OUTREACH AND EDUCATION ON HIGH ENERGY PHYSICS

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ABSTRACT

We review ongoing efforts and discuss possible future directions in informing the public and educating students about Particle Physics.

1. Introduction

In the post-Cold War, post-SSC era, many of us in High Energy Physics feel we need to redouble our efforts to communicate what we do and why we do it. While we believe that physicists should devote more time to outreach and education, each of us feels that time is a scarcer resource than money. Nonetheless very substantial efforts are already underway, and we just need to build upon these existing activities. Ongoing efforts range from those done by individuals, to those done by the labs and other organized groups. Inevitably there are questions about whether such efforts are or should be done for selfish or altruistic motives. I don’t find such discussions useful. Many physicists have spent many years in education and outreach; the public and our field have both benefitted.

The Division of Particles and Fields of the APS, as part of its current study of future directions for our field, has created a working group on “Structural Issues.” This working group formed a subgroup to examine ongoing outreach and education efforts and seek proposals for new directions. It called the “Public Outreach and Education Team” (or POET). This group has had six activities so far:

1. An evening meeting at Fermilab on February 14, 1994 at which general issues were discussed.

2. A survey of ongoing ideas and of proposals was conducted via e-mail. The results of the survey and the Fermilab meeting were distributed via e-mail.

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3. An electronic bulletin board was set for discussion of these issues (but it has not been used much).

4. At the Structural Issues Working Group meeting at LBL on July 9, 1994 a report was given and feedback obtained.

5. At the DPF’94 meeting in Albuquerque on August 2, 1994, a plenary session on Public Outreach and Education was held at which four reports on these issues were given.

6. At the DPF’94 meeting in Albuquerque on August 3, 1994, the POET group met with conference attendees and had an intensive discussion of proposals for future directions.

The DPF’94 meeting was the first general meeting at which a plenary session was devoted to outreach and education in High Energy Physics. Despite the late hour of the session (4:30-6:00 PM) half of the attendees remained for the entire session. The moderator of the session was Geoffrey West (LANL). The speakers included: Malcolm Browne (Pulitzer-Prize-winning writer for the New York Times) on “High Energy vs. Low Education: A National Challenge,” Julia Thompson (Pittsburgh) on “Outreach to Women and Minorities,” Ernest Malamud (SciTech and Fermilab) on “Using Science Centers to Expose the public to the Microworld.” This report is a summary of my talk in this session.

In general, we have heard many comments about the need to convey the excitement of physics, and not just the big discoveries but the controversies too. There seems to be a consensus that we need to find means to recognize and reward outreach and education activities by physicists. The holding of a plenary session at a major conference was a good first step.

I am reporting here not on my own activities or ideas but on those received through the survey and various meetings. In the following sections, I will briefly review selected activities and proposals concerning general lay audiences, students, the government, the news media, etc. The topics of targeted groups such as women and minorities and of science museums were covered by other speakers. I will discuss the use of the World Wide Web, the creation of a catalog, and activities by collaborations.

Regrettably, the lack of space and color make it impossible to reproduce the many color transparencies, figures, and photographs that were sent to me. Clearly many of us pursue physics education/outreach for physics as a whole, but I will limit the scope of this report to HEP-related activities.

2. Reaching Lay Audiences

Many people have told us about their talks and classes for lay audiences. In a later section I will discuss resources that are available to people interested in presentations to any non-technical audience. There are a variety of books available to the public about Particle Physics topics. There have been suggestions that someone should produce a large-size “coffee table” photo book showing some of the detectors, accelerators, events, and even people of High Energy Physics.
Two recent books brought to our attention were: Cindy Schwarz’s *A Tour of the Subatomic Zoo*, which was written for the interested layperson/undergraduate/high school teacher or student. It assumes no prior physics background and can serve as an introduction to the basics. It was published by AIP. Lawrence Krauss’ *Fear of Physics*, tries to reach out to a broad popular audience, in order to explain what physicists are interested in and why.

The Florida State University Physics Department has been producing mall exhibits for a number of years and report that they are quite popular. CERN has set up its own science museum, MICROCOSM, and has now built a separate building for it. They say its purpose is “to let the public see the research work carried out by the physicists in their quest to understand the laws of Nature.” The number of visitors has remained consistently very high.

3. News Media

In connection with the announcement of the initial top quark candidates, Fermilab carried out an excellent program to inform the news media about the physics and the experiments in a manner that allowed the media to report the news accurately. They put together a substantial package of information well-suited for the target audience. They had excellent results in getting good coverage in many media outlets throughout the country.

We do not always have big news to report. However, many people have reported success at getting media coverage for aspects of their experiments. Some sample comments: “We had a press conference when we did the last touches on the experimental hardware... It works, but takes a lot of work and courage... We were on the evening news. One key point was good contact to the public relations office. One has to be extremely careful about the scope of their press release... I think a press conference after the publication of key result or a press conference when an experiment takes first data is the best approach.”

One comment was “It is often easy to interest journalists in (well-defined) stories, but it needs a significant effort to establish the ‘networking’ links to them.” Some thought should be given to how we can do this.

A common problem felt by many physicists “is the NEGATIVE peer pressure to go public.” The culture of our field has equated talking to the press about one’s research to “publishing in the New York Times.” Clearly one should continue to publish in the standard journals, but in the world we now live in, we are obligated to communicate our results, our conclusions, and the benefits of our work to a broad audience. Physicists should be encouraged to describe what we are doing and why. We are excited by the theories and experiments of our field, and we should not be ashamed to share that excitement. These lessons have not been lost on the astrophysicists; their stories appear weekly in the press (even the less-glamorous stories).

A number of people at Fermilab have proposed a national meeting of science writers and physicists to discuss the reporting of science. Clearly many of us feel that both the quantity and quality of reporting about particle physics are not adequate. It is a difficult subject about which many writers may feel insecure. Such a meeting might
not only help break down some these barriers, but would help foster contacts between writers and physicists.

4. Radio, TV, and Cable TV

In general it is difficult to present science on television because of the cost. However, Bernice Durand (Wisconsin) teaches modern physics for nonscientists very successfully on Madison area cable TV where watchers know her as the “physics lady.”

PBS has recently begun a new television series called the *Magic School Bus*. Several people has asked whether we might be able to interest the producers in an episode on Particle Physics. It is a fully animated children’s educational series. It features a teacher named Ms. Frizzle (played by Lily Tomlin), who takes her students on a magically powered bus for scientific field trips into the human body, around the solar system, or back to the time of dinosaurs. “Children’s interest in science starts to erode in the elementary grades,” project organizers say. *The Magic School Bus* project is designed to keep children’s curiosity alive.

People have noted that other sciences seem to be featured in 60-second science profiles on the radio and have asked why not HEP.

5. Government

It is generally agreed that our field could do a better job of informing Washington officials about what we do and why we do it, about the benefits of our research, and about the excitement of particle physics. Other areas of physics participate in APS’ congressional visits programs much more than we do. My own experience is that many Members of Congress and their aides have never seen an HEP physicist and are happy for the opportunity. The recent Drell Panel report had a significant impact, in part because of significant followup in Washington by members of the panel and others.

It has been suggested that the DPF should sponsor occasional Congressional Fellows similar to those from the APS and AAAS. The cost is about $50,000 each in salary, moving expenses, etc. Unfortunately I doubt that the DPF can afford this. One should not underestimate the impact of Congressional Fellows. I have been told by aides in other offices that these Fellows are regarded as “gurus” on science issues. Unfortunately they have usually not been from our field, and in fact, they have even campaigned *against* our interests. It has been suggested that we should simply push to end APS’s program which we pay for and which some believe may have done more harm than good with respect to HEP. These Fellows in no sense represent our field, nor is it clear to some of our respondents that we get the best qualified people to accept such positions.

A former Congressional aide has suggested that we would benefit more by sponsoring quarterly receptions for Members and aides (from the House and Senate) at which leading figures in HEP would discuss HEP physics issues and developments. He estimated that these evening receptions would typically attract 15-20 people (assuming food was provided), and felt that such numbers were well worthwhile. This is already done by other fields including chemistry and biological sciences.
6. Science Community

One of the lessons of the SSC debacle is that we could benefit from better relations with the rest of the science community. A British correspondent reported that they have made great strides in improving their relations with other communities and that it is greatly benefitted them.

A proposal has been made to hold a meeting in Washington on the benefits of basic research for America, cosponsoring it with biologists, chemists, medical researchers, geologists, astronomers, etc. Leading researchers from each field would speak about the importance of basic research. Reporters would be invited to attend. Later participants in the meeting could visit the Capitol to relate this message to whatever committees or individuals are interested. The purpose of the meeting would be general and not to promote any particular projects. It would serve the dual purpose of reaching out to these other fields and explaining to the public the value of basic research.

7. Documenting the value of basic research in HEP

A number of people have urged a new effort to document the impact of basic research in areas ranging from education to technology transfer to medical benefits to economic impact. One suggestion is to trace the history of particular technologies. We have not received any specific proposals on how to coordinate this.

8. College students

A recurrent theme from many respondents is that there are enormous numbers of young people taking introductory physics courses in our own universities and that we are wasting a tremendous opportunity by not turning them on to physics and basic research as much as possible. These people will be the congressional aides, opinion leaders, etc. in a few years.

Others have proposed that we should spend more time giving talks at neighboring colleges.

9. Teachers and school children

Many physicists are currently active in bringing particle physics to high school students. This can be done through presentations, workshops, open houses, the creation of materials, etc. The national laboratories all have such programs which I will discuss later. One very active national group is the Contemporary Physics Education Project (CPEP) which consists of teachers, educators, and physicists (among the physicists are Cahn, Goldhaber, Quinn, Riordan, Schwarz, and myself). This group has created the wall chart on Fundamental Particles and Interactions (in three sizes) and distributed more than 100,000 copies of it. It also has very popular color software for high school/college students in both Mac and PC versions. It mailed a packet of classroom activities about particle physics to every high school physics teacher in the US. They are completing a book on the subject of particle physics, detectors, accelerators, and astrophysics. CPEP conducts many workshops for teachers on how to use CPEP materials to teach particle physics. CPEP has been featured in Science, Physics Teacher, and even on the BBC World Service.
The American Chemical Society together with AIP periodically publishes booklets for students with cartoons, etc. The April 1993 issue was on particle accelerators. The book published by Cindy Schwarz with AIP (described earlier) is intended for high school students.

A popular suggestion has been the idea of creating a catalog of resources, materials, workshops, etc. on particle physics. This would be made available (for free) not only to teachers but to physicists to aid and stimulate them in joining education/outreach efforts. The catalog would be available both in printed form and on the World-Wide Web. Some people propose mailing it to all high school teachers, but others feel that would not be useful.

A number of people are currently making presentations and giving workshops at teachers meetings such as the American Association of Physics Teachers (AAPT) and the National Science Teachers Association (NSTA). These organizations have national, regional, and state meetings. Those involved in these presentations find them well received and advocate that more people do it.

Another proposal is that we set up a national referral service (via telephone and e-mail) that would direct high school and college teachers with HEP questions to physicists who are willing to answer questions. The idea would be to refer the teachers to physicists in or near their own state. They might call a number such as 1-800-PARTICLE (extra digits are ignored). This service may also provide a list of speakers.

Finally, physicists can and are working with local school districts and state agencies. In addition, there are university, college, high school alliance programs (organized via the APS).

10. **Resources available to physicists**

Many of the national laboratories such as Fermilab, SLAC, Brookhaven, and CEBAF have substantial education departments that sponsor workshops and programs for both students and teachers, and material development. They are anxious for the involvement of additional physicists.

Fermilab opened the Leon M. Lederman Science Education Center in September 1992. They have their own building with many exhibits. They have 45 precollege programs serving over 40,000 teachers and 8,000 teachers per year. In addition they have many college programs. They sponsor workshops for Latin American countries and create Spanish versions of instructional materials. Physicists are involved in Fermilab programs as research mentors, seminar speakers, role models, question & answer sessions with school kids, consultants on science content, hands-on-science in the classroom, museum volunteers, and SBIR proposals. CEBAF programs emphasize "Teach science by doing science."

Existing materials include transparencies, slides, comics, software, etc. These will be included in the catalog discussed above in the section on teachers and school children. The public relations staff at laboratories and universities often have resources available for physicists.

We should continue to report on outreach/education at DPF meetings to inform physicists about resources and ongoing activities. Many have suggested that we should
work through the DPF and other organizations. We can also communicate about these activities via Internet bulletin boards and newsgroups.

11. Using the Information Superhighway

More and more public schools are gaining access to the Internet. One suggestion is that the labs should set up files from which events pictures, detector designs, accelerator pictures, etc. can be obtained by anonymous ftp. These should be appropriately annotated.

The World-Wide Web (WWW) presents tremendous opportunities as use is growing by 300 percent a year. Major news media are searching the Web for stories, among them the New York Times. Even the sheriff of Tulsa, Oklahoma has listed Tulsa’s most wanted criminals on the Web.

An example of the impact of WWW can be seen in the interest generated by LBL’s “Whole Frog” link-up. Users can examine many three-dimensional images of the frog with or without skin, from any angle. Different organs can also be seen separately. In half a year 160,000 users from 56 countries have connected to it [http://george.lbl.gov/ITG.hm.pg.docs/dissect/info.html].

CERN organized a major WWW Workshop on Teaching and Learning with the Web in May 1994. They had speakers and participants from throughout Europe but few from the US.

NASA has placed on WWW tremendous numbers of images from the Hubble Space telescope and elsewhere including pictures of supernova, comets, galaxies, planets, etc. These are annotated and sometimes very useful for education. There are also a variety of animations. A prime focus of NASA pages is always on hot and current topics. They have coordinated the efforts of their many different labs and facilities.

Fermilab has made great strides in making a major presence on the Web with some excellent educational pages and a coherent, organized approach. They cover the physics, the detectors, the accelerators, the benefits, and more. I suggest you look at it.

Clearly HEP (like NASA) should have a coordinated approach to the Web with a single homepage for the public that points to the labs and other relevant sites. This effort may require a meeting of the interested groups. This page should contain short items summarizing the current excitement and controversies in particle physics and point to lab and university homepages for more information.

Physicists may also need to make some effort to aid schools and libraries getting onto WWW. Many are already on the Web (even some elementary schools classes have their own pages), but most are not.

Other suggested approaches are to create multimedia CD-ROM programs about particle physics or even Nintendo-type games.

The AIP has an e-mail news service on physics education. It summarizes information on resources, national initiatives, outreach programs, grants, publications, etc. To subscribe to AIP’s PEN, send an e-mail message to listserv@aip.org. Leave the “Subject” line blank. In the body of the message, enter the following command: <add pen>.
12. Outreach by experimental collaborations

One suggestion is that experimental collaborations should be responsible for creating WWW and ordinary printed materials about their experiment. These should describe the physics motivations of their experiment and explain how the experiment might accomplish these goals. There are people who believe that any experimental collaboration that cannot explain these basic concepts to the public should not be funded.

Several people have suggested that experimental collaborations can do much more. A very interesting proposal is one under which traditionally non-research colleges (and possibly high schools) could become “affiliates” of experimental collaborations. Arrangements would be made whereby they would “participate” in research activities. Their work might involve a small scale hardware study (table top) or a simulation study. They would need computer time or the loan of some small hardware system for a few months.

An incentive for these schools would be very important: some degree of recognition of being part of the experiment. The institution names might be listed on scientific papers under the banner “educational institutions.”

One possibility with CDF or D0 data for a college senior lab experiment would be to do some data analysis and event reconstruction for particles such as $Z$, $W$, and top.

Once such educational material is developed, it could be distributed to other colleges. Later it might be distributed to high-level high schools as a test.

Astrophysicists have already developed such a program, and it has been very successful. It is called “Hands on Universe.” The organizers feel it gives high school teachers and their students the opportunity to become collaborators on real scientific research. The program provides them with access to professional grade telescopes, analytical tools and the training to use them. It is currently delivered to high schools across the United States. Students can request telescope time to obtain images of the moon, planets, galaxies, or supernovae.

The program recently made national news (ABC Nightly News, Associated Press, etc.) when two 17-year-old juniors at a Pennsylvania high school while searching for a galaxy photographed a supernova (1994I). While they did not, of course, recognize this, their photograph was the earliest one taken and therefore quite valuable. Both the publicity for science and the impact on young people were also valuable.

13. Conclusions

There is no doubt that there are some exciting things happening in high energy physics outreach and education, carried out by educators and by physicists. However, the reality is that extremely few physicists spend any time at all on these efforts. They heartily endorse these programs, but find that they lack either the time or the inclination to join in.

This plenary session was an attempt to change attitudes, and we thank the conference organizers for their precedent-making initiative. It is important to show by our
actions that we value public awareness. We should make communication a priority and reward it. We need a mechanism to make this happen, and motivation for people to do it.

As the conference’s summary speaker (Howard Georgi) said, we need to think of speaking with the news media as a means of informing the public about the impact of public money spent on high energy physics, and we need to stop calling it “publishing in the New York Times.”

Conference participants who attended our POET meeting seemed especially interested in the following proposals:

1) Create a catalog of HEP resources (materials, workshops, etc.) for teachers and for physicists. It would be printed and on the World-Wide Web.
2) Together with basic researchers from other fields, organize a meeting in Washington on the impact and importance of basic research.
3) Organize a unified approach to presenting Particle Physics on the World-Wide Web, presenting the highlights and controversies of our field.
4) Begin a program of educational affiliates of experimental collaborations who would perform specially designed analysis or experiments.
5) Find means to better inform Washington staff and officials about HEP (quarterly receptions at the Capitol, congressional fellows, etc.).
6) Organize a national science writers meeting with physicists.
7) Encourage more HEP participation in science museum programs and find means to present our subject in museum-type settings.

For these and other efforts to succeed, the DPF needs to give them some priority and provide vital organizational support. Moral support is welcome, but if we wish for outreach and education activities to progress, meaningful action by the DPF would be more beneficial.