moore's biggest frustrations with teaching undergraduate chemistry is that the lessons don't last. A 30-year classroom veteran now at the University of Wisconsin, Madison, Moore says: "The students go away for a summer and forget what we think we've taught them." So Moore fought back. Last June he submitted a sweeping proposal to the National Science Foundation (NSF) to create a new curriculum. Whatever NSF's verdict, Moore is committed to leading a coordinated effort between the University of Wisconsin and a handful of state universities, liberal arts colleges, and minority institutions in the East and Midwest to write a curriculum that will crystallize chemistry concepts in the minds of thousands of students. No more would newly acquired knowledge of acid-base reactions, phase changes, kinetics, and the like evaporate with the first summer breeze.

PHOTOS BY JEFF MILLER





Grand design. Not content to reform a single course, John Moore is trying to revamp all of undergraduate chemistry with his proposal to NSF.

Moore already knew that NSF was looking for radical curriculum reform. Last year, the foundation issued a Request for Proposals that dangled the prospect of a $10-million pot and individual grants of as much as $1 million. "We asked them to come up with a vision for systemic changes across curriculum," says Stanley Pine, then a NSF undergraduate education program officer. To underline his point, he added: "We want to change the whole thing, not just fiddle with a course here and there."

That's just what Moore's plan will do. Each of the schools within the consortium will experiment with a new approach, and a team of independent evaluators will figure out what worked, what didn't, and why. As a whole, the consortium will focus on five areas:

■ **Discovery-based and open-ended labs.** This idea, already in use at the College of the Holy Cross in Worcester, Massachusetts, reverses the usual sequence whereby students learn a concept in the classroom and reinforce it in a cookbook lab exercise. Instead, the lab experiments allow students to discover a concept and then learn more about it in the classroom. There will also be pilot studies in "open-ended" labs, where students define a problem and solve it using what they have previously learned. One class at Wisconsin was given techniques to measure hardness, oxygen levels, and the phosphate content of water. Groups then posed their own questions and designed experiments to answer them using water samples they collected. Moore says he hopes the approach will permit students to "experience the relevance of chemistry to their lives."

■ **Topic-oriented approach.** Professors at Wisconsin are starting to build courses around real-world topics to emphasize the relevance of the curriculum. For example, Clark Landis now begins his introductory chemistry course with a 3-week topical seminar, "Buckyballs, Diamonds, and Pencil Leads," that describes technologies associated with diamond film and buckyballs and explains the impact of structures on the properties of materials that share a common composition. Other topics under consideration are the ozone layer controversy and designer drugs.

■ **Use of information technology.** The group hopes to create software that would allow students to tailor courses to their interests and provide "interactive texts" on various topics, all interlinked through a program called hypertext. Students could view video clips of different chemical reactions, create and manipulate molecular structures, and calculate molecular properties. With the click of a mouse, students could change parameters of a reaction or other process.

■ **Better connections among disciplines.** Moore plans to coordinate chemistry classes with other science and mathematics courses to demonstrate the connections between disciplines. The goal is to prepare students to work on the interdisciplinary teams that carry out modern research projects. One approach would offer three-course clusters, such as math, chemistry, and engineering, that would focus on a common project or issue. The difficult part, says Moore, will be to convince faculty members to mold the courses into a coherent unit.

■ **Active/cooperative learning.** The goal of the reform efforts, says Moore, is to make the atmosphere supportive and noncompetitive without lowering standards. The consortium hopes to do this with group projects that reward cooperation.

Moore says a new curriculum will be cobbled together with the best of the various approaches. The final step, he says, could be a voluntary nationwide curriculum ready for students as they enter the next millennium.

–Faye Flam

Novel Course III: Undergrad Labs "Get Real"

Getting the chance to do lab experiments as an undergraduate didn't satisfy Pamela Fischer, who's winding up her doctoral program in chemical physics at the University of Oregon. Thinking back, she says, "usually you can complete a whole experiment in three-and-a-half hours."

What Fischer loved were the 10 weeks of sheer frustration she experienced as an undergraduate in a highly unusual lab course at the University of Oregon's Chemical Physics Institute. "In the CPI lab," recalls Fischer, "we saw all the quirks of doing new, exciting research. We actually had about one productive week, where we were getting spectra we could analyze. Research is not magic—you have to work at it, and you have to spend a lot of time thinking about the problem you're investigating."

Welcome to science education as conceived by Geraldine L. Richmond. A chemist, Richmond developed this unusual lab course about 7 years ago in response to a call for proposals from the National Science Foundation (NSF) for a new program entitled Research Experiences for Undergraduates (REU). "I already knew just how important genuine lab experiences were for keeping students in science," she says. But tradi-