Report of

American Physical Society

Division of Particles and Fields

Ad Hoc Committee on Particle Theory

April 13, 1990

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EXECUTIVE SUMMARY

During 1989, there was a great deal of discussion in the high energy physics community of the importance of strengthening theoretical research in areas relevant to experiment. In response to this discussion, a Committee was established by the Division of Particles and Fields of the American Physical Society to study the problem further and to make recommendations. The Committee met several times, held two town meetings, and solicited opinion widely by mail. The unanimous view of the Committee and the broad consensus in the community is that this kind of theoretical research needs support and encouragement. To this end, the Committee offers a number of recommendations in the following general areas:

1. Collaborations

   The DoE and NSF should be prepared to fund collaborative proposals from groups of theorists, especially those engaged in large-scale projects directly relevant to ongoing and planned experiments.

2. Schools and Training

   University physics departments should insure that their courses for particle theorists remain up-to-date and that they emphasize the interdependence of theory and experiment. The DoE and NSF should make every effort to increase their support of the very successful Theoretical Advanced Study Institute in Elementary Particle Physics. The national laboratories should consider establishing summer programs for graduate students after their first or second year of study.

3. Financial Support for Graduate Students

   The current level of support in theoretical particle physics is inadequate for the health of the field, in particular for the training of graduate students in areas close to experiment. Experimental groups are urged to share in the support of such students in appropriate cases. The creation of Graduate Research Assistantships by the SSC and other laboratories would help greatly to encourage Ph.D. training in these areas.

4 Workshops and Programs

   DoE and NSF should support long-term workshops on important topics in particle theory at existing institutions, and the national laboratories should make more use of targeted visitors programs.

5. Comments on a National Center for Particle Theory and on the SSC Laboratory

   The Committee does not recommend that a new national center be established at this time. Instead the Committee recommends the strengthening of existing programs and institutions and the rapid development of theoretical physics at the SSC laboratory. The latter should include visitor programs, computational support for long-term projects, and beginning steps in the formation of a permanent theoretical group.

6. Career Positions

   If particle physics is to remain as robust and intellectually exciting as it has been, it is crucial that particle theorists whose work is related to experiment be able to find faculty appointments in the leading physics departments of the country. Departments are urged to consider the question of balance within particle theory as a normal part of the appointments process.

I. INTRODUCTION

During the summer of 1989, both through a BITNET echo and through exchanges at various conferences and workshops, there was considerable discussion within the high energy community of the desirability of encouraging more theoretical research in areas that have a close connection with ongoing and future experiments. As a result of these discussions the Executive Committee of the Division of Particles and Fields of the American Physical Society established an ad hoc Committee to study this question. The Committee is composed of T. Appelquist, E.L. Berger, R.D. Carlitz, J. Dorfan, E. Eichten, M.B. Einhorn, M.K. Gaillard, H. Georgi, P. Langacker, F. Paige, R.D. Peccei (Chair) and M. Shochet. The charge to the Committee is included as Appendix A of this report.

The Committee met three times: in Dallas on October 1, 1989, at Fermilab on November 19, 1989, and at Santa Barbara on March 1, 1990. In addition, the Committee made a concerted effort to solicit the opinions of the high energy physics community and of representatives of the Department of Energy and the National Science Foundation. In early October a letter and questionnaire (see Appendix B) was sent to a large number of DoE and NSF Principal Investigators in both theory and experiment asking for their comments. Furthermore, a letter (see Appendix C) reporting on the progress of the Committee and soliciting further input was included in the general DPF mailing in December, 1989. The Committee, as a further means of gathering community input, held two open meetings. The first one on November 20, 1989, was at Fermilab, while the second was during the DPF Annual Meeting at Rice University, on January 4, 1990.

The Committee, both as a result of its own internal discussions and from the strong response and thoughtful input received from the community and the funding agencies, agreed on some preliminary recommendations by the end of 1989. These views were presented to the Executive Committee of the Division of Particles and Fields in Houston on January 4, 1990. Since then, the Committee has continued to gather input and refine its findings. These findings are contained in the final report that follows, which includes a set of broadly agreed upon action recommendations.

II. OVERVIEW

The unanimous view of the Committee is that theoretical research in areas that have contact with experiment needs to be encouraged. This opinion of the Committee is shared by the large majority of physicists polled, although in the community there is a considerable range of opinion concerning exactly what steps should be taken. The Committee feels that this breadth of views reflects, in part, the different interpretations that various people have as to what constitutes theoretical particle physics.

For the purposes of this report, it is useful to distinguish two different classes of problems addressed by theorists interested in the phenomena of particle physics:

(1) Large phenomenological projects related to experimental analysis or projects tackling computationally intensive questions. Some examples of such projects are given in Appendix D.

(2) More "small-scale" endeavors developing new ideas with experimental consequences or pursuing the experimental implications of existing ideas.

Clearly the steps which might be useful for encouraging the latter kind of theoretical research are quite different from those which are needed to foster large, experimentally oriented projects. Furthermore, even though the larger scale research projects are more labor intensive, most theoretical research in particle physics today is of the "small-scale' variety.

Many of the "large-scale" projects listed in Appendix D have received limited attention thus far, mainly because of their intrinsic difficulty and limitations on human and financial resources. To make substantial progress in most of these problems requires the concerted efforts of a number of interested and highly motivated physicists. The Committee feels that to encourage work in these areas will require both innovative funding mechanisms and an increased appreciation within the high energy community itself for the intrinsic value of such enterprises.

Large-scale projects are, however, only a part of the theoretical effort needed to guarantee a healthy field. Indeed, in the responses received by the Committee from the community, another issue seemed to be the main focus of concern. It is apparent that in the last few years some of the best young theorists have concentrated on rather formal endeavors, very remote from any experimental probing. This is a very troubling phenomenon, particularly as particle physics is embarking on an era of unprecedented experimentation, using electron-positron, electron-hadron, and hadron-hadron colliders to explore an entirely new energy range. The Committee discussed whether it is it possible to rekindle the interest of young (and not so young) theorists in the pursuit of theoretical physics closer to experimental reality. This issue does not appear easy to address, as theorists will naturally work on what they find challenging and exciting. Nevertheless, to the Committee, the best approach appears to be an increased emphasis in student education in particle physics along lines that stress the interconnection of theory with experiment. The Committee believes that university departments should reevaluate their curricula in this light, and the Committee includes among its recommendations suggestions for increased funding for graduate students doing phenomenological work.

A specific issue in the original discussions and in the charge to the Committee was whether a new national center for particle theory should be established at this time. The consensus in the community and among the members of the Committee is that this is not an appropriate time to initiate a new center. An important factor in this view is that the SSC Laboratory intends to build a broadly-based theoretical group over the next few years. The Committee is pleased that a primary goal of the SSC Laboratory is to become a major resource for science education. The SSC Laboratory theory group could and should respond to many of the above concerns, and the Committee strongly encourages the SSC Laboratory management to proceed aggressively with a program of long- and short-term workshops, visitor programs, and the development of its own internal theoretical group. These and other points are discussed in more detail in the set of recommendations that follow.

III. RECOMMENDATIONS

Theoretical Collaborations

The Committee makes two recommendations aimed at fostering some of the large-scale phenomenological activity necessary for the future health of the field:

i) Theorists working in different universities, or in the national laboratories, who are interested in collaborating in a "large-scale" problem should organize themselves into a formal collaboration and request funding from federal agencies in the same way as experimentalists do at present. Both DoE and NSF should be prepared to accept collaborative proposals of this kind, and after proper review, make every effort to provide sufficient resources for the task.

ii) It might be necessary for theorists engaged in one of these larger collaborative endeavors to spend considerable time together. In these circumstances, funding support to allow for faculty release time and travel, and dislocation allowances would be perfectly appropriate, so that the collaborators can gather at a university or national laboratory. Indeed, it appears very sensible to the Committee that some of this "large-scale" phenomenological activity - irrespective of whether it is directly related to SSC physics - might well take place at the SSC Laboratory.

Schools and Training

The Committee examined the graduate curriculum from a number of universities that produce a sign)ficant number of Ph.D.'s in high energy physics. Although the data are not complete, comments in letters to the Committee reinforce the impression that there is some cause for concern. All too often, the theoretical and experimental courses are disconnected. Especially for theoretically inclined students, there may be too little emphasis on particle physics as an empirical science, and the interconnections of theory with experiment are lost in formalism. The Committee suggests that this may be something for the Division of Particles and Fields to follow up, perhaps through a systematic survey and evaluation of graduate curricula. In any case, the Committee encourages individual physics departments to examine the content of their course sequence for theorists with a view toward emphasizing the interdependence of progress in experiment with progress in theory. With the new accelerator facilities now contemplated or under construction, it w-ill be as important in the future as in the past that theorists appreciate and communicate with experimenters in matters such as the design of detectors and the interpretation of data. With regard to national policy on support for graduate education, the Committee has a number of recommendations:

iii-a) The annual Theoretical Advanced Study Institute (TASI) in Elementary Particle Physics provides an opportunity for students who are pursuing thesislevel research or who have just obtained their Ph.D.'s to expand their vistas and be presented with a variety of pedagogical lectures that span the subspecialities of particle theory. Frequently, the personnel who are brought together in this four-week summer program provide a greater diversity of expertise than exists at any one university. The TASI Scientific Advisory Board

has consistently encouraged the integration of phenomenologically relevant lectures, and the programs generally include lectures and seminars by experimenters as well as theorists. The Committee is pleased that the NSF Physics Division and the DoE Division of High Energy Physics have cooperated to provide joint support for TASI for the past 6 years. Much of this support goes directly to subsidizing the expenses for students who attend, and this is one of the few programs specifically directed toward graduate students. The Committee believes that TASI should continue to receive financial support, and, at this time when university funds for supporting graduate student expenses to attend are especially scarce, DoE and NSF should consider increasing the budget for this important national institution.

iii-b) It may be that other such programs directed toward graduate students should be initiated. For example, one might consider summer programs based at the national laboratories with a focus on exposing theoretically-inclined students to the excitement of the laboratory environment and their experimental programs. The focus might best be toward students completing their first or second year of graduate school, generally before they have begun thesis research. While the precise content and format of such programs would require careful planning, the goal should be to provide opportunities for students to participate in the process of analysis and discovery. One may also want to include a series of organized, pedagogical lectures. Rotating such programs among the national laboratories would provide diversity without putting undue strain on the personnel or resources of any one lab. These intensive programs would certainly provide experiences and opportunities now available at only a very few universities and would sign)ficantly enhance graduate education in our field. Because such students seldom would be able to draw upon financial resources from their home institutions, it would be necessary to provide funds to support such students fully during these programs. In addition to proposal vi) below, this would be another way in which laboratory scientists, both theorists and experimenters, could become more involved with graduate education. It would reinforce the intellectual goals of the national labs and would involve theoretical students sooner.

Financial Support

Although the Committee does not have hard data, it would appear that financial support in real terms for theoretical high energy physics decreased substantially in the 1980's. There is anecdotal evidence from the experiences of members of this Committee and from the letters sent to the Committee that, during the past decade, the level of activity supportable from research contracts decreased for various reasons. Nominal budget increases were certainly less than the inflation rate for scientific research. Generally, along with a relative decline in Federal support for education, there were substantial increases in University overhead rates and tuition together with the salaries of Graduate Research Assistants (GRA's.) As a result, a typical elementary particle theory contract can now support fewer than 0.5 GRA's per funded faculty member, far fewer than on a typical experimental contract. Consequently, theoretical graduate students have less time to spend

on their research, leading to a decrease in research productivity. An increase in the average number of students that a faculty member could support would benefit both the students and the research program. However, the Committee does not advocate an increase in the overall number of Ph.D.'s in particle theory, but particle physics would benefit from a relative increase in the percentage of Ph.D.'s doing phenomenologically relevant theses. To this end, the Committee recommends:

iv) Especially in those universities active in both experimental and theoretical high energy physics, it might be possible to increase the number of GRA's for students who wish to pursue problems related to theoretical predictions for feasible experiments and for the analysis of experiments, including the differentiation of signals from background. Where possible, support for such graduate students could be shared between experimental and theoretical groups.

v) In analogy to the recently established SSC Fellowships for postdoctoral researchers and junior faculty (supported by the State of Texas through the Texas National Research Laboratory Commission,) the Committee urges the creation of a number of Graduate Research Assistantships in theoretical physics, funded by the SSC or other national laboratories, for thesis work broadly related to experiment. The existence of a national competition for such awards based on merit should also increase the recognition for such activities and the attractiveness of such research.

The Committee believes that an effective way to bring students into contact with theorists often concerned with experimental issues would be to encourage opportunities for graduate students to meet and possibly work with scientists at the national laboratories. To this end, the Committee recommends:

vi) National laboratories and universities should explore ways to increase the number of students who work in collaboration with laboratory scientists. Furthermore, theorists at the national labs should be allowed and encouraged to teach courses in universities. With the support of laboratory and university administrations, the expenses for these activities might be borne, at least in part, by the national labs, thereby indirectly generating more faculty release time for conducting research.

Workshops and Programs

It is the opinion of the Committee that the most effective way at the present time to stimulate interest in experimentally relevant theory would be to encourage a broad set of measures aimed at strengthening some of the programs and institutions that already exist. To this end, the Committee has two recommendations:

vii) Long-term workshops on important topics in particle theory, including those at the interface between theory and experiment, should be encouraged at existing institutions such as the Institute for Theoretical Physics in Santa Barbara, which has substantial experience in such programs, the Aspen Center for Physics, the national laboratories, host universities, and possibly elsewhere. The Committee recommends that the funding agencies set aside a certain allocation for such purposes and that, after proper peer review, DoE and NSF support should be a matter of course.

The Committee is aware that there are many short-term worl;shops related to particle physics in the U.S. and abroad, and it does not recommend a substantial increase in their number. Rather, the Committee feels it would be better if support were increased for certain programs, which, in the estimation of the community, are of potential importance for the further development of particle physics. The Committee recommends that a few worl;shops be of longer duration, like some of the programs at the ITP Santa Barbara, which run as long as six months.

The visitor programs at the national laboratories serve a very useful function, permitting the natural exchange of ideas between theorists from universities and laboratory staff, both experimenters and theorists. The Committee feels, however, that these visitor programs might benefit from more focus occasionally:

viii) The national laboratories should consider making more use of targeted visitors programs, in which some selected group of theorists with overlapping interests might focus their energies on a problem of physical importance over an extended period of time. These visitors' programs appear to be especially vulnerable to budget strains and a conscious effort must be made to give them the priority they deserve.

Comments On a National Center for Particle Tlleory and the SSC Laboratory

The discussion of a possible new national center for particle theory has passed through two distinct phases. The first phase, taking place largely through the medium of an electronic mailing established during the summer of 1989, involved about 200 physicists with a substantial fraction taking an active role. These physicists represented primarily the views of the phenomenological particle physics community and generally favored the establishment of a new national center. The second phase was initiated by this Committee through a mailing to principal investigators holding grants from the NSF or the DoE. This group, which was broader-based than the electronic mail discussion group, was much less favorable to the idea of establishing any new facility at this time. In the absence of a clear consensus for a new facility, the Committee feels that it is best to concentrate upon strengthening existing programs and institutions. The discussions of the last year offer a number of suggestions on possible courses of action. With the SSC theory group still in its planning stages there is an opportunity to implement some of these plans immediately.

The need to develop a theoretical group at the SSC offers an exciting opportunity to stimulate research in phenomenology and attract the best young theorists to this subfield. The Committee is pleased that a primary goal of the SSC Laboratory is to become a major resource for science education generally. The Committee recommends that the following steps be rapidly taken to establish a strong theoretical presence at the SSC laboratory. In addition to addressing some of the immediate needs of the particle physics community, this strategy will enhance the laboratory's chances of attracting first-rate physicists to form its permanent theoretical group.

ix-a) Establish a program to maintain 10-20 visiting physicists throughout the calendar year. Funding should be provided for visitors' salaries and expenses and for support of accompanying graduate students. Flexible arrangements should be encouraged to permit a certain amount of commuting between the SSC and other national laboratories and universities.

ix-b) Continue the program of SSC fellowships at the postdoctoral and junior faculty level and develop a similar program of predoctoral fellowships. The predoctoral fellowships should be offered on a competitive basis to students doing thesis work in an area relevant to the SSC's physics program. The fellowship holders should receive travel allowances to permit them to interact with physicists who are resident at the laboratory as part of the visitors' program.

ix-c) Provide computer support for long-term projects and for the maintenance of databases in particle physics. The SSC would be a natural home for long-term development efforts in Monte Carlo simulations and the analysis of hadronic structure functions. A portion of the planned SSC computing capacity should be made available for theoretical calculations relevant to SSC physics. SSC databases could provide high energy physics data, up-todate analyses of structure functions, individual calculations of complicated amplitudes, and programs and packages of programming tools. A small level of personnel support would be required to implement this suggestion.

Appoint physicists at some early date whose responsibilities would include the coordination of scientific activities of the visitor programs. Although it may be sensible to postpone the hiring of a full complement of theorists until the accelerator itself is nearly completed, it is essential to have people dedicated to making the laboratory function as an intellectual center for the particle physics community. If the SSC is established as an intellectual center of this sort, then not only will the needs of the particle physics community have been well-served, but the task of recruiting a permanent staff of high quality will be facilitated.

Career Positions

Over the past five years or so, many theorists have moved toward more formal, mathematical physics. Along with this evolution of the field, a great many physics departments have added young faculty whose interests lie in these directions. Even though this group of young theorists includes many of the most able of their generation, this has led to a concern among the community that theoretical particle physics will drift too far from problems more directly accessible experimentally. While the abundant data emanating from new and upgraded facilities in the 1990's may help alter this trend, it is important that physics departments give serious consideration to this matter when planning for new appointments. Specifically, the Committee recommends that

The process leading to the appointment of a new particle theorist to the faculty of a physics department or to the staff of a laboratory should include thoughtful discussion of the balance between formal and more real-world work, both in the specific institution and in the field as a whole. There are many bright and creative young theorists whose work is motivated more directly by physical questions including some who deal directly with problems of current experimental interest. It is crucial that these people be able to find faculty appointments in the leading physics departments of the country. Experimentalists can and should play an important role in these discussions of theoretical appointments.

The open problems in theoretical particle physics are exciting, challenging, and important. Many are very directly tied to the goal that drives the entire field: exploring and understanding the structure of the physical world at its most fundamental level. Theoretical work on these real-world problems can flourish in the years ahead if it is supported and encouraged by everyone in the high energy physics community.

APPENDIX A: CHARGE TO THE COMMITTEE

During the last few months there has been extensive discussion in the high energy physics community of the need to encourage theoretical research which is in clear contact with experiment, possibly through the establishment of what has been termed a national center for particle theory. This discussion, whose public aspect has centered around a "bitnet echo," has addressed an important set of issues. Even if one were to judge only by the length and breadth of opinions expressed in the electronic mail, this is a subject with many aspects and implications for the field of high energy physics. Especially as we are on the verge of a major change in the experimental side of particle physics with the commitment of funds for construction of the SSC, this topic merits a full examination.

Accordingly, the Executive Committee of the Division of Particles and Fields is establishing a committee to study the needs for support of theoretical work which interfaces with experiment and how those needs might be met, including the possibility of the establishment of a new national center or institute. I thank you for agreeing to serve on this important committee.

In particular, it would be desirable that this committee, consisting of T. Appelquist, E. Berger, R. Carlitz, J. Dorfan, E. Eichten, M. Einhorn, M. Gaillard, H. Georgi, P. Langacker, F. Paige, R. Peccei, and M. Shochet will:

(1) Identify the perceived needs for theoretical work at the interface with experiment, as well as the specific analysis tools whose development may benefit from targeted efforts;

(2) Consult with our colleagues, both theorists and experimentalists, in universities, the national laboratories (including the SSC!), the ITP in Santa Barbara, and the IAS in Princeton, as to their perceptions and experiences - This may include one or more "town meetings" at which members of the community may express their views and concerns;

(3) Recommend how the needs may best be met, and specifically whether a new center (alone or in conjunction with other activities) or the enhancement of existing structures is the most appropriate solution;

(4) Recommend, if a new center is advisable, what its scope and mission should be, what level of staff and budget is appropriate, and how it would relate to the host institution and interact with theory groups at the national laboratories and universities.

I hope that the committee will be able to begin its work in the very near future, so that an interim report on its progress could be given at the DPF meeting at Rice University in January, 1990.

Fred Gilman
Chairman, DPF

APPENDIX B: LETTER FROM COMMITTEE TO PRINCIPAL INVESTIGATORS

October 13, l9S9

I am writing to you as the Chairman of a Committee recently set up by the Division of Particles and Fields of the American Physical Society. The establishment of this Committee, which is composed of T. Appelquist, E. Berger, R. Carlitz, J. Dorfan, E. Eichten, NI. Einhorn, M. K. Gaillard, H. Georgi, P. Langacker, F. Paige, R. D. Peccei and M. Shochet, has been in response to extensive discussions within the high energy community of the desirability of encouraging more theoretical research in areas which have a close connection with ongoing and/or future experiments. Specifically, the Committee has been charged with:

i) Identifying the need for theoretical work in areas which have clear contact with experiment.

ii) Suggesting mechanisms by which theoretical research of this kind might be fostered.

Concerning the second point we have been asked, particularly, to recommend whether the creation of a national center for particle theory (NCPT) or the enhancement of existing institutions -or both - would be the most appropriate action to take. In the case we were to deem the creation of an NCPT to be advisable, the Committee should also detail what it sees to be the scope and mission of such a center and how the center might relate to the host institution and interact with tlleory groups at the national laboratories and in universities.

The Committee had its first meeting in Dallas recently, on the propitious occasion of the SSC fess. Although the Committee found itself in complete agreement on the need to encourage theoretical work which interfaces with experiment, we felt strongly that we also needed further community input on a host of questions. To help the Committee in its deliberations, we would very much appreciate it if you could take some time to respond frankly to the enclosed list of questions. Your answers will be kept confidential. You may write to me directly, or reach me via bitnet (Peccei@UCLAHEP) or FAX [213-206-1091]. If you would prefer, you can also communicate with the Committee as a whole via bitnet (DPF-COM@PITTVMS).

We plan to discuss the community response to our questions in our next meeting at Fermilab on November 19th. We shall also have an open meeting of the Committee, where more community input will be welcome, from 10 AM to 12:30 PM on November 20th in Curia II at Fermilab.

Roberto Peccei
RP:fa

Enclosure

QUESTIONS

1) Do you feel that it is important to encourage more U.S. theoretical physics research in areas which have a close connection with present and planned highenergy experiments? If so, what specific topics or projects ought to receive increased attention?

2) How do you rate the importance of fostering this type of research compared to fostering research on more fundamental, but perhaps more remote, problems? Do you have any suggestions on how one could attract good young people into phenomenology?

4) Do you feel there are few tenure positions for phenomenologists in universities and national laboratories?
Would you consider giving a tenure track, or tenure appointment in your insti tution to a theorist whose principal interests reside in the application of funda mental theory to ongoing or future experiments in high energy physics [i.e. to a phenomenologist]? Could you support the appointment of someone whose prin cipal activity was right at the interface of theory and experiment [e.g. someone interested in developing Monte Carlo programs for fragmentation]?

6) Several suggestions have been made on how to stimulate phenomenological research in the U.S. Which of the options below do you favor [you may indicate more than one choice]:

a) Augment the existing programs at the national laboratories by, for example, increasing the number of phenomenologically oriented visitors.
b) Establish collaborative programs among various university and laborator~ groups to tackle important large scale projects [e.g. the study of whether the O(c~ ,) corrections for hadron-hadron scattering can be unraveled from uncertainties in the structure functions and in the experimental jet defini tions].
c) Have more workshops on phenomenological topics in existing institutions, like the ITP in Santa Barbara, Aspen, etc.
d) Create a National Center for Particle Theory with the principal goal of pur suing phenomenologically oriented research.
e) Develop summer study programs at the national laboratories, or summer school courses, to better train students in the phenomenology of particle physics.
f) Encourage the formation of an autonomous theory group at the SSC which would have a strong phenomenological bent.

7) Establishing an NCPT is viewed in some quarters as threatening, because it is felt that it will absorb monies and people from ongoing programs. What is your opinion about this?

8) If an NCPT were to be established, should it have a moderately large permanent staff (6-10) or should it have a small permanent staff and devote the bulk of its resources to an extensive visitors program? Also, what contact would you envisage this center should have with formal theory, experiment, and other disciplines?

9) Do you have any further comments?

APPENDIX C: LETTER FROM COMMITTEE TO DPF MEMBERSHIP

November 27, 19&9

Dear DPF Members:

The DPF, in response to extensive discussions last summer within the high energy community of the desirability of encouraging more theoretical research in areas which have close connection with ongoing and/or future experiments, decided to set up a committee to look at this question. I have been asked to Chair this Committee, which is composed of T. Appelquist, E. Berger, R. Carlitz, J. Dorfan, E. Eichten, M. Einhorn, M.K. Gaillard, H. Georgi, P. Langacker, F. Paige, and M. Shochet. Our specific charge is to:

i) Identify the need for theoretical work in areas which have clear contact with experiment.
ii) Suggest mechanisms by which theoretical research of this kind might be fostered.

Concerning the second point, the Committee was asked, particularly, to recommend whether the creation of a National Center for Particle Theory (NCPT) or the enhancement of existing institutions - or both - would be the most appropriate action to take.

I am using the opportunity of this DPF newsletter to briefly report on our activities and preliminary findings. At its first meeting in Dallas in early October, the Committee decided that it would be useful to solicit the opinion of a broad spectrum of high energy physicists on these matters. As a result, a letter and a questionnaire was sent to (most of) the DoE and NSF Principal Investigators in both theory and experiment. The Committee was very gratified by the nearly 100 letters it received back from this select group, and spent a great deal of its recent meeting at Fermi lab analyzing these responses. As a further means of gathering community input, the Committee also held an open meeting on November 20th at Fermilab, which was reasonably well attended.

From these activities, and as a result of our own discussions within the Committee, we have arrived at some preliminary perceptions on our charge. The following three points received broad resonance both within the Committee, as well as with the physicists we polled:

i) There is a wide consensus that theoretical research in areas which have clear contact with experiment does need to be encouraged. A number of suggestions have been made and are under consideration.
ii) Of all the things that can be done, student training in particle physics - **along** lines that stress the interconnection of theory and experiment - needs much more emphasis, as young people are the key to future progress in the field.
iii) Although some were in favor, the majority of the respondents and of the Committee, for a variety of reasons, did not support the creation of a National Center for Particle Theory in an era of stringent budgets and at a time when a new National Laboratory was coming into being. There was also widespread skepticism

that such an institution, at least as a free-standing entity, was the best method of effectively addressing the myriad problems involved in stimulating relevant research and attracting students to particle theory.

Having reached these initial conclusions, it is clear that considerable further reflection will be needed before we can arrive at a set of recommendations which, if acted upon, might benefit our discipline. The Committee is presently studying a broad range of possible action items but still feels it could benefit by further community input. Thus they would like to solicit the DPF membership for their suggestions especially concerning the first two points above, as well as comments on the third point. In addition, the Committee would be grateful for the membership's opinion on those areas of theoretical work which need more attention and/or might be usefully pursued in the future. These suggestions can be mailed directly to me [R.D. Peccei, Physics Dept., UCLA, 405 Hilgard Ave., Los Angeles, CA 90024-1547] or sent via Bitnet [Peccei@uclahep or egolchm@uclamvs.bitnet] or FAX [213-206-0864]. If you prefer, you can communicate with the Committee as a whole via bitnet (DPFCOM@PITTVMS). If it is possible -but the present schedule is already overcrowded - we shall also try to schedule another open meeting of the Committee at the Rice meeting.

We plan to make a preliminary presentation of our recommendations to the DPF Executive Committee in January. We aim to have a final report, which we hope to widely distribute, ready by March 1.

Sincerely yours,

Roberto Peccei

APPENDIX D: LIST OF LARGE-SCALE PROJECTS

The following is a representative list of topics which could benefit from systematic and ongoing theoretical analysis:

(1) Structure functions: the advent of large hadron colliders accentuates the need for a systematic project to develop standardized structure function programs that are reliable and accurate over a wide kinematic range. This would have to incorporate all data relevant to structure functions (regularly updated and including the propagation of the uncertainties in the data) as well as the best possible QCD-derived theoretical expressions.

(2) Fragmentation: the development of realistic Monte Carlos for the description of jet fragmentation, incorporating all relevant theory and experiment, are essential for the interpretation of almost all high energy experiments.

(3) Systematic calculations of all relevant hard processes involving quarks and gluons, at least through order-α_s

(4) Jet Physics, theory and phenomenology: this involves the combination of the results of (1), (2), and (3) above for the full description of jet physics. The goals are to predict observables, compare the predictions with data, and apply the results to QCD tests, tests of electroweak and other standard model physics, and to searches for new physics.

(5) Detailed calculations of QCD backgrounds for top quarks, supersymmetry, etc.

(6) Spin physics: A systematic evaluation of single and double spin asymmetries at the partonic level is needed to identify the best experimental approaches to the structure functions of polarized hadrons. Such information is essential for the intelligent evaluation of polarization options at new accelerator facilities.

(7) Resumming large logarithms in QCD: As the energy of hadronic colliders increases, the domain in which perturbative QCD analyses may sensibly be applied also increases. To exploit this fact it is necessary to develop techniques for resumming the large logarithms that occur in such perturbative calculations. This will allow one to extend QCD predictions to regions of small longitudinal or transverse momentum fractions and thereby compute the bulk of the hadronic cross section at new colliders.

(8) Electroweak radiative corrections: the interpretation of high precision electroweak experiments requires systematic calculations of the radiative corrections for all experiments using a consistent renormalization scheme.

(9) Global analyses of neutral current data: the full interpretation of neutral current and weak boson data requires global analyses making use of all of the data, full radiative corrections, and a consistent theoretical framework.

(10) Global analyses of charged current data: systematic global analyses of the neutral kaon system, B meson oscillations and decays, CP violation, etc., are needed to determine the structure of the quark mixing matrix, constrain the top quark, and test the standard model.

(11) Hadronic matrix elements of weak currents: the interpretation of the weak decays of hadrons (especially in the B system) will require considerably more theoretical and phenomenological effort in the calculation of relevant matrix elements. This includes but is not restricted to the results of lattice QCD simulations.

(12) Systematic studies of supersymmetry - theory and phenomenology: the many possibilities for the pattern of masses and couplings in broken supersymmetry complicate the search for supersymmetry. Systematic analyses of the possible patterns, their experimental signatures, and their relation to current theoretical ideas are necessary.