nized primarily outside professional societies. The tradition, atmosphere, and bureaucracy of the existing professional societies could not accommodate the excitement associated with those meetings. The Metallurgical Society of AIME formed an electronic materials committee and helped organize some meetings; but those meetings were not included in the regular meetings of the society and the proceedings could not be published in the society's transactions. We argued for years that the proceedings should be a part of an archival journal rather than be published in self-standing volumes. When I became chairman of that committee, we finally convinced the society to publish our proceedings. Indeed, they appeared for the first time in March 1964, in volume 230 of the Transactions of the Metallurgical Society of AIME. One or two years later, however, this practice was discontinued. I know that today's leaders of that society regret their predecessors' attitude and actions.

The Electrochemical Society formed an Electronics Division which organized meetings on topics ranging from materials to devices. This society exhibited some flexibility. It was a relatively small society and had the potential to become a materials society. However, the name of the society was not quite appropriate; in addition, the traditional membership viewed the electronics people as outsiders. I was a member of the Corrosion Division before I joined the Electronics Division, and thus a member in good standing. When I became president of The Electrochemical Society in 1967, I convinced the directors to consider changing the society's name. For obvious reasons, I suggested the J. Willard Gibbs Society as a potential name. We brought the matter to the membership for a vote. I wrote an editorial, "Our Society's Name," in the *Journal of the Electrochemical Society*, (July 1967), in which I pointed out the benefits to be derived from a name change. The membership voted down any name change and a great opportunity was lost.

> The pressure was immense to develop materials, processes, and structures that would bring to life phenomena and devices already conceived theoretically, and even patented.

Soon after MRS was founded, I felt strongly (and so did Rustum Roy) that we should honor Arthur von Hippel. He was the earliest true pioneer in materials science and engineering. As far back as the early 1940s, his Laboratory for Insulation Research at MIT was an interdisciplinary center. Doctoral thesis research was carried out there by graduate students from the departments of chemistry, physics, electrical engineering, and metallurgy (including ceramics). He most appropriately defined his work as molecular science and molecular engineering. It was unfortunate that Professor von Hippel's vision and experience were not utilized when the Materials Research Centers were organized at MIT and elsewhere in the 1960s.

As one of its founders and as its first president, I am proud of MRS. We created a forum for the young, exciting materials community. The growth of MRS shows the magnitude of the need we met. We must appreciate, however, that rapid growth has inherent hazards. The potential for attracting opportunistic and/or limelight-seeking individuals is one such hazard. The possible loss of flexibility is another. A third hazard is the potential loss of readiness to respond promptly to emerging materials fields. I trust that MRS's leaders are addressing those challenges head-on.

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EDUCATION EXCHANGE

Science/Math Carnival

Among the many letters sent to Sandia National Laboratories/California from local teachers and students during the past two years, we find letters from:

- A first grade teacher in Tracy, California, who wrote: "These kinds of experiences are so important in keeping science alive for students and teachers. It could not have gone better. Many thanks.";
- A teacher who was signing up for some summer courses on science so he would be able to better teach his students, who were asking for more science;
- Students writing to thank us for our Science/Math Carnival, describing their favorite activity (and why it was their favorite), and explaining why they want to be scientists when they grow up;
- Students who sent drawings of how a laser works, of a floating bubble, or of an idea they want to patent;
- Parents asking us what the Science/Math Carnival is, because their children came home "really excited, and kept telling us about the things they learned in school that day.";
- Teachers saying how they would continue to teach a certain "Carnival" science topic in their classes;
- The director of a bilingual migrant worker program, who was so thrilled by our presentation that he wanted to arrange a partnership with Sandia on future programs (two joint activities have already resulted from this); and
- Pictures from a fifth grade class of what a scientist looks like, showing about a third as women and half as minorities. (The same drawing assignment prior to a presentation by Sandia National Laboratories resulted in 30 drawings of white males.)

What prompted these letters? They were all written after a **Science/Math Carnival** had been held at their schools. The impact of Carnival has been immense in the local schools, and in this article I hope to give you a feeling of what it is, why it was started, and how much fun and excitement it generates (not only from teachers and students, but from the staff as well).

In April 1991, in an effort to increase our education outreach activities, Sandia National Laboratories/California decided to go directly to local teachers. We invited a group of elementary school teachers in the Bay Area to an after-school meeting, whose purpose was to ask how we, a national laboratory, could

use our resources (both equipment and people) to meet their needs. Our efforts were prompted by a notice in 1990 from U.S. Secretary of Energy Admiral James Watkins, requesting that *"each Department Laboratory and research facility make an institutional commitment to participate in science and mathematics education programs, with direct programmatic funding and through the use of overhead support."*

A brainstorming session followed. Out of that meeting came the concept of a **Science/Math Carnival,** in which different science demonstrations and activities would be packaged into a traveling "Carnival" that would be made available to schools and teachers at no charge.

As ultimately organized, the Carnival is a unique education outreach program that provides at one and the same time : (1) **hands-on-activities** for elementary school students; (2) a **diverse staff** of Sandia personnel who provide positive **role models** for all students; (3) a chance for students to experience the fun and excitement of science; and (4) a source of **encouragement** and **continuing learning** for both teachers and students.

On May 17, 1991 (one month after the meeting with the teachers) we brought five activities to a school in Livermore. By the end of that school year (June 1991), we had completed a total of seven Carnivals at schools in Livermore and Hayward. Our current catalog lists 14 activities.

During 1991–1992, the Carnival went to a total of 71 schools (55 during the traditional September–June school year and another during Summer 1992). This year we went to 60 schools from September 1992 to June 1993, and 20 schools are scheduled for Summer 1993. It is estimated that more than 1,300 teachers and 40,000 students participate in the program each year.

A typical Carnival consists of eight 20-minute sessions during the morning. There are from eight to 11 activities set up as stations in individual classrooms. Classes of 30–35 students (with their teachers) are rotated through the stations. The school makes the decisions regarding which classes will participate and how many stations each class will see.

Our contingent (equipment and a staff of nine to 15 individuals) will typically leave Sandia at 8:00 a.m. and arrive at the designated school before 9:00 a.m. A half-hour is needed to set up all the activities. Ideal conditions include an individual classroom for each station. Most Carnivals last about three hours. As each class participates in a station, the Sandia scientist provides information about the science the students are seeing, oversees the hands-on activities or demonstrations, and serves as a positive role model. A different class comes in every 20 minutes.

What kind of demonstrations or activities do we show? They range from simple to complex. The equipment can include inexpensive items from someone's garage or a $50,000 infrared camera. The only common denominator is the relationship to science and fun. At a typical Carnival session, students might start off as "junior chemists," making long-chain polymers with Elmer's glue and Borax, then have their pictures taken with an infrared camera (a la "Predator"), followed by hands-on activities with glove bags, microscopes, lasers, magnetic levitation, and many other activities. Throughout the morning, our staff demonstrates, in real life, that "Science is FUN."

About 200 Sandia/California staff members (from a total staff of approximately 1,100) have taken part in the program. Our goal is for staff members to help with one Carnival each month, and approximately 40–50 people do so. The average for the whole group is about once every three months. All staff participants are volunteers; no one is assigned to particpate. It is important that each participating individual *wants* to work with the Carnival, and feels it is important. We also want the staff to be diverse (one that includes minorities and women) in order to present proper role models to students. Making it happen this way has required a conscious effort on our part.

The Science/Math Carnival is not meant to be a "one-shot" deal. For that reason, we have presented many Teachers' Workshops, to help teachers continue to teach topics from the Carnival in their classrooms. Included in the workshops are presentations of the science behind each activity, and a curriculum development plan that can be used in the classroom. Beginning this September, each school that sponsors a Carnival will send at least one teacher or administrator to a one-day workshop at Sandia, in which the "inner workings" of a Carnival and the activities and science behind each one are presented. Teacher-developed curricula will also be provided to each school for teachers to use in their classrooms. Pre-Carnival activities will help prepare the students for the Carnival, and post-Carnival curricula will enable the teachers to continue teaching specific science topics after the event is over.

In-house training for the Sandia staff is also provided. Last year, lunchtime training sessions were conducted for each of the Carnival activities. Videos of those sessions are available for anyone interested in participating in a Carnival.

In summary, the Science/Math Carnival exists as a unique education outreach effort, stemming from a commitment to a mission of education outreach in which both students' and teachers' needs are met. The program continues through the efforts of the staff of Sandia/California.

Ray Ng *is a mechanical engineer and a senior member of the Technical Staff of Sandia National Laboratories in California. He serves as an education outreach coordinator at Sandia/California, where the Science/Math Carnival is one of the programs under his direction.*

The Education Exchange highlights the experiences of scientists and engineers with local schools, along with helpful hints and resources. If you would like to share your own involvement in science education, contact Finley Shapiro, Department of Electrical and Computer Engineering, Drexel University, Philadelphia, PA 19104, U.S.A.
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To receive additional information on how you can get involved in enhancing K-12 science education, circle number 120 on the Reader Service Card.

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