

education division. In South Carolina, for example, an individual who has taken just one science course in college—whether that be introductory geology, chemistry or astronomy—can be certified to teach any science subject at any grade level.

NSTA is now considering SS&C for kindergarten through sixth grade, grades in which science education has typically been weak. According to Aldridge, development of an elementary school program may start as soon as next year. But here, too, finding qualified teachers may present a problem.

The NSTA models recommends a total of seven hours of science per week, which for most students means that other courses would be displaced if the new approach is adopted. Where will the extra time come from? In Houston seventh-graders would

normally take only five hours of science per week. To make room for the additional two hours, the schools have reassigned time that would have been spent in reading class to science, with the stipulation that the students read about science during that time. Other solutions may be to scale back to five hours of science per week, to integrate science with math or science with social studies, or to move such nonacademic courses as driver education or home economics to after school. There has also been talk of lengthening the school day, although that means more money.

The NSTA reform may be vulnerable to the charge of giving science too large a place in the overall curriculum. After all, why should more and more time be devoted to science class when students do poorly in other areas as well?

For all that, NSTA's proposal could end up being the biggest change to come about in science education since the post-Sputnik reforms. Proponents of the SS&C approach are gambling that their way of doing things will retain the best of the old system while getting rid of the worst. They maintain SS&C will keep students in the science "pipeline," thereby funneling more into science careers while raising overall science literacy.

"What we have in the United States is a strong tradition of teaching science through open-ended, laboratory-oriented discovery, which I think in the end makes for more inventive scientists," Moore says. "But what we're missing is getting the average student to be science literate. We're hoping that Scope, Sequence and Coordination can change that."

—JEAN KUMAGAI

PARTICLE PHYSICS EDUCATORS DESIGN 'PERIODIC TABLE,' SOFTWARE PROGRAM

In an effort to infuse modern physics into the traditional introductory curriculum, a group of physics teachers and researchers, with the backing of some of the largest US particle accelerator laboratories, has put together a package of teaching material on particle physics that includes a giant color wall chart and an interactive computer program.

The package is geared toward high school and first-year college physics classes. Its designers, who are known collectively as the Contemporary Physics Education Project, hope that the wall chart will someday enjoy the same position in physics classrooms that the periodic table of elements now does in chemistry classes.

The chart, measuring 1 meter by 1.5 meters, is a colorful compilation of figures, tables and text set against a black background. At the center is a representation of the atom's structure. On either side are tables that list the properties of fermions and bosons; below is a table on the various particle interactions. Short definitions of widely used terms—spin, matter and antimatter, and so on—are interspersed throughout the chart. Across the bottom of the chart are illustrated examples of three particle reactions: neutron decay, electron-positron annihilation and decay of an unstable hadron.

The idea for a chart originated with Frederick S. Priebe, a physics teacher at Palmyra Area High School in Pennsylvania, who proposed it at a

conference on teaching modern physics held in 1986 at Fermilab (see PHYSICS TODAY, March 1986, page 103). The purpose of the conference was to promote the teaching of particle physics and cosmology in high school and introductory physics courses; among

the other big projects to result from the conference is a teacher's guide on modern physics topics (see box).

Following the conference, the CPEP group was formed. From the outset the committee decided to restrict the wall chart to what was

Teacher's Guide Covers Modern Physics Topics

Two major projects arose from the 1986 conference on teaching modern physics. One project has resulted in the particle physics wall chart, as described in the accompanying news story. The other, called Topics in Modern Physics, has yielded a teacher's guide and a training program for teachers.

The Topics in Modern Physics project was organized by Friends of Fermilab and Fermilab's education office and was funded by a two-year, \$190 000 NSF grant. According to the project's director, Marjorie G. Bardeen, the teacher's guide is written for the high school or first-year college teacher and covers six specific areas in modern physics: accelerators and detectors, cosmology with general relativity, and elementary particles with symmetry. The idea is to allow modern physics to be "sprinkled" throughout the introductory curriculum. The guide contains background information as well as classroom activities. For example, the section on accelerators and detectors includes descriptions of Fermilab and SLAC, sample problems, lab assignments, diagrams of detector components, and a list of educational videotapes available from Fermilab. Following a pilot test in 1988, the guide was revised and a new edition was published in June 1990.

The project has also spawned a series of workshops that have been held throughout North America. Participants learn about a specific topic from a researcher in that field and then discuss how to incorporate the information into their courses. Bardeen says that about 3000 teachers have already taken part in the one-day workshops.

The *Topics in Modern Physics Teacher Resource Book* and a schedule of upcoming workshops are available from Friends of Fermilab, Fermi National Accelerator Laboratory, Batavia IL 60510. A Spanish-language edition of the teacher's guide is also available.

"known and certain," says Michael Barnett, a particle theorist at Lawrence Berkeley Laboratory. "At the first meeting, we sat down and listed what we thought was the minimum such a wall chart should contain," Barnett says. The chart is intended to summarize the major results of the past three decades of particle physics research. But given that most teachers can only devote one or two weeks to the topic, deciding what to include and what to leave out was somewhat involved. Indeed, it took four more years of meetings and regular correspondence to iron out the details.

The project has received the bulk of its funding from the US Department of Energy, Lawrence Berkeley Laboratory and the Stanford Linear Accelerator Center, with additional support from corporate sponsors and the American Association of Physics Teachers. Committee member Helen Quinn, a particle theorist at SLAC, estimates that the project has cost about \$100 000 so far.

A preliminary version of the wall-chart appeared in the December 1988 issue of *The Physics Teacher*. With the assistance of the Lawrence Hall of Science, the committee then conducted a field test with the cooperation of about 400 high school and college teachers, who were given copies of the chart as well as a teacher's guide and computer software explaining the basic concepts of the standard model.

One of the field test subjects was Cathy Mariotti, a physics teacher at William P. Clements High School in Sugar Land, Texas. She incorporated the material into a three-week unit on nuclear physics, which she teaches at the end of the spring semester.

"When the students first look at the wall chart, they're a bit overwhelmed by all the new terminology," says Mariotti. "They may have heard the word 'quark' before, but not in the context of physics."

Mariotti says her students have been especially taken with the software, which is interactive and is illustrated with some clever graphics and animation. With the aid of physicists on the committee, Andria Erzberger, a physics teacher at Palo Alto High School in California, designed the software using the Hypercard program, which runs on Apple Macintosh computers. Hypercard allows one to "page" through a branching series of screens or "cards." In Erzberger's software, for example, a picture of the wall chart is displayed on-screen and a student can then select a word or figure to have it explained further. The software also includes a set of cards describing the design, use

and history of particle accelerators and detectors, which are not dealt with in the chart.

Mariotti readily admits that, like many of her colleagues, she had a sketchy understanding of particle physics before she began the field test. To bring herself up to speed, she did a lot of outside reading and studied the teacher's guide thoroughly; she even wrote a study guide to accompany the software. Other teachers have attended CPEP-sponsored workshops on the use of the chart and software.

Barnett reports that nearly all the field test participants were enthusiastic about the wall chart and the related materials. Based on the results of the field test and other feedback, the chart was recently updated and reprinted. The new chart is much more readable and better organized, says Barnett. The software package has also been revised, and an IBM-compatible program is now being developed. CERN has translated the software into French and incorporated it into a popular ongoing exhibit at its visitors center.

CERN also plans to translate the wall chart and will distribute both it and the software within Europe. The teacher's guide is being rewritten as a textbook for students.

The CPEP group, which originally consisted of 10 physics researchers and teachers, has since grown to 18 members; last year it was incorporated as a nonprofit organization. The group now plans to continue its mission by producing an education film on particle physics.

Distribution of the wall chart and interactive software is being handled by the SSC Laboratory. The materials can be purchased by contacting CPEP, c/o Office of Education and External Affairs, SSC Laboratory, 2550 Beckleymeade Avenue, Dallas TX 75237-3946. Full-size wall charts are \$5 each. Half-size charts (0.75 meter by 0.5 meter) and notebook inserts are also available: The half-size charts are \$4 and inserts are \$6 for a package of 30. The software is \$14. (Prices do not include shipping and handling fees or sales tax.)

—JEAN KUMAGAI

AIP AND AGU APPOINT CONGRESSIONAL SCIENTIST FELLOWS

William T. Elam, a research physicist at the Naval Research Laboratory in Washington, DC, will be the Congressional Scientist Fellow sponsored by the American Institute of Physics in 1990-91. The American Geophysical Union has selected Jeffrey L. Payne of the College of Geosciences, Texas A&M University, to be its Congressional fellow in the coming year.

Elam received a bachelor's degree in physics from Mississippi State University in 1973. He completed his graduate studies at the University of Maryland, where he received a master's degree in 1977 and a PhD in physics in 1979. His thesis work involved electron spectroscopy of materials.

From 1979 to 1982 Elam was a postdoctoral research associate at the University of Washington, where his research included determining the structure of the active site of a biologically important protein using x-ray absorption spectroscopy. In 1982 he began working at the Naval Research Lab. He received NRL's research publication award in 1985 and 1988.

Elam succeeds Kenneth A. Goettel, who worked for Representative Vic Fazio, a California Democrat, as general science expert. Goettel got involved with 20 or 30 issues, mostly

scientific, including the earthquake hazards reduction program, solar and renewable energy, and magnetic confinement fusion.

Payne earned his BS in geology at West Virginia University in Morgantown in 1979 and his PhD in oceanography at Texas A&M University, College Station, in 1989. He has worked as shipboard scientist on several marine expeditions and as a consulting scientist or technician on numerous other projects. His principal research interests are geodynamics and ocean surveying techniques.

Payne replaces Barbara Frank, who spent 1989-90 working for the House subcommittee on international scientific cooperation.

The other Congressional science fellows sponsored by AIP member societies in 1989-90 were Charles P. Blahous III (The American Physical Society) and James Mastracco (Acoustical Society of America). Blahous worked for Senator Alan Simpson, a Wyoming Republican, mainly on matters requiring mathematical proficiency; he now has taken a permanent position on Simpson's staff as a legislative assistant with responsibility for taxes, banking, education, the arts and government affairs. Mastracco worked for Senator Pete V. Domenici,