USERS AND BUILDERS

W. K. H. Panofsky*
Stanford Linear Accelerator Center
Stanford University, Stanford, California

When I had the pleasure of visiting the Cosmotron at Brookhaven in 1956 I took some statistics on the conversations in the hall. I found that 10 per cent was small talk, 25 per cent was about physics, and 65 per cent was about scheduling. These percentages give an indication that even at that time the social problems of high-energy physics appeared to take precedence over the subject itself, and indications are that this situation is getting worse. If a recent brochure advertising a particular choice of location of the next large accelerator is any indication, then the general discussions in a high-energy laboratory of 1980 will be 10 per cent small talk, 10 per cent physics, 70 per cent skiing and fishing, and 10 per cent as to the best way out to go home!

To be more serious, all these discussions which are becoming so prominent in relation to high-energy accelerators have to do with two basic problems: the first is the question of how to allocate the resources of a national laboratory--particularly running time--to competing scientific users. Since in the foreseeable future the demand for running time will exceed the supply, this problem will stay with us. Most of the administrative arrangements, involving layers of committees, are an attempt to grope with the correct balance between reasonably significant experiments which are "sure to work," on the one hand, and the more speculative experiments which may be of more profound significance on the other. Whatever the mechanism of allocation may be, I can conceive of no arrangement so convincingly fair that an experimenter whose proposal has been rejected will say: "I guess you fellows were right all the time."

The second basic question, which is the topic of this talk, deals with relationships between accelerator builders and operators on the one hand, and the users on the other. Few people in this room are both users and builders; I am afraid that this particular breed of cats is becoming extinct. Ed McMillan, now Director of the Lawrence Radiation Lab, personally wired the control desk of the 37" Cyclotron; had he done this with the Bevatron, the unions would probably have gone out on strike, and the Bevatron would almost surely not have worked. I took some pride in having been a good operator of the 1-BeV electron linac at Stanford; I predict that in the future if I approach the Control Room of the two-mile Stanford Linear Accelerator the professional operators will throw a cordon around the controls to prevent me from pushing all the wrong buttons.

We have thus a situation where specialization is taking over, and the success of an accelerator's operation depends on working out effective cooperation among builders, operators, experimentalists, data reducers and theorists. It is essential that the contributions of each of the links in this chain be recognized so that the credit for a successful new scientific result does not go only to the successful experimentalist who happened to have access to an accelerator at an opportune and critical time.

To achieve public understanding of this proper distribution of credit, as well as to improve general comprehension of the methods and aims of high energy accelerator physics, better communication of the technical community with laymen is essential. This is not as difficult as you might think, as illustrated by the following slightly liberal quote from last week's hearings before the Joint Committee on Atomic Energy. One of the scientific witnesses was paraphrasing high energy scattering experiments in terms something like: "We consider the chance that one particle will bounce off the other in a certain direction." A California congressman replied, "Oh, you mean like angular variation of the scattering cross-section."

Why is the problem of establishing satisfactory user-builder relationships so difficult? The reason is that the two extreme solutions which might ordinarily come to mind will not work. At one extreme, we assume that in the future the community of "using" experimental physicists would establish requirements for the next high-energy accelerator and would secure Government financial support. The job would then be turned over to the "builders" who would construct the accelerator and continue to operate it as a service to the users. All of you know that this scheme wouldn't work for any number of reasons. In the first place, the building of a large accelerator is a creative enterprise, and--as documented by the papers given at this Conference--some very basic problems have to be attacked. Under the circumstances I have indicated, really good people would find it difficult to participate in advanced accelerator building, and also the continual give-and-take between particle physicists and applied accelerator people would not take place. It has been this close relationship between accelerator people and particle-research physicists which is largely responsible for the success and excitement of current high-energy physics.

The second reason is that the Government agencies responsible to the Congress for proper spending of Government money have good cause to be reluctant to authorize construction of a multi-hundred-million-dollar accelerator,

*Dinner Speaker.

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unless an experienced organization or institution is available and willing to manage the job. Ultimately, if accelerator building were to move further into a service function, then the user-builder relationship will become a consumer-supplier relationship. This would mean that the only way accelerators could be built is through commercial enterprise. As you know, this method does, in fact, work rather well for low-energy accelerators where the general characteristics of the desired machines are well established; but it surely would not work (or would at least be extremely expensive and speculative) if one talks about the pioneering accelerators of the future.

At times management of a complex technological project has been attempted for the benefit of users and under user control, but without having a responsible scientific institution actually do the work. In an example of this kind the mechanism for managing the project, in admittedly highly simplified form, is as follows: The basic scientific requirements for the project are established by a "Users Committee" formed for the purpose of advising the responsible Government agency. This agency in turn delegates the direct engineering responsibility to an industrial contractor not involved in the scientific program in any way. What is missing in this picture is the scientific institution which could combine under one roof the responsibility for overseeing the "building" of the project and its eventual scientific use. I believe few will disagree that this pattern is an example which should not be imitated in the construction of a large accelerator laboratory.

The other extreme of accelerator construction would be to make the builder the boss; that is, a laboratory is set up which first builds the accelerator and which then hires a scientific staff to become the primary users of the machine. This has often happened in the past, when the field was paced and therefore controlled by accelerator technology. This is no longer so: at present, accelerator designers cannot define a sharp limit beyond which the technology of an AGS or a linear accelerator could not be extended. Moreover, the theorists cannot identify a sharp energy threshold beyond which novel phenomena would no longer be expected, nor can experimentalists define a value of the energy beyond which experimentation would become too difficult. For these reasons, the energy of the next step in accelerator construction is determined in practice by a balance between the desires of the scientific users and economic requirements. As long as builders and users were frequently the same people, and as long as accelerators were being made available to almost all willing and able to build and to use them, there was little objection to the scheme in which a laboratory was managed solely for the benefit of its in-house staff. Since the high cost now limits the number of first-line accelerators, and since the scientific users are distributed over thirty or so institutions in the U.S., operation for the use by the staff of one single university is no longer defensible.

Neither of these extremes of operation--either a "service" laboratory under the control of outside users, or a laboratory operated entirely for the benefit of its "in-house" staff--is feasible today. Therefore, any future accelerator arrangement has to be a compromise between the extremes. It would be too optimistic to assume that even the best compromise will avoid arguments; we shall always have a tug-of-war among people in whose judgments the balance between those two solutions should be more one way or the other.

A further reason for the increased noise of the debate stems from the fact that high-energy physics becomes more difficult to carry out in the traditional academic pattern. High-energy physics is not alone in this respect; it just happens to be the first field of university science to pioneer in the application of the larger tools of research. However, many other university-based research fields are not far behind. In the face of increasing costs and a decreasing number of accelerators, each university must face the choice of whether to become a user of accelerators managed by somebody else, or else to share in the doubtful pleasure of managing an accelerator laboratory. Curiously enough, the majority of universities seem to prefer the latter solution.

I find that the controversy now centering around the management and location of the next step in high-energy accelerators--namely, the construction of a 200- to 300-BeV proton accelerator--is much less a regional argument than a debate as to the best compromise between the responsibility and authority of users versus builders. The builders object to the downgrading of their prestige in the creation of the next generation of accelerator facilities; whereas users, with notable and laudable exceptions, would like to have the maximum control over the program and the operation of the accelerators, but the minimum responsibility for carrying out the work. In my experience it has been difficult to involve the future users of accelerators during the period of construction of the facility. Most users prefer to wait in line for their turn on the running schedule of existing accelerators rather than to participate in the planning of general-purpose accelerator facilities, or even of their own experiments, before an accelerator has actually produced a beam. It is unfortunate that in the current debate about management schemes for future accelerators the only topics which seem to reach the public are the question of equitable access to the facility by future university users, and the question of the possible economic or prestige benefit of such an accelerator to a given region. In this debate the problem of the most efficient way to actually create an operating laboratory over a period as extensive as 10 years tends to be forgotten. I believe we have ample demonstration that there is very little correspondence between the management

scheme under which a laboratory operates and the way in which the user-builder or user-operator relations actually work out in practice. Each large laboratory tends to develop along lines peculiarly its own. As an example, the accelerator which has seen the largest involvement of users with the accelerator builders during the construction period has been the ZGS of the Argonne National Laboratory. Yet this is the laboratory which had been managed through a single university, but where there evolved a great deal of objection to single-university management.

A further question which has caused controversy in establishing the right balance in the user-builder relationship concerns the amount of service the Central Laboratory should provide to its users. Again, we can look at two extreme solutions, with the right answer presumably lying in between. On the one extreme, the Central Laboratory provides the accelerator, the facilities to use the beam, perhaps the bubble chamber, the data processing, the computing facilities, and a publication service. We might add to this sufficient automatic equipment so that the user simply has to specify which particle he wishes to have scattered on which other particle, and then THE PHYSICAL REVIEW article gets printed out automatically under the user's name. At the other extreme, the Laboratory provides only the accelerator, and the user has to bring in many truckloads of equipment for his own individual use which will have to be set up anew for each experiment.

Clearly, the actual practices will be somewhere between these two limits, and it is perhaps fortunate that the way this actually is done is different in each of the laboratories.

I hope that during this discussion I have illuminated some of the questions which appear to cloud constructive builder-user relations. Each of the questions has a common feature: the problems will not be solved by extreme, one-way solutions; these problems are a feature of a new era of experimentation using large shared instruments. On the one hand, the objectives and the fundamental interest are just as "academic" as they have always been in the past when large tools were not required; on the other hand, the technical necessities are such that traditional academic methods cannot be blindly continued. In order to solve these problems there is a clear need for the builders to understand the problems of the users, and the users, the problems of the builders. Only if this is achieved can one hope that the conversations in the hall of the 1980 laboratory will deal less with politics and more with science.