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Structural Issues In High-Energy Physics

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1 Introduction

In light of such events as the SSC cancellation, the controversy surrounding the decision on siting the B Factory, the declining budgets, and other problems facing U.S. high-energy physics, the DPF Executive Committee decided in late 1993 to add a Working Group on Structural Issues to the Long Term Planning Study already underway. At a time of such great change, it seemed reasonable to ask, for example, if the present HEP advisory structure needed improving. The time frame of this DPF Study overlapped the deliberations of the HEPAP Subpanel [1] chaired by S.D. Drell. To keep the Subpanel informed of our activities and to avoid interference, the DPF conveners participated in town meetings of the Drell Panel, and several Subpanel members attended meetings of the DPF Working Group. Interactions between the DPF and the Drell Panel were highly constructive, and the section on Governance in the Drell Panel's Report, issued in May 1994, reflects much of the input from DPF. The Drell Report has served as an important resource for subsequent DPF deliberations.

The DPF Working Group on Structural Issues began its work by posing to the community a number of questions and issues in February 1994 (See Appendix A). We received many messages by e-mail in response to this, and conducted three open meetings to get further input: May 6/7 at Johns Hopkins University; July 8/9 at the Lawrence Berkeley Laboratory; and August 7 in Albuquerque, following the 1994 DPF meeting.

It was decided early to separate the issues to be covered into three distinct tasks, each with a separate subgroup: Governance and Advising; Career Issues; and Education and Outreach. The reports of the subgroups follow.

2 Governance and Advising

2.1 The Existing Systems

For many years HEPAP has served as the primary advisory body on high-energy physics, and has long been cited as a successful model for communicating technical advice and, through HEPAP subpanels, making important decisions affecting the directions of the U.S. HEP program. The primary charge to HEPAP is to advise on the health of the High Energy Program. HEPAP members are chosen from among practicing experimental and theoretical high-energy physicists and accelerator physicists, in such a way to ensure diverse expertise and knowledge of the problems of each substantial constituency.

Recently, however, concerns have been raised regarding the effectiveness, limitations, and flaws of HEPAP in an era of constant or shrinking budgets and increasing demands on available funds. Since HEPAP is a DoE Institution it is constituted to advise on questions raised by DOE, with the result that the dominant concern is necessarily the operation of the DOE accelerator laboratories. Participation by the NSF is asymmetric and secondary. Scientific issues are discussed only infrequently, and there is no role for an advocate for University programs equivalent to that of the Director of a National Laboratory. It has become difficult for HEPAP to cope with the interlaboratory strife resulting from inadequate budgets.

HEPAP's effectiveness is compromised because by law it can meet only in public session. Because of this it is denied access to confidential information including preliminary budgets, and is unable to conduct the frank, confidential discussions that are essential to a thorough analysis of policy and program alternatives. As a con-

sequence HEPAP is often reduced to reacting after the fact to decisions to which it has had little input.

Whenever important issues arise demanding advice based upon confidential deliberations and privileged information, DOE requests HEPAP to convene a Subpanel that is not bound by the public-meeting constraint. This process has usually resulted in well-thought-out reports and recommendations. However, the recommendations have often not been fully implemented by DOE and occasionally they have even been contradicted. As a result a certain cynicism has set in throughout the high-energy physics community. Even under the best of circumstances, the Subpanel process can be slow and divisive.

2.2 Deliberations toward a New Role for DPF

The Structural Issues Working Group focused on the advisory structures in HEP, and how to improve them. After several meetings at which the issue was discussed, draft proposals were prepared for a fuller discussion and adoption at the DPF94 meeting in Albuquerque last August. The proposals centered around the issue, raised often in e-mail and discussion, of whether DPF should institute a panel with a somewhat broader, complementary role to that of HEPAP. Such a group could concentrate on physics questions with less attention to institutional issues, address issues of concern to either or both DOE and NSF programs, and be a resource for governmental agencies and institutions, and for the public generally, providing information on particle physics.

One possible proposal for debate called for a STANDING COMMITTEE, commissioned by the DPF Executive, to examine and report on scientific progress and opportunities in Elementary Particle Physics. The committee would be composed of nine active researchers in the field, chosen for their knowledge of the program and insight into the scientific problems that the program addresses. More specifically, such a committee could perform the following:

- study physics questions and explore future directions by commissioning committees and workshops to address specific questions of science;
- monitor the modes of research in HEP, with a view toward ensuring that resources are optimized to produce the strongest possible scientific program, giving particular attention to the needs of universities;
- explore and enhance the relationship between HEP and related fields;
- serve as a resource to HEPAP, governmental bodies, and the general public; and
- serve as an advocate on behalf of high-energy physics and related science.

What sort of science questions with major impact on the HEP program might this committee consider? Examples of current interest might include: new experimental initiatives on neutrino oscillations, neutrino astrophysics, or rare decays; the need for overlap in various B-physics programs; upgrades of major accelerators and detectors, *e.g.*, the Tevatron energy or intensity; and the Next Linear Collider.

It was strongly emphasized that this committee should focus on the science, so as to complement and not directly compete with HEPAP. However, this proposal if adopted would institute an additional standing advisory body, whose role would have to be carefully crafted to avoid confusion or confrontations.

Promising developments during the spring and summer of 1994 led the Working Group to consider modifying the above proposal. First, the Drell Subpanel, which had expanded its charge to address governance and management, clearly took into account the ideas discussed by the DPF. Next, the report was well received in Congress, and by the funding agencies. The DoE and NSF have both declared their commitment to increase communication and cooperation, and to devise a more formal, expanded role on HEPAP for the NSF. A third development was the agreement of DoE to implement the Panel's recommendation for more direct input by scientists in budget planning.

As a result, an alternative proposal was presented by the Working Group at the Albuquerque meeting. Working within the present DPF structure, it builds on the experience and success of the SNOWMASS concept, invented by DPF in 1982, which greatly influenced HEP planning for many years. The main difference with the proposal described above is that, instead of commissioning a new standing committee, the DPF Executive Committee would itself take on an expanded role to take care of the responsibilities of the proposed standing committee.

2.3 Our Major Recommendation

During the debate in Albuquerque a consensus formed against forming a new standing committee, and in favour of the following recommendation:

- The DPF Executive Committee should commission workshops and studies on issues of great importance to the field. The Executive Committee would not carry them out, but instead appoint ad-hoc panels to do so.
- Each study should be of short duration, so as to make its conclusions and recommendations available in a timely manner.
- The reports resulting from workshops and studies should be disseminated promptly to the HEP community, DoE, NSF, the Laboratory Directors, and the public.

We are confident that this proposal will greatly reduce any potential conflict with HEPAP. The expanded responsibilities and roles will change the nature of the DPF Executive Committee, and in fact of DPF itself. However, these new responsibilities fall within the DPF charter, which reads:

> "The objective of the Division shall be the advancement and diffusion of knowledge of the fundamental particles and fields, their structure, their interactions and interrelationships, the design and development of high-energy accelerators, and the design and development of instrumentation techniques for high-energy physics."

2.4 Discussion

The recommendation only addresses items (1) and (2) of the new responsibilities proposed in the previous section for DPF. During the course of discussion, many members of the working group felt that items (3) (exploring relationships among HEP and other related fields) and (4) (acting as a resource to governmental bodies and the general public) have not diminished in importance and should also be addressed by the next DPF Executive Committee as part of its new expanded role. For example, item (3) could be dealt with by a study commissioned by the Executive Committee. However, for items (4) and (5), a satisfactory solution has not yet been found. Some feel that it would be a healthy component in the advisory apparatus to have a voice for the field which is not bound by a direct relationship with a single federal agency when so much of the government (Congress, OMB, OSTP, NSF) is directly involved in matters which very directly impact the planning and execution of a balanced program. (Here, "balanced" means proportioned according to science and not necessarily to institutional priorities.) While the Executive Committee could take it upon itself to represent the Field to these other important players in the management of HEP, this could also be delegated to an ad hoc group.

Finally, we suggest that the Executive Committee begin a tradition of preparing an annual, written "white paper" for the DPF membership on the State of the Field. This document should integrate over the panorama of the recent scientific accomplishments as well as current scientific needs and preparation for future scientific projects. It should include an appraisal of the progress made, or not, by the relevant governmental partners in meeting those needs. Given its intended audience it is best that this document should be rather brief. It could be prepared for the Executive Committee through an ad hoc review panel, which would broaden its base. This document would be distributed to the DPF membership, discussed with HEPAP, and generally shared with the other relevant agencies as an assessment of how well the scientific and administrative necessities are being met to keep this fragile science on course to continued success. The purpose would be to be constructive, to help keep policy in line with the scientific priorities.

3 Career Issues

3.1 The Problem

The demise of the SSC immediately put more than 100 physicists into the job market. The resulting shortage of positions and loss of physics opportunities convinced some of the SSC displaced-persons as well as many other promising people in HEP to leave the field, and also demoralized scientists with short-term positions as they contemplated searching for their next job in such a hostile climate. Calls for action came from many sources; the Users' Groups at the National Laboratories were particularly concerned. The DPF responded by including a study of careers as one of the Structural Issues in HEP, and the working group has begun to study the situation.

3.2 Establishing a Data Base

As soon as the discussions about career issues was begun it clear that reliable demographic data would be a crucial prerequisite for meaningful deliberations. Unfortunately very little useful data exists. The latest relevant survey was done by the Sciulli Subpanel of HEPAP in 1991. Hence the first action of the working group was to ascertain what plans there were, if any, to compile the necessary information and to analyze it. We learned in June 1994 that the DoE had proposed two years ago that the Particle Data Group (PDG) should undertake a comprehensive manpower survey, and that The PDG had submitted a draft questionnaire to the DoE for approval. No action had been taken on it, however, because several well-known crises with higher priority for DoE attention had intervened. The Structural Issues group decided to try to catalyze the process, with the result that the DoE and the PDG have scheduled the survey for Fall 1994. We are glad to report that the NSF has agreed to join the effort, and to contribute to its financial support. (Such a survey could not be complete without the close involvement and cooperation of the NSF.) The survey is now being prepared for broad circulation, its prime goals being to obtain least a 90 per cent response rate, and to reach all persons who have been active in HEP for any significant period within the past 15 years.

The survey will answer demographic questions such as the following, and then will search for trends:

- How many students, postdocs,faculty members, permanent laboratory staff members, etc., are supported by the U.S. HEP program?
- How long do typical scientists spend at each level as they progress from new PhD to senior researcher?

- What classes of positions do new PhD's choose in HEP, industry, medicine, law, finance, etc.?

Obtaining accurate data is only the first step toward improving the advising and utilization of high-energy physicists. Even more important, the DPF must inform its scientists of all the various career paths open to them both within HEP and without; it must educate them as to the needs of employers in industrial laboratories, government, finance, etc so that they can optimize their qualifications and résumés; and it should show employers how high-energy physicists can contribute to their enterprises. As a first attempt in this direction, the DPF cosponsored a Career Workshop at the Albuquerque meeting along with the AIP and APS.

3.3 A Recommendation

To produce lasting, significant improvements in the career situation, a long-term, planned effort will be required. Therefore, the Structural Issues group recommends:

- The DPF Executive Committee should organize a Subcommittee on Careers to arrange meetings, prepare literature, consider the appropriateness of, and possible improvements in the training of graduate students and postdocs, etc.

Several people willing to serve have already been identified, and have begun by assisting the DoE and the PDG with the Career Survey. The subcommittee would optimally be expanded to include representatives from each major constituency: universities, national laboratories, and industry.

4 Education and Outreach

4.1 Introduction

In the post-Cold War, post-SSC era, it became clear to many high-energy Physicists that we need to redouble our efforts to communicate what we do and why we do it, even though we feel 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. Such discussions do not seem to be 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. Named the "Public Outreach and Education Team" (or POET), this group has initiated several activities so far, including:

- An evening meeting at Fermilab on February 14, 1994 at which general issues were discussed.
- 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.
- An electronic bulletin board was set for discussion of these issues (but it has not been used much).
- At the DPF 1994 meeting in Albuquerque on August 2, 1994, a plenary session was held on Public Outreach and Education, at which four reports on these issues were given. Later in the meeting, the POET group met with conference attendees and had an intensive discussion of proposals for future directions.

The DPF 1994 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."

A general them of the many comments we have received is the need to convey the excitement of physics — 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. A list of possible proposals for future action is given in Appendix B.

In the following sections, we shall briefly review selected activities and proposals concerning general lay audiences, students, the government, the news media, etc. Of particular interest are the use of the World-Wide Web, the creation of a catalog, and activities by collaborations. We are also working on activities targeted on underrepresented groups in HEP, and on enhancing the offerings at science museums.

4.2 Reaching Lay Audiences

Many people have told us about their talks and classes for lay audiences. In a later section the resources that are available to people interested in presentations to any non-technical audience will be discussed. 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.

4.2.1 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 on how to 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.

4.2.2 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 the producers could be interested in an episode on Particle Physics. It is a fully animated children's educational series, featuring 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.

We note that other sciences seem to be featured in 60-second science profiles on the radio — why not HEP?

4.2.3 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. 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 it is doubtful that the DPF can afford this. However, one should not underestimate the impact of Congressional Fellows, who are often regarded by lay congressional staffers as "gurus" on science issues. Unfortunately these fellows have rarely been from our field, and in fact, they have even campaigned *against* our interests. It has been suggested that the DPF 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. In no sense do they represent our field, nor is it clear that we get the best qualified people to accept such positions. A more positive view would hold that DPF should identify and recruit better qualified fellows.

A former Congressional aide has suggested that we would benefit more directly 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.

4.2.4 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 particle physicists have made great strides in improving their relations with other communities in Britain, and that it has greatly benefitted them.

A proposal has been made to hold meetings 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 such meetings would be general and not to promote any particular projects. They would serve the dual purpose of reaching out to these other fields and explaining to the public the value of basic research.

4.2.5 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.

4.2.6 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.

4.2.7 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 M. Barnett, R. Cahn, G. Goldhaber, H. Quinn, M. Riordan, C. Schwarz). 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. Packets of classroom activities about particle physics have been mailed to every high school physics teacher in the US, and a a book on the subject of particle physics, detectors, accelerators, and astrophysics is nearing completion. 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 do work together with local school districts and state agencies. In addition, there are university, college, high school alliance programs (organized via the APS).

4.3 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 in a dedicated building with many exhibits. They have 45 precollege programs serving over 40,000 teachers and 8,000 teachers per year, as well as 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 children, consultants on science content, hands-on-science in the classroom, museum volunteers, and SBIR proposals. Programs at CEBAF 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.

4.4 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, with which 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).

Other organizations are already well underway in exploiting the Web for educational purposes. As a prominent example, 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>.

4.5 Outreach by Experimental Collaborations

An interesting suggestion is that experimental collaborations should be 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 suggested for a college senior lab experiment would be to do some data analysis and event reconstruction for particles such as Z, W, and top, using CDF or DØ data. Clearly it would take a significant amount of development work for this to be feasible, but once such educational material is developed, it could be distributed to other colleges. Later it might even 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.

4.6 Summary

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.

Perhaps, as we hope, attitudes are changing, since 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.

Appendix A: Questions on Governance

During the spring of 1994, the HEP community was encouraged to express its views on the following issues, responding to the Working Group by letter or e-mail.

- The only formal mechanism for advising the federal government is the HEPAP organization. Does HEPAP work effectively? If "yes", why. If "no", why not?
- What additional mechanisms do you think should be considered by DPF to more adequately plan for the future of HEP?
- Should structured consultative mechanisms be created between HEP and Congress as a whole or in part, NSF, DoE, OSTP?
- How should the support levels be optimized between university and national laboratory programs, domestic and offshore experiments, etc., and unnecessary duplication be avoided.
- Should interface subjects such as nuclear physics, astrophysics, etc., have separate, identifiable mechanisms for consultation with the government?
- Should HEP seek a structured public education role? If so, how broad should such an activity be and how should it be organized?

Appendix B: Proposals for Outreach Activities

DPF94 Conference participants who attended the POET meeting seemed especially interested in the following proposals:

- Create a catalog of HEP resources (materials, workshops, etc.) for teachers and for physicists. It would be printed and on the World-Wide Web.

- Together with basic researchers from other fields, organize a meeting in Washington on the impact and importance of basic research.
- Organize a unified approach to presenting Particle Physics on the World-Wide Web, presenting the highlights and controversies of our field.
- Begin a program of educational affiliates of experimental collaborations who would perform specially designed analysis or experiments.
- Find means to better inform Washington staff and officials about HEP (quarterly receptions at the Capitol, congressional fellows, etc.).
- Organize a national science writers meeting with physicists.
- 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.

References

[1] S.D. Drell *et al.*, "High Energy Physics Advisory Panel's Subpanel on Vision for the Future of High-Energy Physics", May 1994, DOE/ER-0614P (U.S. Department of Energy, Office of Energy Research, Washington, D.C. 20585).