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## "Science in Action": An Interdisciplinary Science Education Program

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Science in Action is an education outreach program for pre-collegiate students. It is based on the concept that, in order to interest students in science, they must see science and scientists at work. The program encompasses the full range of scientific disciplines - the core sciences, engineering and mathematics. A unique aspect of the program is the involvement and support of scientists and engineers representing local professional societies, industries, businesses, and academic institutions.

The first "Science in Action" program took place during National Engineers' Week in 1990; the second expanded program at the same time in 1991. "Science in Action" is part of the annual WATTeC conference in Knoxville, TN. The WATTeC conference is a week-long technical conference sponsored by a consortium of local professional/technical societies. The theme for the past several years has focussed on "competitiveness." Since the education of our young people is an essential part of "being competitive," the educational program was a natural outgrowth of the conference.

For the 1990 program, "Science in Action" was a two-day program specifically targeted to middle school students and was held in a multi-story building, the Candy Factory, at the World's Fair Site in downtown Knoxville. We wanted to reach students before they made the fatal decision to drop out of the advanced mathematics curriculum in high school. On each day of the program, 6 middle schools were invited to bring 40 students and teachers. Although only 5 of the schools were able to attend on the scheduled days, because of the enthusiasm for the program, the attendance on the first day neared 300 and on the second about 250. The middle school teachers and administrators were thrilled that someone was finally having a special program for them....they were really appreciative.

In 1991, "Science in Action" expanded to four days and moved to the Tennessee Valley Authority (TVA) Towers, also located in downtown Knoxville. The move permitted consolidation of the program on a single floor of the building. However, because of the size of the auditorium in the TVA Towers, attendance was limited to about 200 students each day. The first day was devoted to elementary school students. Small groups (5 students and a teacher - a "car load") were invited from the elementary schools in the surrounding cities and counties. Over 30 schools were able to participate. The second and third days followed the 1990 middle school format (although we reduced the number of students invited from each school to 30); nine middle schools participated. The final day involved small groups of 8 to 10 students from the 15 high schools. For this program, we did not design the program for the top few students in the school; these students have many opportunities to visit Oak Ridge National Laboratories and other local technical businesses. Instead, we specifically targeted students who are interested in science but are not currently considering it as a career. The program emphasized the broad range of potential careers in science and engineering-related fields.

### "Science in Action" Presentations

The goal of the presentations is to be highly interactive. We want the students to have some "hands on" experiences and to leave with a good feeling about science and engineering. To present a broad spectrum of role models, scientists and engineers were involved as presenters, guides, and exhibitors. Presentations for "Science in Action" followed the format: Keynote Presentation followed by Small Group Presentations

and visits to the Exhibit area. In 1990, the exhibits were available for the students to visit before the program and during lunch. In 1991, the program was modified so that a visit to the exhibits was considered one of the small group presentations. The keynote was the only presentation given to the group as a whole. After the keynote, the group split into the individual school groups for the remainder of the program. The groups cycled through the balance of the presentations; each presentation was given to each school group. In order to allow maximum participation and have appropriate presentations for the age of the students, there was a different set of presentations on each day.

Keynote Presentations: The keynote presentation in 1990 was "Creatures of the Night" by a local veterinarian. The presentation focussed on animal science and environmental science (the habitats of all animals). Live owls and opossums were an integral part of this program; the students were able to actually touch the animals.

For 1991, the keynote varied with the age group of the students. "Raptor Tales" was presented by the Clinch River Raptor Center to the elementary and one group of middle school students. This program informed the students of the value of raptors and their place in our environment. Live raptors were a major part of the program; the birds were handled by middle school age children who work at the Raptor Center. The second middle school keynote was "Fun with Chemistry," an introduction to chemistry given by a professor from Tennessee Technological University, Cookeville. "Fun with Materials," an introduction to materials science and engineering, was the keynote presentation for the high school students. (Detailed description can be found under the small group presentations.)

1990 Small Group Presentations: The small-group presentations covered a wide range of topics. Two of the most popular were "Fun with Materials" and the "Magic of Chemistry in Today's World." The "Magic of Chemistry in Today's World" was an interactive demonstration of chemical reactions -- all performed with chemicals that could be obtained in supermarkets. The "Fun with Materials" presentation is an adaptation of the original presentation by Bob Pond, an emeritus Johns Hopkins professor who is known throughout the United States for his "Fun with Metals" presentations. The students learned about the properties of materials and how materials scientists modify the properties for specific applications. All participants left with an aluminum "coin" that showed the crystal structure of the metal. A lucky few were able to catch some melt-spun tin as it left a round cake pan spun by a drill. The tin was melted inside of a foot-long glass dropper by a standard home workshop propane torch; students operated the drill.

In "The Microscopic World," the students were able to operate a real scanning electron microscope (SEM) (courtesy of the Metals and Ceramics Division, Oak Ridge National Laboratory). In the SEM, they were able to view insects, fractured surfaces of metals, diamond films, a human hair, and an integrated circuit. They also saw the "creatures they swam with in the pond last summer" in a life-sciences optical microscope demonstration. Two top-of-the-line metallographic microscopes were also part of this popular presentation. The presentations focussed on what we learn from microscopy and how this information is used in scientific and engineering investigations.

The noisiest presentation was "Neat Stuff with Humans." Presented by the Institute of Industrial Engineers, the presentation included a robot, a demonstration of how to design an effective assembly line (the students assembled ball point pens with a variety of approaches), and the impact of excessive noise on the quality of production (students attempted to communicate data while the group provided background noise).

In "Radiation, It's Only Natural," students learned about the occurrence of radiation in our natural environment, how radiation is detected, and how it is used. "Fun with Figures" focussed on mathematics

and how it can be fun, with various mathematical tricks and short cuts. "A Hitch-Hikers Tour of the Solar System" consisted of a slide show from various space explorations.

1991 Small Group Presentations: In 1991, we repeated several of the 1990 presentations. For the elementary students, "Fun with Materials" and "Fun with Rocks and Minerals" were presented. "Fun with Rocks and Minerals" explored the history of the earth through rocks and fossils. The students hammered on rocks to learn about the difference in hardness and left the demonstration with their own personal fossil.

The middle school presentations included "Fun with Materials," "Statistics," "Electricity and Magnetism," and "Ceramics Processing." The statistics presentation introduced basic mathematical concepts related to statistics. The electricity and magnetism presentation included hands on demonstrations. Ceramics Processing focussed on modern methods of processing ceramics. It involved a microwave oven for heating ceramics and a demonstration of how chemistry is used to process ceramic powders. A magnet was floated over a high temperature ceramic superconductor and a number of high tech ceramic car parts and a space shuttle tile were on display.

For the high school students, the small group presentations were "Electricity and Magnetism" and "Radiation: It's Only Natural" (presented in 1990). Both of these presentations were elevated to the high school level and stressed possible careers in these important fields.

Exhibits: In addition to the presentations, there were exhibits from a number of technical societies and local facilities. In 1990, the students visited these exhibits prior to the beginning of the program and during lunch. In 1991, due to the interest in the exhibits and the positive interactions between the students and the people manning the exhibits, a visit to the exhibit area was made an official "small group presentation." Each of the student groups was assigned a period of time for visiting the exhibits.

A variety of exhibits was on display each year. The University of Tennessee (UT) student chapter of ASM International had a display that included shape-memory alloys. In 1990, the biomedical engineers exhibited medical equipment such as a blood pump (demonstrated with a full-scale model of the circulatory system) and a number of other biomedical devices. This was a very popular exhibit; we were dismayed when this group could not schedule an exhibit for 1991.

In 1990, there were wooden models of various types of structures in the display sponsored by the civil engineering group. This exhibit was considerably expanded for 1991 to include numerous examples of civil engineering including road and bridge materials. The American Nuclear Society had an exhibit of how radioactive materials are used in our lives every day.

In 1990, the High Temperature Materials Laboratory from ORNL had a light-box display that highlighted various materials developments for high temperature environments. For 1991, the number of light boxes was reduced and the exhibit expanded to include a superconductor demonstration and a display of car parts fabricated from ceramics.

The National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCCChE) sponsored a computer game that tested knowledge of the contributions by black scientists and engineers. In 1990, they also had a number of drawings by local school children that focussed on the theme of environmental protection. In 1991, there was a working model of a refrigeration cycle.

One of the highlights of the 1991 exhibits was an infrared camera provided by ALCOA. Infrared photos were taken of each of the students. The application of this technology in manufacturing was discussed during the exhibit. ALCOA also provided an exhibit on aluminum recycling.

In 1991, the microscopy small group presentation became part of the exhibit area. Due to logistic difficulties and expense, the scanning electron microscope was not part of the exhibit. The pond water microscopy and optic metallographic instruments were retained and were a great success. For the upper level students in 1991, the Information Sciences group had an exhibit that described how information science is used in engineering and technology. Oak Ridge Associated Universities (ORAU) also sponsored an exhibit on its programs for high school and college students.

### Organizers and Sponsoring Organizations

The co-organizers of "Science in Action" are Linda Horton, ASM International, and Julie Watts, Association for Women in Science. Both Horton and Watts are also staff members at Oak Ridge National Laboratory (ORNL), a facility operated for the Department of Energy by Martin Marietta Energy Systems (MMES). In 1990, the program was held at the East Tennessee Discovery Center (ETDC), located at the World's Fair site in downtown Knoxville. A pizza lunch was provided for all participants, presenters, guides, and exhibitors. For 1991, the program was moved to the TVA Tower office buildings, a more convenient location. Also, while the students enjoyed the pizza, serving it presented logistic nightmares. In 1991, bag lunches were provided.

The success of this program is the result of the cooperation and integration of the local technical and professional societies. Obviously, those involved also have the full support of their employers. In addition to support from ORNL, MMES, TVA, ALCOA, and the ETDC, many other groups contribute to the program. A partial list of these includes ORAU, Carl Zeiss, Inc., International Scientific Instruments, Inc., UT, Science Applications International Corporation, Grumman Aerospace, Pizza Hut, Dillard Paper Company, Pellissippi State Community College, and California State Polytechnic University. Professional society involvement also included the Institute of Industrial Engineers, the Health Physics Society, NOBCCChE, the Project Management Institute, the American Nuclear Society, the Tennessee Society of Professional Engineers, and the American Society of Civil Engineers.

The support of employers is surprisingly easy to obtain. Representatives of local businesses serve on the Board of Directors of WATTeC. In addition, education activities have the unqualified support of both Alvin Trivelpiece, the Director of ORNL; Clyde Hopkins, the President of MMES; Richard Ray, the Manager of ALCOA; and Jon Veigel, the President of ORAU. Most importantly, however, everyone involved is interested in promoting science education in our schools. All are volunteers who use a tremendous number of hours of their personal time on behalf of "Science in Action."

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