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Thoughts from the Guest Editor

Fred Stein

As Guest Editor for this Newsletter of the APS Forum in Education, I am pleased that the theme of this issue is a particularly important and exciting form of physics education outreach.

For the *Physics on the Road* Conference in February, all roads led to Fort Collins Colorado. On the first day, fifty-five participants from 38 universities attended the annual open house of the highly regarded outreach program from Colorado State University, *The Little Shop of Physics*. That day, over 2,000 students, children, and parents strolled through *the Little Shop of Physics*, which was held in two huge ballrooms containing 150 physics displays. A staff of 20 CSU science majors helped with setting up, maintaining and explaining the exhibits.

The conference, on the next day, brought together physics faculty who are experienced in designing and providing year-round mobile physics displays and those who are interested in initiating similar outreach programs. Sessions were devoted to demonstrating, promoting, and disseminating the many approaches to traveling physics experiments using interactive exhibits and mobile demonstration shows. The next day, the conference began with Doug Osheroff from Stanford University giving an excellent keynote presentation on how a traveling science show was, for him, a defining moment in his career. Afterwards, the participants held panels, discussions, workshops and poster sessions and met in small groups to talk shop.

This newsletter is dedicated to those physicists who take demos and hands-on exhibits on the road to students of all ages in small rural towns, inner-city schools, and foreign countries. In addition, it relates the stories of those hard working and often insufficiently recognized physicists who prepare demonstrations on a daily basis for college and university physics students in order to engage, motivate, and excite them.

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Reflections of a Physics Road Show Workshop

Stanley Micklavzina

I consider the workshop held at Colorado State University in Fort Collins Colorado a great success. The first full day observing Brian Jones's Little Shop of Physics open house was truly inspiring. I have always marveled at Brian's program and the creative and organizational energy that goes into it. I was inspired to try new ideas for low cost apparatus and also to develop a program where the public can interact more with fun physics apparatus. The education that undergraduate students get from running such an exhibition and explaining physics principles is as important as the program itself. During this day it was also nice to be able to slowly meet the participants of the workshop around these interactive demonstrations. I came out with new ideas for road show and interactive apparatus, not just from Brian, but from all the attendees at the meeting. Ideas that were discussed I will take home and also think should be passed on in the proceedings report are listed below.

Difference between Physics Demos Shows and Hands-on Interactive Displays

This is a personal struggle for me for sometime. Being one who generally does shows, I was sensitive to comments from colleagues that these shows are not useful since students may not actually learn from lecture style presentations filled with flashy demos. I always felt that there was truth in what they said, but I have received so much positive feedback from the shows that I was not convinced they were useful. Through discussions at this workshop, I have arrived at the conclusion that it all depends upon your focus.

The demo shows are great for lighting a spark of scientific interest to students. It also provides a name for the university and is a great public relations avenue. The public relations can go beyond assemblies at schools and into presentations for the general public as well as other groups such as senior citizen centers. The interactive display type of outreach is much better when you are actually concentrating your efforts on teaching a particular principle to a smaller number of students. Of course, combine the two can be the best approach: a large show to spark the interest and then the more interactive activities to give the student the opportunity to get a hands-on experience to learn some principles.

Nuts and Bolts

The session on nuts and bolts was very instructive. Moving equipment is always a huge part of taking a physics show on the road. I would rate the following items as the most important:

- 1) As your road show gets established, purchase or build equipment that will only be used in the road show.** Equipment for a road show needs to be a little more robust. If you put together equipment for just the show, than you do not need to repack every time. Items needed for the show will less likely be forgotten, busted equipment will not hamper someone else, and the person doing the show will have more confidence in the equipment being used.
- 2) Build the packing into the demo!** This is a great idea where if you are building a demonstration, or mounting a demonstration onto a platform, do it in the actual packing crate. When you are loading you simply put the lid on the demo and you are done. An example could be mounting a demonstration on the lid of a packing crate. Packing is done by just putting the lid and the crate back together.
- 3) Get a vehicle.** Find the funding for a van as soon as you are starting to have a show where you are doing a considerable amount of off campus activities. The wear and tear on a personal vehicle can be very high. Funding a van could come from the alumni association, the university student-recruiting group, used motor pool vans, and even perhaps the college dean. One mem-

ber mentioned having rolling mail carts and a wheelchair lift mounted on the van to help with loading.

- 4) Publicizing your program.** Better results are obtained by getting information to school parent organizations. Principals and teachers have many things to read and think about. Parents are motivated to get some extra programs into the schools. Perhaps getting on the agenda of a district principals meeting may also help.
- 5) Staffing.** Using student volunteers has its problems with dependability and expertise. A paid staff offers stability and responsibility. Also a program where students earn credit for the outreach has some success. The credits need to really help them with their academic career.
- 6) Goals and Assessment.** These discussions were controversial at times. Understanding that assessment is a key ingredient in obtaining outside funding is an issue that needs attention. Establishing your goal and then implement an assessment process regarding that goal. The goal does not have to be to directly increase a students understanding of physics. Goals could possibly be ones that increase awareness of science such as creating a popular public display, increasing the use of apparatus in teaching physics or physical science in schools, or reaching 50 teachers a year with workshops on obtaining and using apparatus in a classroom.
- 7) Respecting the teachers.** Not alienating the teachers you are working with is extremely important. Coming with the attitude that you are going to help the poor teacher and that you know more than them is detrimental to any program. Indeed, many teachers can feel intimidated with your program and fear that you may get the students asking questions they cannot answer. The communication channel for having this not occur is essential.

The Future and Physics 2005

The enthusiasm for this was very high. I believe everyone wants to be a part of this project and it will be interesting to see what occurs in the upcoming communications between participants. The networking done at this meeting was very high. I think people interacted extremely well and I believe a high collaboration is possible over the next few years

The Sharathon Session

This was a good part of the meeting and came at the best time, at the end of it all. People at this point were very tired of thinking and talking and taking some time to look at demo ideas and having a little fun seeing some real creative ways of doing what we do was great.

Closing

In closing I was truly impressed meeting this set of colleagues in one place. It was fascinating to see programs that were totally run by students. It was great to meet people beyond the folks who generally only attend the AAPT meetings. I cannot say enough good things about this workshop and I truly hope we get to do it again. I would ask that the APS find ways at their future meetings to promote the importance of road show programs and the personnel involved in activities such as demonstrations and school outreach programs. Get the information to research faculty members and department chairs, who will then hopefully pass it along. In that way we could get more individuals involved in instructional support and apparatus active on a national level

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The Little Shop of Physics: A Traveling Hands-On Science Experience

Brian Jones

Background: Twelve years ago, Brian Jones, the Director of the Little Shop of Physics, presented a series of programs at the Windsor Colorado Middle School. The experience was, to put it mildly, not a success. The students were not interested in watching someone else do interesting science; they wanted to do it themselves. This failure resulted in the birth of the Little Shop of Physics, a unique traveling hands-on science outreach program at Colorado State University. Brian decided that the next time we came to this school, he was going to be certain to bring a program in which the *students* were the scientists. As the project took shape, a group of local teachers volunteered to provide valuable direction and insight, and a group of undergraduates at CSU volunteered to provide the energy and initiative. After a modest start which brought 25 hands-on science experiments to a half-dozen schools in the 1991-1992 school year, the Little Shop of Physics has grown to a rotating collection of 75+ hands-on science experiments, presented by a large and enthusiastic crew of tie-dye clad undergraduate students. It has traveled the region, the nation, and the world, bringing a remarkable hands-on science experience to nearly 200,000 children to date.

The fact that the program is developed and presented by undergraduate students at CSU is the key. These undergraduate students who develop and present the experiments come away with an amazing experience as well. No other program at Colorado State University involves so many undergraduates across so many majors in doing interesting, creative work – as a team. From the college students who develop and present the programs to the K-12 students we visit, we share a message that science is exciting, fun, and something anyone can do.

Overview: We refer to the Little Shop of Physics as an interactive traveling science experience. Our experiments are designed and

Defining Key Elements of Different Models of Mobile Hands-on Experiments

Julie Conlon

Each participant was asked to evaluate the percent of importance given to each of three goals for the hands-on programming of his/her on-the-road show: improve attitude/perceptions towards physics, teach science process skills, teach physics/science content. Although a few of the participants currently have either no hands-on component or no physics on the road program, the overall ranking of those who do was 60% as an effort to improve the perceptions/attitudes towards physics and 40% as an effort to teach the content and/or process of physics/science. With little exception, all operating programs are serving the K-12 population. In addition, two or three of the institutions identified part of their program goals as providing opportunity for folks to consider teaching and to provide opportunity to gain experience teaching science.

This group identified the benefits to using hands-on activities: Children need physical activity to learn, and by using common, ordinary items, they can better understand the connection and relevance of physical science concepts to their everyday lives.

Discussion led to the question: What is our role as outreach professionals? There is a need to locate programming that includes the 5-E model (engage, explore, explain, elaborate, evaluate), while at the same time addressing state science standards. Current programming utilizing short (usually one day) “one shot” visits are not intended as “a fix” for teachers lacking physics education and/or certification in physics.

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built by undergraduate students at Colorado State University and presented to K-12 students at schools around the state and region. We share exciting science with thousands of students each year, but we also share an idea: that science is something they can do. We provide workshops for teachers, evening programs for students and their families, and a local television program, *Everyday Science*. We also offer classroom materials and support to teachers, a Web site (<http://littleshop.physics.colostate.edu>) where students and teachers can ask us questions in addition to presenting talks and workshops at local and national meetings. We also travel internationally; in recent years, the Little Shop of Physics has presented programs and workshops in Canada, Chile, Azerbaijan, Ethiopia, Belize and El Salvador. We have hosted visitors from The Gambia, Korea and Chile. There are several aspects of the Little Shop of Physics program that make it unique and effective:

- *Scope of Schools Visited.* The Little Shop of Physics visits over 50 schools each year, presenting programs to over 15,000 K-12 students. Since our start in 1992, we have presented programs to over 200,000 students. Since we travel, we can provide programs to schools that are far from science museums and other such resources: on the Navajo reservation, in the San Luis Valley and on the eastern plains. Many of the schools in these areas have high minority populations. Some schools that we visit get few, if any, such outside programs. Given that many of the schools we visit have limited resources, we have no set fees for our programs and only take donations. Our international travels are, as well, generally off the beaten track, to destinations such as the Baku Teacher Training Institute in Azerbaijan and Abbiyi Addi College in Ethiopia.

- *Hands-on approach.* The Little Shop of Physics is the only traveling *hands-on* science outreach program of this scope in the country. We bring 75+ experiments and four to five helpers to each school we visit, and our emphasis is on making the students the scientists.

- *Nature of experiments.* Each of our experiments uses common, everyday objects. To show sound waves, we don't use an oscilloscope; we use a black-and-white television set that we have modified. To make a Cartesian diver, we don't use a pipette; we use a ketchup packet from McDonald's. The key is accessibility; every experiment in our collection can be duplicated by teachers from the schools we work with, and most can be done by the students themselves.

- *Service learning component.* The undergraduate students that work with the Little Shop of Physics (approximately 60-80 each year) gain valuable experience in building experiments, developing instructional materials, and presenting science to students at various educational levels. Many of the students plan on becoming teachers and so these lessons are especially valuable. We have recently begun offering a course, Physics Teaching Experience, to formalize this experience.

- *Sense of fun.* The most important part of the Little Shop of Physics is this: everyone who takes part in it seems to have a good time doing so. The Colorado State University students who work with the program, the students to whom we make presentations, the teachers who bring us into their school classrooms and participate in our workshops, and the parents who bring their children to our evening programs. All of these people learn that science is accessible, but most importantly that it is fun and exciting.

- Each year, we produce a new tie-dyed t-shirt with the dates and locations of our “world tour” on the back. The t-shirts also note the theme of the experiments that we develop. In each case, the theme promotes the universal accessibility and excitement of physics.

- *Science Magic.* Our brief introduction to our presentations in the 2000-2001 tour showed a series of “magic” tricks that, on further inspection, were really based on science. “Is it magic?” we'd ask, and

University of Maryland Traveling Physics Demonstration Programs

Richard Berg

In the fall of 1972, after six years as an assistant professor of Physics, working on the new cyclotron and teaching large lecture classes in physics at the University of Maryland, I was offered the position of Director of the Physics Lecture-Demonstration Facility. Also that fall I purchased my new 1972 Pinto station wagon. In the fall of 1973, the second of my two sons joined their older brother in elementary school. Very shortly thereafter, one of their teachers asked if any of the parents could come to school to talk about their job. I packed up a bunch of demonstrations in the Pinto and trundled off to the school, initiating the University of Maryland physics demonstration road shows.

It seemed that word of these programs passed among local teachers only slightly slower than the speed of light, and soon I was being asked to present programs at more schools than I could possibly accommodate while actually doing my real job. This arrangement continued until 1989, when the Pinto sputtered for the final time, leaving me without adequate transportation for the equipment. When we pointed this out to the University, the Dean of the

College of Mathematical and Physical Science and the Office of School/University Programs put up about \$15,000 to purchase and outfit a new Physics is Phun van. Our van has served well for the ensuing 13-plus years.

Our new Lecture-Demonstration logo with appropriate lettering was installed professionally, and the manufacturer installed a standard wheelchair lift, accessed through the sliding door at the right side of the van. Most of the demonstrations are carried in two 21/2 foot by 31/2 foot rolling mail baskets that can be loaded into the van using the lift; anything too large for the baskets can be loaded through the side or rear doors onto the floor of the van beside the baskets. This van arrangement allows us access to any schoolroom that is handicapped accessible, which includes virtually every conceivable location in the years after 1989.

In the fall of 1991, in coordination with the Acoustical Society of America meeting in Baltimore, we obtained an Eisenhower grant from the State of Maryland to offer workshops on sound for about thirty middle school science teachers. The workshop consisted of

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The Little Shop of Physics continued

the kids knew to respond, "No – it's science." A valuable lesson indeed.

- *The Amazing Physics of Everyday Objects.* This title, which was suggested by Fred Stein many years ago, perfectly captured the spirit of the 2001-2002 tour, in which we presented a set of experiments all of which were built out of equipment that was either bought at a hardware store, a discount store or a garage sale.

- *Discover Your Inner Scientist.* Science is a process, a way of learning about the world. And most people already know how to do it. This is the heart of the 2002-2003 tour theme – and the associated experiments.

Experiments

Our traveling collection of experiments – now numbering well over 200, of which we take 75+ on the road – are reworked versions of classic experiments using simple equipment, new uses we have come up with for everyday items, and some very odd and interesting experiments that grew out of working in a large group of creative people. Some examples:

- The Wiggly Goo Ball: A children's toy plus a massager plus a strobe light - the Wiggly Goo Ball vibrates in strange and unusual ways.

- The Spark Amplifier: A camera flash is connected to a fluorescent light bulb, and can be triggered from a distance by a static charge.

- Sodium Light Box: A monochromatic security light makes the world look all the same color, unless you look through the glassblower's glasses.

- Peanut Cruncher: Pressure from a bike pump compresses packing peanuts to a fraction of their original size. What happens when the pressure is released? And where does the cloud come from?

- Little Shop Vacuum, of Physics: Feel the pressure of the atmosphere. If you have ever wanted to be vacuum packed, this is the experiment for you.

- String Thing: A big version of a classic children's toy. The string is held in a graceful arc by the air from a blower.

- Fluorescence in Nature: Everyday objects such as flowers, rocks, and shells reveal exciting new dimensions in ultraviolet light. We have some scorpions too - freeze-dried, thank goodness - that light up bright green.

- Echo Drums: Two drums and a spring combine to make very cool sounds.

- It's Raspberry Time: A digital clock is used to show you a little bit about how your eyes and your brain work to process images.

- The Bernoulli Barrel: A \$1.00 shop vacuum from a garage sale has been adapted to levitate beach balls.

International Connections: The Little Shop of Physics approach to developing experiments with common items is of great use in developing new experiments in Colorado State University's physics labs, where money is always tight, but it is even more valuable in the international venues we visit. Around the world, changes in physics education seem to be tracking changes that have occurred in the United States over the past few decades. Physics teachers all around the world are looking for ways to make their teaching more accessible, more exciting, and more hands-on. And physics teachers all around the world are always eager to share new ideas for lab experiments and demonstrations. The fact that we have some experience building things out of everyday objects is a real plus for teachers in developing countries, where resources are extremely limited. Our usual teacher workshop – no matter what the title – is about how to build physics teaching equipment out of low-cost, locally available materials. Of course, the teachers that we visit have interesting ideas and techniques to share as well, and so our visits are true exchanges of ideas. As with all of our outreach work, we benefit as much as those we visit.

Support and Thanks: As we have developed, we have been fortunate to collaborate with and receive support from several key sources:

- Colorado State University
- CSMATE, CSU's Center for Science, Mathematics and Technology Education
- Hewlett Packard, Kodak, Agilent and others
- The APS and the AAPT (Bauder Fund)
- Schools and teachers around the region support us with donations, enthusiasm and ideas.

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five four-hour Saturday morning sessions to study acoustics concepts, perform related demonstration experiments, and collect equipment that the teacher would keep for use with his or her students. Workshop time was used to train the teachers in use of their new equipment. Inservice credit was available for interested teachers. One of the extended workshop activities was for me to present a physics demonstration program on sound at each participating teacher's school. The next year we obtained a similar Eisenhower grant to present workshops on light to another group of thirty middle school science teachers.

We used this experience to obtain a National Science Foundation grant for the period 1993 to 1995 to repeat our workshops on sound and on light, and to offer additional workshops on Newton's laws and electricity and magnetism (topics generally included in the middle school curriculum in this area). These workshops significantly expanded our number of road trips. Lamentably, the NSF apparently changed their philosophy about such teacher activities and we were unable to continue our workshops.

However, the more recent NSF policy is to support longer-term relationships with individual schools, and the UM Physics Department has become very active in such arrangements during the past several years. The Materials Research Science and Engineering Center (MRSEC) has administered a large number of outreach programs (<http://mrsec.umd.edu/Outreach.html>) in coordination with their NSF grants. Activities include presenting demonstration programs to students at their schools, teacher training workshops, sponsoring science fairs and providing judges, and bringing groups of students to the University for physics activities and the local Physics is Phun programs (<http://www.physics.umd.edu/PhysPhun>).

I have also presented demonstration programs regularly for middle schools in several southern Maryland counties in which the student population has been recognized by the state as being under-represented in college attendance. This is part of an ongoing contract coordinated by the University of Maryland Office of School/University Programs (<http://www.education.umd.edu/SUCP/>).

Most of our school visits originate from unsolicited requests for demonstration programs, generally by representatives of elementary or middle schools. Usually they want some sort of physics demonstration program that will inspire interest in physics (or perhaps science, or perhaps just school), or that can be used as an example of what students might experience later in their academic careers. In this situation I usually refer them to our traveling program web site (<http://www.physics.umd.edu/lecdem/outreach/phun.htm>) and suggest one of the standard programs: Sound and Light, Newton's Laws, or the Physics IQ Test. If the purpose of their program is to reinforce material in other topics, a special program is developed for that occasion.

Although I have set up a few "standard" demonstration programs that I suggest for most inquiries, the nature of our traveling programs over the past 30 years have been quite varied. Many teacher workshops have been given, ranging from one-hour presentations on specific topics to full eight-hour detailed discussions of demonstrations, how they are constructed and how we use them. These workshops have been presented to groups ranging from elementary through high school. Demonstration presentations have been made at professional meetings such as the American Association of Physics Teachers or its regional subsidiaries, and the National Association of Science Teachers or its state or local subsidiaries. These programs have been adapted for levels from pre-kindergarten classes through senior citizen groups. I have presented some set of demonstrations from The Physics IQ Test as the keynote program for science fair and science week events.

One important philosophical issue regarding the presentation of these programs regards use of hands-on activities as opposed to

more of a lecture type format. My personal bias has been in favor of the lecture format, leaving the more hands-on laboratory activities to the teachers. Although I do not usually work in the detailed hands-on mode, I try to include in my programs lots of opportunity where the students are guided in observing specific phenomena illustrated by the demonstrations, and ask them to respond to questions about their observations. As much as possible, I select students to help with the experiments, creating more interest in the demonstrations and their outcomes. I believe that demonstrations are inherently of very great interest to young students, and that as such demonstrations can be a very compelling centerpiece to virtually any program covering classical physics. Hands-on laboratory experiences form an integral part of scientific development for young students. However, I believe that my part in the educational process should be to inspire their interest, show them things that in my absence they would almost certainly not experience, and provide some information to them that is beyond what they might get in their standard classroom/laboratory experience. Even at the lowest level, I prefer to discuss the demonstrations performed in terms of the laws of physics illustrated rather than as a magic show or a show-and-tell experience. As it turns out, some of the content of these programs is not even familiar to the teachers!

Perhaps my favorite program is that on sound and light. The topics of sound and light provide material for discussion that is directly related to the most important human experiences in communication and observation. Examples of this might include demonstrations of curved mirrors. Almost all of the students are aware of the use of convex mirrors in stores, and many are aware of their use as the right-hand rear view mirror of cars. On the other hand, very few are specifically aware that the convex nature of the mirror is what creates this type of image. Almost none are aware of the compromises in the PHYSICS that lead to the specific shape of the rear view mirror, and the warning "OBJECTS IN THIS MIRROR ARE CLOSER THAN THEY APPEAR." Most students are not aware of the numerous uses of concave mirrors, such as reflecting telescopes, microwave dishes, and parabolic microphones for football game sound production. Although virtually all students (and teachers) have used vanity mirrors, most of them are unaware that the reason they create enlarged images is because they are concave and the object (your face) is close. Such examples as this can be included very efficiently in the lecture demonstration format, and "homework" assignments can even be made for them to look at images of near and far objects in their vanity mirrors. Their learning experience might even include how to describe the images produced by these two types of mirrors. Use of a SLINKY spring to illustrate transverse (light) and longitudinal (sound) waves can be accompanied by detailed observation of the differences between the two types of wave. We can do a polarization experiment using a rope and cookie cooler racks, then repeat the experiment using light and crossed Polaroid sheets. An appropriately selected oscillator and loudspeaker combination can be used to demonstrate the range of audible frequencies and introduce use of metric prefixes in words like "kilohertz." Infrasound and ultrasound can then easily be discussed, with numerous applications, such as the students' own sonograms. The idea of audible spectrum can then be extended to the correlation between frequency and color in the prism spectrum of white light, the same colors that occur in the rainbow or in refraction by diamonds. Infrared can be described as an example of heat radiation (one of the three forms of heat transfer that they have studied). Ultraviolet can be mentioned and the associated importance of the ozone layer in our atmosphere. For the more scientific audiences I like to discuss the history of the bell in vacuum experiment, for which the vacuum pump was invented!

My experience has been that demonstrations related to the students' experiences maintain the most interest by the students and

PEARLS: Physics Educational Assistance, Resources, and Learning Strategies

Julie Conlon

What is It?

Purdue University's Physics Educational Assistance, Resources, and Learning Strategies offer a wide menu of options to schools, including FunFest (on campus during SpringFest), Traveling FunFest Demonstrations (Physics on the Road), Focus on Science (week-long visits to schools so all science classes experience hands-on activities from all the sciences, not just physics), Traveling Science Exhibits, PowerPoint Presentations and tours describing Purdue Rare Isotope Measurement Lab, Individual Classroom Visits, Professional Development, Teacher Consultation, and Grant Writing Assistance. In addition, during December, 2002, we learned that our proposal to become a Quarknet Center was accepted. The first teacher-as-researcher training will occur during Summer, 2003.

Who is it For?

Purdue University's Physics Educational Assistance, Resources, and Learning Strategies offers science enrichment activities for school groups at all levels. We also work with any organization who might benefit from what we have to offer.

History of Physics Outreach at Purdue University

In 1987, three department professors, Van Neie, Ephraim Fischbach and Marty Becker, decided that the Purdue University Physics department should present the entertaining side of physics to the community.

The first Physics FunFest was planned for the fall semester of 1988. The first FunFest would be held in one of the department's 285-seat lecture rooms on a Saturday morning. One show was planned for the day and it would be a one-hour program. The list of demonstrations to be used would be off-the-shelf demonstrations that are traditionally entertaining. They included electrostatics, vacuum demos, liquid nitrogen, the bed-of-nails, and others. Advertising for the first show consisted of fliers which were distributed to local schools and posted at local department stores and grocery stores. There was also an announcement on two local radio stations.

In order to help with the smooth transition from demonstration to demonstration, the professors decided that it would be wise to include the lecture room manager, Roger Boyce. Roger was to also have an active roll as a presenter. The day of the first FunFest arrived—Saturday, November 12, 1988. The program was scheduled to start at 10:30 a.m. The four presenters arrived at 8:30 to start setting up demonstrations. People started arriving at 9:30 and by 10:00 every seat was occupied. People were standing in every available space at the back of the room. The hallway was full and people were even standing outside of the building. The presenters made a quick decision to do a second show and word was passed along to the people who were standing outside the lecture room. The sec-

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therefore provide the best opportunity for a positive learning experience, longer retention and the greatest likelihood of interesting these young students in science. As demonstration and laboratory experts with an enormous amount of interesting equipment readily available, we are uniquely positioned to take advantage of these opportunities.

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ond show would start at 11:45. However, that show was standing room only as well!

The FunFest was a huge success. A photographer from a local newspaper covered the event. The article and photographs that appeared in the paper were well done. The presenters held a meeting following the FunFest to discuss future FunFests. They had no doubt that they were onto something that could be really BIG. And, since the campus FunFest was so successful, a traveling FunFest should be equally successful. The idea of hiring a full-time outreach coordinator was born.

The second FunFest went into the planning stage the following August. This time it was *planned* for two shows. There was also a plan to distribute free tickets. Tickets were printed in two colors, each color designating which show would be attended. A movie was offered in the adjoining lecture room while the FunFest was going on. The Student Physics Society (SPS) participated with taking tickets and running the activity in the second lecture room. Calls were received from schools desirous of bringing a busload of kids to FunFest, and these schools were sent a quantity of tickets. Advertising was still done by fliers to local schools, posting at local businesses, and announcements on two radio stations. The problem of having more people show up than could be accommodated remained with the second show. The demonstrations consisted of more off-the-shelf apparatus. During the follow-up meeting, the presenters decided that they would eliminate issuing free tickets, as the tickets were somewhat effective, but other problems were created due to fairness of distribution, and the process was unnecessarily complicated. The third FunFest would be advertised and presented as three, first-come, first-served shows.

As the full-time outreach coordinator, Chris Roddy, from North Carolina State University, started to develop what would become Physics on the Road, the traveling physics FunFest. Chris began scheduling visits to schools. He acquired apparatus dedicated to outreach and he began looking for funding to purchase a dedicated van and equipment that would make the outreach project independent from lecture room demos. Chris was successful in obtaining a \$25,000 grant from the Alumni Foundation. This sum was enough to make the van purchase and to buy the dedicated equipment. In order to meet the expenses of Physics on the Road, schools were requested to make a \$200 donation for a visit. The annual FunFest continued until the year 2000. A decision was made for the FunFest to be held in a larger auditorium. The fourth FunFest was held in an 1100 seat auditorium. One show was given and was attended by over 800 people. This became the forum for the shows over the next several years, but the shortcoming was that the demonstrations had to be very large so they could be seen. To assist, cameras were also used, to project the demos onto a 12' x 12' screen.

Following the 1998 show, the decision was made to return the shows to the physics building and to use four large rooms which would allow the presentors to have several shows going simultaneously. Each room would be set up to run several demonstrations through three consecutive 20-minute shows. The audience would move from room to room during the ten minute intermission between shows. During the years, the demand for Physics on the Road grew to an annual attendance of over 20,000 people, comprised of over 70 visits and nearly 200 shows. The outreach van has traveled to many parts of the country as a vital part of Physics on the Road workshops conducted at AAPT meetings. In March, 2002 representatives from Columbia University traveled to Indiana to observe a school visit for the purpose of taking a science show to Africa. In August, representatives from three universities in South Korea traveled to Purdue University to take notes and to take pic-

There is a Flavor of Outreach for Everyone

Sam Sampere

I had my first taste of physics outreach more than 10 years ago while a MTS at Bellcore, the now defunct research arm of the telephone companies. Bellcore received NSF funding and the Bellcore Summer Teacher Institute was born. For a month in the summer, a select group of elementary school teachers came to Bellcore and were exposed to aspects of math, science, technology, and computers that they had never been exposed to before. I developed a day of physics experiments utilizing very inexpensive materials. I was truly captivated by the enthusiasm and eagerness to learn that these teachers exhibited. These experiences had me hooked – I was exposed to situations I had never been exposed to before. I was more than apprehensive when the school year started and a couple of those teachers asked me to come to their school to work with their students.

My naïve model long ago worked surprisingly well. I brought many small demonstrations to a classroom, asked kids lots of questions about the demo, and asked for predictions. Finally, I selected a student to do the demo. We would then discuss the differences between the outcome and their predictions. The students remained very interested and had a lot of fun. Through conversations with numerous colleagues, I believe that most physicists use this model when visiting their own kids' classrooms; I still sometimes do.

My ideas evolved when I came to Syracuse University. The university has much more equipment at my disposal, and the personnel and expertise to design and build new apparatus. Attending AAPT meetings and seeing what other programs were doing was also very educational. We are currently involved with three very different models of outreach: Demo shows with or without hands-on activities, hallway displays, and teacher workshops.

Several times each year, we do demonstration shows in our auditorium for various groups: Science Horizons, a select group of middle school students who are on campus for the summer, Cub Scouts, and various elementary school groups. These demonstration shows are very interactive, similar in model to those old Bellcore visits. The equipment is of course much better and larger. Most of the

demonstrations are eventually performed by a student from the group. The one demonstration that all students get to experience is our large Van de Graaff generator. The column is 5' tall, and a 1 m diameter dome sits on top. This apparatus generates loud and bright 4' sparks routinely and up to 5' sparks on a good day. Students are amazed when they stand a few feet away and 'feel' the electric field (the ground electrode is about 1' away). Students will usually call attention to some large piece of dust that is alternatively attracted to the dome and the grounded ceiling.

When the demo show is over, we move a large conference room where numerous smaller 'experiments' are displayed. The students are free to roam the room as they please, spending more time with the apparatus that interests them. This is our 'hands-on' portion. Beside each apparatus is sign that suggests something to try with the apparatus and what to watch for. A question or two about what they observe follows the description along with a brief explanation. The text must be kept to a bare minimum. We generally allocate 45 minutes for each portion of the program.

Time constraints are the major drawback to developing more outreach programs. Setting these two portions of a program up can be quite time consuming, especially when we do this many times a year. We have another way to reach out to students who may not otherwise take a physics course. We have a display case in the lobby of the Physics Building, currently with four apparatus exhibited^{1,2}. Thousands of students pass by the case each week, many of whom do not take science classes. This method of outreach has the advantage of reaching numerous students and allows you to develop explanations in greater detail. Students have numerous opportunities to interact with an exhibit that interests them, with the hope that each time, they learn something new.

Developing displays that are robust enough to withstand the onslaught of thousands of hands is time consuming. Once the display is debugged, the time needed for maintenance and upkeep is minimal. We can now reach students at their convenience with no time commitment from us. Unfortunately, the displays are bolted

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PEARLS continued

tures of the demonstrations for the purpose of starting an outreach program that would cover the entire country.

Mobile Physics Programming Today

Purdue University's Physics Outreach Program, Physics Educational Assistance, Resources, and Learning Strategies, has continued to grow and offers a wide menu of options to schools, including FunFest (on campus during the university's SpringFest), Traveling FunFest demonstrations (Physics on the Road), traveling science exhibits in conjunction and at the same time with Physics on the Road, whereby students explore hands-on displays much like in a children's museum. Focus on Science (week-long visits to schools so all elementary or middle school classes experience hands-on activities from all the sciences, not just physics, for a 45-60 minute period devoted to one topic, PowerPoint presentations and tours describing the Purdue Rare Isotope Measurement Lab (PRIME Lab), individual classroom visits, professional development, teacher consultation, grant writing assistance, and most recently, designation as a Quarknet Center to train teachers in the research process and to "allow classrooms to peek over the shoulder's of today's experimenters."

Outreach is the "Extension Office" of Education

When you hear the term Extension Office, you often equate this term with agriculture and 4-H. You also may think about the exten-

sion agent going out to the field with the farmer to solve a problem with, say, boll weevils in the peanut patch. The extension agent listens to the problem or needs of the farmer and brings workable solutions. It was the extension agent who made such a huge difference in agriculture during the first part of the century. So it is with outreach coordinators. One of our functions is to hear the needs of the teacher in the classroom and to bring ideas for possible solutions. This may be a teaching strategy, a way to acquire a piece of needed equipment, or to provide a demo, help to locate and/or to write a grant.

Summary

When Van Neie, Epharaim Fischbach, and Marty Becker decided to make physics come alive and to have fun, they wanted to share a goal of helping their own children appreciate what it is they loved. Their passion has evolved through the years to a growing and vital outreach program. Purdue University Department of Physics provides PEARLS of science wisdom to classrooms throughout Indiana.

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Idaho State University Demonstration Road Show and Teacher Workshops

Steve Shropshire

The Idaho State University Physics Road Show has provided Idaho schools with science demonstrations closely tied to national standards, state standards, and school curricula since 1994. Since 1998, each demonstration (demo) show has been preceded by a short workshop for teachers to decide on experiments for the demo show, and to discuss experiments and activities teachers can use in their classrooms linked to the topics of the show. The primary goal of the ISU Physics Road Show is to improve science literacy and interest in science in K-12 students and teachers.

ISU faculty and students have conducted 332 science demonstration shows for Idaho elementary, middle, junior high, and high schools with a total estimated attendance of over 70,000. The presentations are designed to spark enthusiasm in science, and to complement science curricula by providing flashy demonstrations on required topics in science for the grade levels served according to the Idaho State Board of Education Standards for Excellence and the National Science Education Standards. Prior to a presentation, teachers at the school are contacted to find out what science topics they are covering. This determines the theme for the presentation. An ISU faculty member meets with school faculty in a one to four hour workshop to discuss the presentation and to distribute descriptions of each demonstration. Information is provided on activities for each grade related to the presentation, and to related topics teachers are covering in their class that week. Several of these activities are demonstrated and materials needed for them are left with the teachers. Special care is taken to reference activities and demos to specific chapters and units in the science text used at each school visited. Teachers are also provided with information on teaching resources available in books, journals, and on the web. In elementary schools, attendance by at least one teacher from each grade level is considered mandatory. In junior high and high schools, attendance by science teachers is mandatory. The demo show is

postponed or canceled if too few teachers attend the workshop. This program appears to be popular since the program is currently booked through the spring of 2005 with an average of 32 visits to schools each year.

Organization is very important to outreach efforts. ISU faculty involved in the program have teaching and research obligations as well. Proper organization significantly reduces the preparation time required for each visitation. The vast majority of equipment used is sole-use, i.e. materials that are used only in demo road shows. There is standard set of demos for each show, and lists are maintained of equipment and supplies needed for each demo. As much of the equipment as possible is stored in large Rubbermaid "Action Packers" (sturdy plastic bins), with lists of contents fixed to the inside lid. Also listed are items to be added at the last minute, such as eggs, bananas, and equipment to be borrowed. Having everything you need for each demo in a specific bin saves a great deal of setup time. The bins are easy to transport, are only unloaded right before a show, and properly packed right after.

The demo shows each last between 50 and 90 minutes, selected from approximately 120 minutes of prepared material, with one or more presentations of the same show per school visit. The preferred audience size is 200 students or less. Four different shows have been prepared for presentation, titled "States of Matter", "Forces and Motion", "Electricity and Magnetism", and "Sound and Waves". Each show consists of a series of demonstrations of physical phenomena connected by a common theme and chosen for visual impact. Every presentation begins with a discussion of science and what scientists do, as well as the popping of helium and hydrogen filled balloons with a lighter. Although many of the demonstrations are at first impression destructive, extensive precautions are taken to assure audience safety, and to limit the amount of clean-up necessary after

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There is a Flavor of Outreach for Everyone continued

into the display case, so they only serve Syracuse University students and visitors. We hope to fabricate new displays and copies of our current displays for deployment to other venues such as the Museum of Science and Technology (MOST), the local science museum.

We can reach a limited number of select students each year with the programs detailed above. Our teacher workshops can impact orders of magnitude more students. We organize roughly eight teacher workshops during the academic year³, sending out mailings to roughly 150 high school physics teachers within a 2-hour drive from Syracuse. The workshops are held on a Saturday morning from 9:00 – 12:00. Our attendance averages 25 teachers, some making the 2-hour commute. Colleagues from Buffalo State have made the trek on several occasions. Our workshops give regional high school physics teachers opportunities to interact with their peers, most of whom are the sole physics teacher in their school. In addition to the social gathering, we organize a program of activities to help enhance their teaching skills. These activities are as simple as allowing a 'sharing' session, where teachers describe pedagogical methods that they have found particularly useful in their classrooms. We received Bauder Funds⁴ to develop and host a "Bring in and Fix Your Van de Graaff Generator" workshop. Twenty five broken Van de Graaff generators arrived that Saturday morning and were sparking 3 hours later. These teachers came because they did not know how to repair the equipment in their classroom, nor could they explain how these machines worked. The teachers left this workshop with new skills and knowledge.

We invite outside 'experts' to participate in our workshops. Last year, two high school teachers who attended a Modeling Work-

shop⁵ led a similar full day workshop. That workshop exposed teachers to new educational strategies. This year, an outreach group (PARTICLE)⁶ from the University of Rochester gave a presentation describing their program. Several teachers are applying for admission to the PARTICLE workshop this summer workshop. These teachers most likely would not have applied had they not been exposed to this program through our workshop.

I recently attended a physics outreach conference at Colorado State University. Doug Osheroff stated that we should all feel compelled to do outreach, recalling his memories of such childhood experiences. Perhaps you do not know where to start or what to do. My intention was to describe our various outreach programs here at Syracuse University with the intention that at least one may intrigue you enough, fit your interests and time schedule, to start your own program.

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(Endnotes)

¹ Sampere, S.M., *The Neon Sign*, Phys. Teach. 37, 140 (1999).

² See also <http://www.physics.syr.edu/courses/demos/displayweb.html>

³ See <http://www.physics.syr.edu/courses/K-12/K-12page.htm>

⁴ See <http://www.aapt.org/Grants/bauderfund.cfm>

⁵ See <http://modeling.la.asu.edu/modeling-HS.html>

⁶ See <http://www.pas.rochester.edu/~pavone/particle-www/>

Science Theater at Michigan State University

Dan Stump

Science Theater is a student organization at Michigan State University that provides science outreach activities for schools and community groups in the state of Michigan. The organization is sponsored by the Department of Physics and Astronomy at MSU. The history, goals, activities and organization of Science Theater will be described in this article.

History. Science Theater was started in 1991 by a group of graduate students in the Department of Physics and Astronomy. Their

interest was to present public shows made up of physics demonstrations. In one of their first shows, 20 students participated at Science Day at the Meridian Mall, an event at which science teachers from area high schools and colleges showed science activities at a local shopping mall to raise the level of interest in science. The shows by Science Theater attracted approximately one thousand people at that event. This and later similar presentations introduced Science Theater to the community, which led in turn to many invitations to

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Idaho State University Demonstration Road Show and Teacher Workshops continued

each presentation. All demonstrations are chosen and explained at a level appropriate to the particular audience.

The States of Matter show contains demonstrations on the nature of solids, liquids and gasses. These include a balloon balance, a candle ladder with a CO₂ "wave", floating and sinking things in a fish tank, a vacuum chamber, Madelung hemispheres, and several experiments involving liquid nitrogen. Phase changes are demonstrated with the collapsing of a 50-gallon steel drum. How airplanes fly, how curve balls curve and how houses explode with the passage of a tornado is illustrated with the use of leaf-blowers, a shop-vac, toilet paper, a few spinning styrofoam balls, and a giant vortex generator.

In the accompanying teacher workshop, teachers are shown how to illustrate pressure with several experiments using plastic pop bottles, balloons, and water. They are shown how to use a 60 cc syringe to make a miniature vacuum chamber. Experiments on density and buoyancy, temperature and heat, and the differences between the states of matter are discussed. Recipes for glue and borax "goop" are distributed, and several Bernoulli experiments are performed with hair dryers, straws, and Styrofoam cups.

The Forces and Motion show involves a bit more audience participation and focuses on demonstrations of kinematics. Demos include a toilet paper tug, weights with breakable strings, the old tablecloth trick, a resolution of forces tug-of-war, an egg toss into a sheet, action and reaction with skateboards, a water rocket, and a Culligan water jug rocket. A rotating stool, bike wheel, and a rolling chain are often shown as well. The bed of nails serves as a finale.

In the Forces and Motion teacher workshop, teachers are given several cheap energy toys, a water rocket and launcher, and a stomp rocket launcher made from a pop bottle and PVC pipe. Toys are used to discuss Newton's Laws and energy. As with all teacher workshops, teachers are encouraged to involve students in inquiry-based interactive activities and experiments. When time allows, teachers are guided through examples of activities using these techniques.

The Electricity and Magnetism show covers electrostatics, electricity, magnetism, and their interrelations. The concept of charge is introduced with balloons, fur, plastic pipe, silk, glass, ping pong balls, soap bubbles, and ISU students running around with styrofoam balls. Several experiments are also done with a Van de Graff generator. Magnetism and its relation to moving charges is demonstrated with electromagnets, electron beams, and simple motors and generators. Several smaller experiments are projected onto a large screen with a video camera and projector. To caution the audience on the dangers of electricity a pickle is electrocuted. The show is topped off with exhibitions of an 8' Jacob's ladder, a rail gun, and a Tesla coil.

For the Electricity and Magnetism workshop, teachers build electroscopes and use them in electrostatics experiments. The connection between electricity and magnetism is shown with a battery, wire, and a compass. Teachers are also shown how to build electromagnets, simple motors, and how to connect a cheap dc motor to a

headphone jack of a radio to make a speaker.

Sound and Waves presentations are the most difficult to set up and present. It begins with a laser light and sound show that serves to introduce sound as a vibration. Other demos include waves on springs, a 20' torsion wave machine, singing rods, Chladni plates, hoot tubes, resonance boxes, and a wine glass tune. Short lengths of PVC are handed out to students, who "pop" them on their hands to perform a simple tune. A wine glass illuminated with a strobe light is shattered with sound. A laptop computer with Fourier synthesis software is used to demonstrate the recipe of sounds. As in the Electricity and Magnetism show, several of these are projected onto a large screen. An 8' flame tube is used as a finale.

In the Sound and Waves workshop, teachers are given slinkys, a set of the pvc "poppers", a set of golf-tube "boom whackers", and a coffee can drum and mirror they can use for their own laser light and sound show. They are guided through an experiment with yarn to illustrate the effects of tension, length, and mass on the speed of waves and the pitch of the sound carried by the waves. Also demonstrated are cup and string phones, film can crumhorns, soda straw reed pipes, and soda straw torsional wave machines. As in all of the teacher workshops, teachers construct these themselves if there is time. Otherwise, samples are distributed, demonstrated, and discussed.

Demonstration shows are difficult without external funding. For the first four years of the program, schools were requested to provide funds to cover expendable materials and supplies, and to deposit into an account for equipment repair and. The total requested was usually around \$85. The PTA for the school usually covered this cost. Since 1998 the program has been entirely supported by grants and funds provided by the ISU College of Arts and Sciences. The publicity and popularity of the road show is responsible for the administration's decision to designate ISU funds to support the program, and purchase of an ISU cargo van for physics outreach. Grants have been awarded by the Idaho Community Foundation, the Albertson's Foundation, and the NASA Idaho Space Grant Consortium. The annual budget for the road show has been approximately \$8,500 for the last four years. Most of this is used to pay students to assist in the presentations and to construct and repair equipment.

To increase public awareness of this program and to provide public education, the ISU Society of Physics Students have organized a demonstration show on campus once or twice a year since the fall of 1993. The total estimated attendance for the campus shows is estimated to be over 3,500. A series of web pages linked to the Department of Physics home page providing complete descriptions and schedules of outreach and educational programs, information on demos and activities teachers can do in their classroom, and a forum for questions, feedback, and reservation requests are available at:

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Science Theater at Michigan State University continued

appear in school assemblies, classrooms, and community events. To manage the activities, a formal organization was established, with by-laws and election of officers.

Two important tasks in the early years of Science Theater were to build or acquire equipment for physics demonstrations, and to develop scripts for shows on various physics topics. This work was funded by a grant from the National Science Foundation. Also, a booklet entitled *Recipes for Science* was written, describing the demonstrations that are available in the Science Theater shows, for documentation and for reference for teachers who wish to schedule Science Theater presentations in their schools.

As the demand for Science Theater increased, undergraduate students joined the organization. Activities in sciences other than physics were also developed. Today Science Theater includes student volunteers from many branches of science and engineering. Within the organization are separate department groups for Biology, Chemistry, Computer Science, Engineering, and Physics & Astronomy.

Goals. The general goals of Science Theater are focused on the issue of science literacy. The purpose is to create in the audience an enthusiasm and appreciation for science. Two types of events are pursued today—school visits and community visits. The Science Theater web page lists the specific goals for each case. The goals for school visits are:

1. to act as a resource for teachers;
2. to interact with students;
3. to show the relevance of science in everyday life;
4. to provide positive role models in science for students;
5. to support and encourage teachers in science.

The Science Theater presenters do not replace the classroom teacher in science, but provide resources that would not be available in a typical school.

The goals of community visits are:

1. to be an interface between the general public and the scientific community;
2. to demystify science;
3. to discourage stereotypes of science and scientists;
4. to provide accurate information about the role of science in everyday life.

Activities. Science Theater presentations take two forms—stage shows and “hands-on” activities. In both cases the tone of the presentation is informal, and interaction between participants and presenters is encouraged. In hands-on experiments the participants perform science demonstrations themselves, guided by the Science Theater presenter. The stage shows run from 30 to 60 minutes and are presented to larger groups in an auditorium setting. Even in a stage show, audience members should be actively engaged, rather than passive spectators.

For school shows, a group of science demos are combined to form a unifying theme. Many different stage shows are available for schools, some of which are listed below; the descriptions are taken from the Science Theater brochure:

- Pressure (physics): Balloons, marshmallows, paper cups, and a bed of 1000 nails, are used to dispel some common misconceptions about force and pressure (grades 2-12).
- Temperature (physics): Begins with the three states of matter and how heat can change matter from solid to liquid to gas. Students then observe the changes that occur to various objects when exposed to extreme temperatures via liquid nitrogen (grades 2-12).
- Electricity (physics): Begins with electrostatics and then

moves on to show how flowing electricity works. Includes a Van de Graaff generator, current, voltage, a simple circuit, and some fascinating electromagnetism demonstrations (grades 4-12).

- Aerospace (engineering): Explores Bernoulli’s Principle and how it relates to flight. It starts off with the simple concept of pressure and flies into discussions of Newton’s laws and rockets (grades 7-12).
- What is an Experiment? (chemistry): This chemistry-oriented show, designed for younger folks, introduces the audience to the concept of developing a theory, then testing it through the use of an experiment (grades K-8).
- Microworld (biology): Using the video microscope, students are exposed to the tiny world of protozoa and bacteria. The concept of symbiosis is demonstrated using termites and their microbes.

The majority of Science Theater activities occur in elementary, middle and high schools. In recent years the greatest demand has come from elementary schools. Other common venues are at science fairs (such as the state finals of the Science Olympics competition), scouting events, and the Impression 5 Science Museum.

Organization. Science Theater is a student organization. The steering committee and presenters are undergraduate and graduate student volunteers. The positions and duties on the steering committee are listed below:

- Director – Oversees all activities; funding and grant writing
- Assistant Director – Assists the director; daily operations
- Social Director – Coordinates social events and recruiting members
- Biology Director – Schedules biology-related events; develops biology demos
- Chemistry Director, Computer Science/Engineering Director, Physics and Electricity Director – same as Biology Director for these fields
- Office Manager – Communications and financial tasks

Student volunteers are recruited as members of Science Theater at the MSU Student Organization Recruitment Fair at the beginning of each academic year. During the 2002/03-year, approximately 30 students were active presenters (working at least 8 hours on Science Theater activities).

When a student first joins Science Theater, he or she must go through a training regimen covering the presentations and safety issues. For each scheduled show, one presenter is designated as the coordinator for that site. The coordinator must be an experienced member of the group, who has previously presented at other sites the demonstrations that will be used in the show. The coordinator is responsible for rounding up a sufficient number of trained volunteers for the cast. The training can be obtained at large all-organization training sessions, or in one-to-one meetings with an experienced group member. Safety is always a concern with the science demos, and all training sessions pay special regard to the safety issues of each demo. After a student has participated in a show, he or she becomes eligible to act as coordinator for the same show at later sites. These training procedures illustrate how the student organization can function over an extended period of years although any one student participant would be involved for at most a few years while a student at MSU: the experienced juniors and seniors pass their knowledge on to the first and second year students.

Connection to the Department of Physics and Astronomy. The Department is the official sponsor of the Science Theater organization, although the group is essentially self-governing. There is a

Exploring Physics – an Extracurricular Program

Meera Chandrasekhar

For Middle Level Students

Exploring Physics is an extracurricular program targeted to female students in grades 5-7. The program focuses on hands-on activities that are concept oriented, with several activities structured to develop a given concept. The program runs for eight 90-minute sessions in the students' schools. While many outreach programs take a "smorgasbord" approach, we chose to develop a program that explores a few concepts in depth via sequenced activities. Students explore the concepts over a four-week period, at the end of which they have done several activities and constructed a few toys or gizmos. Science teachers, who receive content training at Summer Teacher Institutes, conduct the programs. Kits of equipment and materials are stocked and organized by staff in the University of Missouri Physics Department, and teachers check them out for the four-week period. The program is currently available at several Missouri schools. Enrollment is limited to 20-30 students per four-week program. About 300 students participate in the Exploring Physics annually.

Program philosophy

Development of Exploring Physics units began in 1992, funded by grants from the National Science Foundation's program for Women and Girls. We developed each content area over the period of a year and now have units on Optics, Electricity and Magnetism, Mechanics, and Sound. The initial development and formative evaluation of each content area was done in collaboration with two middle-level science teachers, a physics undergraduate or graduate student, the science coordinator of the school district, and the authors. Each area (e.g., Optics) is organized in several modules (Optics has four modules: Reflection, Refraction, Color, and Polarization). Each module has six to ten hands-on activities, developed using the following philosophy based on the 5E learning cycle¹:

- Students begin a module with an exploratory game or activity. These games will serve to internalize the concept, rather than learn it in a formal sense.
- Students use the internalized concepts to build a gadget, art project, game or toy, thereby developing their building and mechanical skills.
- Experiments that use both commonly available materials and

simple scientific equipment, for example, digital voltmeters or ray boxes are used to develop and expand the concept. Students see that science is manifest in everyday life, and simultaneously gain familiarity with laboratory equipment.

- Students use common shop tools under supervision of the teacher. Many female students express awe at having used an electric drill in the program.
- For students in the higher grades, quantitative analysis is introduced.
- The last session of each program is a family night, when students get to explain their activities and creations to parents, and also view a few "gee-whiz" type exhibits. These exhibits are handled with interactive explanations so that they are not regarded as "magic". Family night helps publicize the program and excite the interest of parents in the "dreaded" area of physics.

Unit content

Exploring Physics is organized into seven separate units, each of which has about twenty to thirty activities and takes eight sessions to complete. Level I units are used for 5-6 grade, while level II units are used for 6-8 grade (grade groupings vary by school). The content modules in each of these units is listed in Table I below:

Table I: Units and modules in Exploring Physics

Matter and Mechanics I: Air and Stability	Matter and Mechanics II: Water, Density and Simple Machines.
Optics I: Reflection and Color	Optics II: Refraction and Polarization
Electricity I: Static Electricity, Batteries, Bulbs and Switches, and Circuits	Electricity and Magnetism-II: Magnets, Solenoids, Resistors, and Capacitors.
Sound I: How sound travels, Vibrations, Pitch, Volume and Resonance	

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Science Theater at Michigan State University continued

historical connection in that the founders of Science Theater were graduate students in physics and astronomy. Today the department provides space for Science Theater in the Abrams Planetarium Building, which is used for storage, meetings, and project development work. Also, the physics department provides the use of a van for travel to shows. Any student who may be a van driver must be included on the insurance policy. The department also assists with fund raising and various kinds of advice. In return, Science Theater can be called on to perform at outreach activities involving the physics department.

Science Theater has been an important component of science outreach for the College of Natural Science at MSU for the past twelve years. The Department of Physics and Astronomy and the National Superconducting Cyclotron Laboratory (at MSU) are engaged in numerous other outreach programs, e.g., for high-school teachers and students or the general public. Most of the departmental activities are conducted during the summer, and on campus. Science Theater is complementary to these other programs because

it is available throughout the academic year and at sites such as schools in other cities and towns. The demand for Science Theater programs in schools continues to be high and the shows are generally well received by teachers and their students.

Science Theater is also a valuable experience for the MSU student volunteers. Giving presentations provides experience in appearing before an audience, and explaining science. Developing new demos, or equipment, is an opportunity for members of the group to think about science and be creative. A group spirit exists among the organization members, produced by working together on science topics in which all are interested. Finally, the student presenters come away from a successful show with a sense of accomplishment from raising the interest in science in the audience.

Further information and contacts for Science Theater can be obtained from the group's web site at www.sciencetheater.org.

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Evaluation

The primary goal of the Exploring Physics programs was to increase female students' interest and confidence in the physical sciences. While it was amply evident from talking to the students and their parents that they had enjoyed the programs and learned from them, measuring changes in attitude turned out to be a challenge. After several iterations, we developed an instrument that proved to be reliable. This six-item instrument was given before and after the program (same instrument pre- and post). Fig 2 shows a graph of the confidence of female 5th grade students before and after they participated in an Exploring Physics program, compared with a peer group of females and males. Before the program, both groups of females showed confidence levels on all six items that were lower than that of the male students. After the program, the female students who participated in Exploring Physics registered a confidence level higher than that of the male students. Similar results were observed for the Electricity unit.

Applications, Expansion and Future Plans

While the Exploring Physics program was designed as an after-school program for female students, we have found that the materials have multiple uses. With the addition of quantitative applications, we have developed a summer professional development program for inservice teachers, which have the dual benefit of training teachers to teach the extra-curricular program as well as to introduce the concepts and materials into middle level classrooms.

The Electricity and Magnetism unit has been expanded and published as a CD *Exploring Physics, Electricity and Magnetism*, with an extensive collection of background links, animations, lists of materials and sources, challenge activities, and quantitative problems (sample version at www.exploringphysics.com).

Table II below summarized the activities and concepts explored in Reflection module:

Reflection Maze (game)	Internalization of the law of reflection: a maze is built with wall blocks. Mirrors are placed to reflect a laser beam on to the target.
Multiple Reflections	Discovery of the number of images one sees with two mirrors.
Corner Cube reflector (project)	Application: build a 4" a corner cube reflector similar to the one the Apollo astronauts left on the moon. Examine the corner cubes used in bike reflectors.
Kaleidoscope	Build a kaleidoscope with mailing tubes and mirrors
Reflection—Quantitative	Discovery of the law of reflection.
How does a periscope work?	Discovery of how mirrors need to be placed in a periscope.
Making a periscope (project)	Build a periscope.
Curved Mirrors: sort and order	Discovery of the criteria to sort and order concave and convex mirrors of several different focal lengths.
Reflection from curved surfaces	Discover more about curved mirrors: how it relates to the law of reflection, and where the focal points are.
Focal lengths of mirrors	Measure the focal lengths of the sorted mirrors.

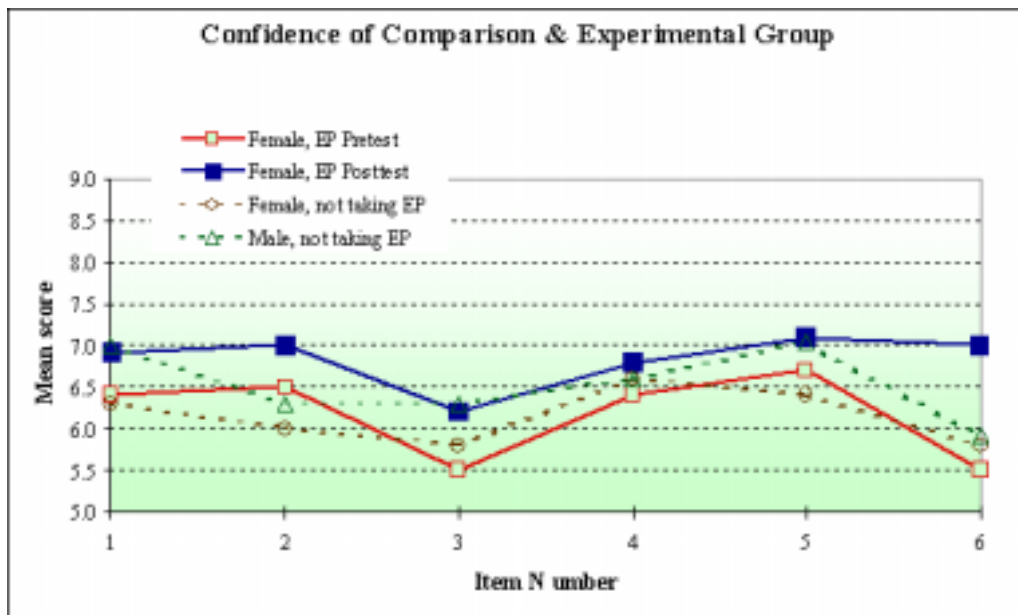
Program support:

This program was supported by the National Science Foundation, through grants NSF HRD 96-19140 "Promoting Young Women in the Physical Sciences," and NSF HRD 99-08509, 1999 Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring. The first grant has also supported the development of three other extra-curricular programs, Families Exploring Science and Technology (FEST), Saturday Scientist, and the Newton Summer Academy all of which are described on our websites listed below.

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(Footnotes)

¹ National Academy of Sciences (1998). Teaching about evolution and the nature of science. Washington, DC: National Academy Press.



Confidence survey that deals with (1) balancing a tower (2) simple circuits (3) magnets (4) color addition (5) flashlight circuit (6) curved mirrors. Answers are graded on a Likert scale from 1 – 9 (9 = greatest confidence).

Road Show Demonstrations for a Research Laboratory

Stanley Micklavzina

Motivation for the project¹

MAX-lab² is a synchrotron facility located at Lund University, Lund Sweden. The community of scientists using the laboratory comes from around the world, representing chemistry, physics, life sciences and several fields of engineering. The laboratory provides beam lines designed for focusing infrared to X-Ray light that is produced by relativistic electrons moving in three different rings. Experimental stations include an ultraviolet light for photoemission measurements of new types of semiconductors, a beam line for x-ray crystallography heavily subscribed by pharmaceutical and life sciences, an x-ray lithography and micromachining area, and there is also a soft x-ray photoelectron microscope including several instruments for soft x-ray spectroscopy of surfaces, to name a few.

The average visitor to the synchrotron sees an accelerator hidden behind a shielding wall with an enormous number of pipes and cables fed into it. The experiments all look the same, and the high-tech x-ray optics are sealed inside stainless steel vacuum chambers pumped by noisy vacuum pumps. The laboratory itself is not a particularly inspiring environment for anybody except perhaps the involved researchers.

The goal of this project is to give the outside visitor a better picture of the science at the synchrotron radiation source and to emphasize the enormous number of different research projects at the lab. The visitors we are targeting include high-school students, undergraduate physics students, graduate students from many disciplines, funding agencies, politicians, and physics teachers. We also hope to pique the interest of students and teachers to recruit scientists for the future. The result is an interactive science area focusing on the fundamental properties of different wavelengths of light and their interaction with matter. The developed demonstrations show the fundamental physical phenomena that are the basis for both the electron-beam technology and also the research performed at the lab.

Development of the Demonstrations for MAX-Lab

We didn't want the demonstrations to become a bunch of technology with a plethora of connections that overwhelm the visitor with little impact on their impression of the synchrotron light facilities. The displays are made up of more common materials to create an uncomplicated way to observe the physics utilizing more recognizable apparatus. The demonstrations are listed below:

- Electromagnetic Radiation from Accelerating Charges
- Detectors (CCD Camera & IR)
- E&M Absorption & Transmission
- Lithography using Absorption of UV Radiation
- Electron Beam Deflection
- Magnetic Fields: Ferrofluid
- Vacuum Systems
- Principles of X-Ray Crystallography using a Laser and Special Slides (Under Development) radiation from accelerating charges
- Interaction of light with matter: Detectors
- Interaction of light with matter: Absorption & transmission
- Lithography using absorption of UV radiation
- Electron beam deflection
- Magnetic fields and properties: Ferrofluid
- Vacuum systems using a Hittorf Tube

- Principles of X-Ray crystallography using a HeNe laser and special slides (under development)

The interactive science area is set-up in the library at the laboratory. Each set-up has a short description of the science displayed by the demonstration. There is also a set of instructions on how to perform the demonstration and suggestions on what to observe. The demonstrations are flexible and can be used to illustrate both the principle of the laboratory research project and a basic physical phenomenon. Staff and researchers also find a new way to look at concepts through the demonstrations.

Below are short descriptions of some of the experiments to show the principle idea behind the display I designed and put together during a sabbatical leave from The University of Oregon.

Electromagnetic Radiation and Accelerating Charges

The connection between accelerating charges and electromagnetic (EM) radiation is displayed by using a visual source of electrical charges, a plasma tube. Plasma tubes have become popular and are commonly seen in movies, science museum stores and novelty shops. They come in various shapes and forms and have become relatively inexpensive. The colorful bottled lightning easily attracts attention and can be used for a number of physics demonstrations. Here, the accelerated charges produce electromagnetic radiation in the radio frequency range and the radiation noise produced can be picked up by an AM radio placed a few meters from the tube. One can make a visible connection that the accelerating charges actually produce EM picked up by our detector, the AM radio. We also have available items so observers can explore shielding and properties of matter using this display.

Interaction of light with matter: Detectors

Most of the EM radiation produced at MAX-Lab is outside of the visible part of the EM spectrum so detectors are needed to monitor radiation that the senses cannot perceive. The set-up has two examples of detectors that are sensitive to radiation wavelengths that we cannot see but safe enough for demonstration use. The first is a set of beads³ that change color while exposed to ultraviolet radiation (UV). The nice thing about these beads is that they change back to white after a short period of time once the UV source is removed. They can be used repeatedly to detect UV radiation. The UV source we used is a "Black Light", a source of safe low energy UV radiation great for demonstration purposes.

The second detector is a charge-coupled device (CCD) video camera. A standard CCD camera responds well to infrared radiation (IR) as well as to the visible light that we see. We employ TV and VCR IR remote controls as a source of safe IR to illustrate how the CCD detector can 'see' what our eyes cannot. The CCD camera is especially illustrative since it can be shown in real time on a television monitor. We instruct the observers to point the IR remote control at the camera where they are able to clearly see pulses of IR light coming from the IR diode on the remote control unit.

We also use these safe light sources and detectors to observe the characteristic absorption and transmission properties of different materials, the interaction of light and matter. These are examples of using common materials to display the physics behind the technology and research performed in the research laboratory. Under development is an apparatus to show the principles of X-Ray crystallography utilizing a laser as the source of light and a microscope objective lens as the Fourier analyzer.

The Wonders of Physics at the University of Wisconsin

Jim Reardon

The halls of the Physics Department at the University of Wisconsin—Madison were never intended to seem attractive to the American public. Equipment in “storage” and cabinets full of supplies take up all available space between offices and labs where professors, students, and academic staff work (often late into the night and on weekends) to carry out the research detailed in the most recent grant proposal. Almost everything, it seems, is sacrificed to utility.

I remember that once a year this academic privacy would be breached. Every February, Prof. Clint Sprott would don a tuxedo and top hat and invite the public into our largest lecture hall for an hour to hear about “The Wonders of Physics”. And the public would come. The chattering, rambunctious crowd would fill the lecture hall to overflowing, and then invade the laboratories, demanding answers from reclusive students and retiring post-docs to satisfy its thirst for knowledge.

I learned then that a lot of people are fascinated by physics, and really want to understand what physicists do, and why. My own background is in magnetically-confined plasmas pertinent to nuclear fusion research, and I knew from sad experience that I could kill a party in five minutes by starting to talk about “donut-shaped energy fields” and the like. How was Prof. Sprott getting people so whipped up about physics?

Prof. Sprott has written that his inspiration was a Christmas 1983 lecture by UW Chemistry professor Bassam Shakhshiri entitled “Chemistry Can be Fun”, which itself was modeled after the tradition of Christmas lectures for children begun by Michael Faraday at the Royal Institution in London in 1825. Faraday’s lectures played a large role in making science socially respectable in Victorian England. Prof. Shakhshiri says “Science needs its fans like a football team needs its fans”, which translates the search for social respectability into terms relevant to modern America, and since 1970 has been sincerely engaged in winning those fans for chemistry. Prof. Sprott was ready with his own physics-oriented lectures by 1984, and since then has given Wonders shows on campus every year, attracting a cumulative total audience of over 50,000 people.

Around 1991, two enterprising plasma physics graduate students—David Newman, currently at the University of Alaska, Fairbanks, and Christopher Watts, now at New Mexico Tech.—derived from the on-campus Wonders shows a traveling version, which it has been my good fortune to inherit. The Wonders of Physics traveling show consists of many of the same demonstrations used in undergraduate physics courses at UW. These demonstration are loaded into a van and driven around the State, for use in hour-long shows in front of almost every imaginable assembly: kindergartners in gymnasium, middle school science nights, high school pep rallies, scouting awards banquets, local Boys and Girls clubs’ health fairs, retirement community dinners, and church groups. Almost all of these groups very much want to enjoy the presentation, and greet the presenter with an order of magnitude more enthusiasm than students in the typical university introductory physics course.

The traveling show has been seen by as many as 15,000 people a year (during the 12 months between June 2000 to May 2001, 150 shows with an average attendance of 100 per show). While the on-campus Wonders shows are free to all, the traveling show comes for a requested donation of \$100 to \$500. Other Wonders educational materials are available. Videotapes of the on-campus shows are sold for \$25. A lecture kit developed with help from the NSF, containing descriptions of the demonstrations, written handouts to give to students, software, a videotape, and sample publicity materials, is sold for \$90. The lecture kit is intended to contain enough information to allow a high school physics teacher or a scientist to start a program similar to The Wonders of Physics.

My predecessor, Roger Feeley (recently returned to the University of Maine), who built up a huge reservoir of good will across the State towards The Wonders of Physics, taught me several secrets. One is that the same demonstrations can be used for any audience, merely by changing the wording a little. Little children, for example, love to touch a common “plasma sphere” and watch how

continued on page 15

Road Show Demonstrations for a Research Laboratory continued

Controlling the Electron Beam

The electrons travel in an evacuated environment and are controlled with magnetic fields. The beam radiation is also enhanced with oscillating magnetic fields interacting with the electrons as they travel. To give some basics demonstrations of how the laboratory machine works we used commercial apparatus; an electron beam apparatus to show the steering of an electron beam, a Ferrofluid cell⁴, which contains a stable colloidal suspension of nano sized (10^{-8} m) magnetic particles in a liquid carrier, to show matter interacting with a magnetic field, and a Hittorf Tube⁵ to demonstrate some phenomena regarding vacuum systems.

Summary

We have developed hands-on demonstrations where the principles of light interacting with matter are described in several different ways for different wavelengths of light. Infra red light is detected using a CCD camera and several different cases are used to show how this light interacts with plastics and dyes. The fact that all light is created by accelerated electrons is exemplified in the plasma sculpture; and also by the RF noise picked up on an AM radio. We have demonstrated the principle of lithography using an array of UV-sensitive beads and a poly carbonite mask, and in the future, a visual demonstration of x-ray crystallography using visible laser light.

Acknowledgments

I am grateful to my host Stacey Sorensen who envisioned and coordinated the project and machinist Gustav Ekberg, who built the supports for many of the demonstrations. We are also thankful for suggestions and ideas from the MAX-Lab staff. Support from MAX-Lab, the Foundation for Strategic Research (SSF) and the Swedish Research Council (VR) is also acknowledged. Pasco Scientific, Kebo Scientific, Per-Olaf Zetterberg and Vernier Software for loaning of equipment during the development of the project, along with Brian Jones at Colorado State University for his inspiration along with the members of PIRA, Physics Instructional Resource Association, for the constant dialog and exchanging of ideas are also greatly appreciated.

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(Footnotes)

¹ Opening Description co-written with Stacey L. Sorensen, University of Lund, Lund Sweden

² See <http://www.maxlab.lu.se>

³ Education Innovations: <http://www.teachersource.com/>

⁴ Education Innovations: <http://www.teachersource.com/>

⁵ Leybold: <http://www.leybold-didactic.de/>

Alabama Science In Motion

Dan O'Halloran

The Alabama Science in Motion (ASIM) program is a visionary educational project established in 1994 by the Alabama State Legislature. The program continues to receive 2.5 million dollars annually as a line item within the budget of the State Department of Education. The goals of Science in Motion are to increase student interest in science through high tech laboratory experiences; provide equitable resources to all public school systems across the state; and to enhance teaching through effective professional development. ASIM is a network of resources designed to provide the equipment, discipline training, and preparation support needed to run an effective secondary science laboratory program. In many instances the cost of the equipment involved would be prohibitive for individual schools or even systems. Sharing this equipment through Science in Motion offers these opportunities to students and teachers from all backgrounds with no cost to either the teachers or the schools. In addition, free professional development workshops improve teacher mastery of subject matter and equipment use. Through these workshops teachers from different school systems gain the opportunity to network with peers, sharing both content knowledge and teaching techniques.

Eleven Science in Motion sites are based at state universities that are Regional In-service Centers. Each site supports two of the three major high school science disciplines: biology, chemistry, and physics. Certified secondary science instructors from each discipline conduct training and development sessions for participating teachers at the host university. These master teachers also provide on site support ranging from equipment drop-offs to

team-teaching in the high school laboratory.

In order to participate in ASIM, teachers must attend training sessions at their host university. As compensation, teachers are paid travel expenses and a modest stipend according to state guidelines. Each host site provides 15 days of teacher in-service per discipline. The majority of this training occurs during the 10 days of summer training. The summer sessions are designed to update and strengthen content knowledge, familiarize the teachers with the use and operation of ASIM equipment, and to model teaching strategies that are successful with a broad range of students. Follow-up workshops during the school year allow teachers to "fine tune" their knowledge and to share suggestions and experiences from their classroom with other teachers of the same discipline.

As a sample of the impact ASIM has had on Physics instruction across the state, please consider the following data from the 2000/2001 academic year. Five of the eleven sites support a physics program. Combined, these sites impacted 1332 physics sessions across 49 school systems, 95 schools, 112 teachers, and 6080 students at a statewide cost per student of just \$46.26. In addition, on average, 16 days of in-service training were provided by each of the 5 physics sites.

For further information and a complete listing of experiments available at Auburn University contact Dan O'Halloran, Physics Specialist, Science in Motion, 206 Allison Lab, Auburn University, AL 36830; Phone:(334) 844-6950; Email: ohalda@physics.auburn.edu; <http://www.auburn.edu/ausim/ausim2000/>

The Wonders of Physics at the University of Wisconsin continued

the plasma arcs move around their fingers; while PhD. physicists are bemused to learn that no description of the magnetohydrodynamics of those arcs has appeared in the literature. Another secret is that the good will towards The Wonders of Physics is a manifestation of public enthusiasm for general science. How a widespread public enthusiasm for science can persist when study after study shows a widespread lack of interest in science and a widespread decline in science literacy, I do not know. But it exists in Wisconsin, and shows no sign of diminishing. The only way we at Wonders have found to destroy it is to intrude too boldly our own research interests into the shows. On the other hand, I have found that after an hour of laser beams and Tesla coils, people can't hear enough about "donut-shaped energy fields".

Recently I attended the APS "Physics on the Road" conference, and met with about 50 others involved in mobile physics outreach. There were people who train physics teachers via teacher workshops, and others who bring whole experiments to schools for the students to use, as well as those of us who drive physics vans. This amounted to a horizontal cross-section of physics outreach. We were astounded by the vitality of the "Little Shop of Physics" outreach program which conference host Brian Jones has built up at Colorado State. That Saturday afternoon, the Little Shop of Physics Open House dominated the CSU campus the way Badgers football dominates the UW campus on Saturdays in the fall (I exaggerate only slightly). I learned from this conference that most university physics outreach programs rely heavily on undergraduates, and a well-run physics outreach program attracts undergraduates to major in physics. If more than 50 enthusiastic, tie-dye-clad volunteers were available to show several ballrooms' worth of physics demonstrations to the public on a cold weekend afternoon, surely the CSU physics department does not need to worry about declining enrollment.

For several years, Wonders had been a member of the plasma

physics outreach community. The Wonders of Physics traveling show has been partially funded since 1999 by the Department of Energy, specifically the Office of Fusion Energy Sciences (<http://www.ofes.science.doe.gov>). The Fusion Energy education program at General Atomics (<http://fusioned.gat.com>) has been very generous in providing Wonders with the resources it has developed for classroom use, which we distribute as we travel across the State. We also make use of the wonderful fusion poster made by the Contemporary Physics Education Project (<http://fusedweb.pppl.gov/CPEP/chart.html>), and maintain contact with the Coalition for Plasma Science (<http://www.plasmacoalition.org>). The presentation of plasmas in the traveling show is similar to the presentations of Paul Thomas ("Mr. Magnet") of the MIT Plasma Science and Fusion Center. We arrange for students to have a first encounter with plasma while they are still young and curious. Presented as a mysterious substance that responds in unexpected ways when poked, plasmas have perhaps the broadest appeal of any of our demonstrations. Students who show special fascination with plasmas are guided to one of the special plasma physics education websites mentioned above.

In sum, The Wonders of Physics traveling show simultaneously accomplishes three missions. We travel across the State and beyond, bringing exciting physics demonstrations to people who would otherwise perhaps not be exposed to physics at all, and "win fans for physics". We attract visitors to the Physics Department. And, finally, we are like the talent scouts for a successful football team, who are always on the lookout for prospects to send to the big leagues. We hope that when once a year the staid halls of the UW Physics Department ring with children's shouts, researchers raise their eyes from computer screens and smile.

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AGENDA: Physics on the Road Workshop

Saturday, February 22, 2003

10:00am – 6:00pm **Attend** Open House of *Little Shop of Physics*

Main Ballroom, Lory Student Center, CSU campus

Long's Peak Lounge / Long's Peak Dining Room will be for exclusive use of APS conference participants during the day for refreshments and informal networking.

12:00pm – 2:00pm **Lunch Buffet**

Long's Peak Dining Room, Lory Student Center

6:00pm – 7:30pm **Dinner**

Long's Peak Dining Room, Lory Student Center

8:00pm – 9:30pm **Poster Session** and Informal Networking

Physics Department: Pendulum Area

Sunday, February 23, 2003

7:30am – 8:00am **Buffet Breakfast**

CSU Physics Department Pendulum Area

Part I: Introductions & Setting the Stage

Hammond Auditorium

8:05 – 8:20 **Welcome & Introductions**

David Krueger, Chair, Physics Department, Colorado State

Brian Jones - CSU

Fred Stein - APS

8:20 – 8:40 **Keynote Speaker:** Douglas Osheroff – Stanford University, Nobelist

The Effect of Physics Outreach on one Particular Youngster

8:40 – 9:30 **Session #1: Panel Session**

Models for *Physics on the Road*

Jones, Sampere, Shropshire, Trappe, Simon

Facilitator: Stein

9:30 – 10:00 **Discussion**

10:00 – 10:30 **Break/Networking/Finish Poster Tour**

Part II: Details of What is Being Done

10:30 – 11:30 **Session 2: Defining Key Elements of Different Models**

Birds of a Feather in Three Concurrent Sessions

- Programs that Consist of Mobile Demonstration Shows
- Room E203
- *Facilitator and Recorder:* Marlin Simon

Programs that Consist of Mobile Hands on Experiments

- Room E202
- *Facilitator and Recorder:* Julie Conlon

Programs that Consist of Other Activities (teacher workshops, etc.)

- Room D104
- *Facilitator and Recorder:* Meera Chandrasekhar

11:30 – 12:00 **Brief reports from Concurrent Sessions**

Hammond Auditorium

12:00 – 1:00pm **Lunch**

Lory Student Center Long's Peak Dining Room

1:00 – 1:30 **Session 3: Topical Discussion**

Hammond Auditorium

Begin the planning and designing a mobile component for the *World Year of Physics in 2005*

- Clark and Harris
- *Facilitator: Stein*

1:30 – 2:30 **Session 4: Topical Discussion in Two Groups**

Rooms: E202 / E203

Developing the Outcomes: Website, Listserv, database, Blueprints and Conferences for *Physics on the Road*

Facilitators and Recorders:

Two groups

- Group 1: Website, listserv, database – “Communications”
Facilitator: Gelfand
- Group 2: Blueprints and Conferences – “Activities and Events”
Facilitator: Shropshire

2:30 – 3:00 **Break/Networking/Refreshments**

Pendulum Area

3:00 – 4:00 **Session 5: Practical Details**

Moving People and Equipment, Scheduling, Finances: The Nuts and Bolts

Hammond Auditorium

Jones, et al. Facilitator: Deborah Kuchnir Feygenson

4:00 – 5:00 **Session 6:** My Favorite Demo or Experiment, A “Sharing” Session

Hammond Auditorium

Master of Ceremonies: Stan Micklavzina

Might be a nice idea to have someone who coordinates this part of the program. Stan would do a great job with it.

5:00 – 5:30 **Session 7: Wrap up Discussion**

Hammond Auditorium

5:30 – 6:00 **Optional Tours**

Physics Department Tour: Jim Sites

CSMATE Tour: *Fred Stein*

Physics Department Teaching Labs Tour: *Brian Jones*

We can arrange other tours as well, depending on numbers and interest. We will also still have the vans, if folks would like to go downtown for dinner at Coopersmith's, say. The first round is on the Little Shop!

We gratefully acknowledge the support of the American Physical Society, the American Association of Physics Teachers, and the APS Forum on Education

VIII Inter-American Conference on Physics Education

Havana University, Cuba

July 7 to 11, 2003



Registration Must be sent by e-mail to the following address: iacpe@ff.oc.uh.cu with copy to fernando@info.isctn.edu.cu . The registration e-mail must include: first and last names, home address, country, phone, fax, email, participant's

For additional information, contact

Prof. Dr. Eduardo Moltó (Organizer of VIII CIAEF).

iacpe@ff.oc.uh.cu or emolto@info.isctn.edu.cu

You may also visit the following Web sites:

www.geocities.com/eventociaef

<http://www.physics.ohio-state.edu/~aubrecht/IACPE.html>

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