THE TRIUMPHS AND TRIBULATIONS OF THE ACCELERATOR BUILDER*

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Accelerator building is now entering the third era of its brief existence. Considering the phase just ahead, it has been difficult to decide whether to adopt a tone of pessimistic optimism, or of optimistic pessimism.

Accelerator building began with the era of the user-builder when Cockcroft and Walton founded our craft about 1930. This period lasted through the war and produced a large number of accelerators, of several different types. It was a triumphant era of real accomplishment — from the original Cockcroft-Walton to the 60-in. cyclotron in one decade was rapid advancement. The user-builder came directly from the physics laboratory with its tradition of fierce independence, and he was little accountable to anyone. Cash requirements for an early accelerator were very small, which was fortunate, because even a small amount of money was hard to obtain in the thirties. There was little orbit theory and design was largely a matter of skill and irtuition. The direct voltage accelerators and cyclotrons would work, unless done very badly, although any of you who have dealt with them know that it takes skill and sophistication to make them work well. The betatron was another matter. It would stubbornly refuse to work at all unless designed and constructed properly. By about 1941 the user-builders were approaching the limits of the early methods of organization and technology. This era was interrupted by the war. For a few years no new accelerators were built.

The second era of accelerator building, begun after the war, was characterized by the continuing search for higher energy and the availability of construction funds. The availability of funds was a political-economic mixture compounded of economic prosperity, the Bomb, and competition with the Russians. The press toward higher energy accompanied — or was accompanied by — two important factors. One was the development of an increasingly sophisticated dynamical theory of orbits and the other was the entrance of engineering. The paper of Kerst and Serber gave a simple method of thinking and visualization by expressing the betatron oscillation frequency in terms of the revolution frequency, and reducing the orbits to a problem in geometry. The McMillan-Veksler discovery of phase stability introduced control of the other two of the six phase-space dimensions. Engineers were introduced into accelerator building, a bit tentatively, at the Radiation Laboratory in Berkeley before the war. After the war engineers began to be seen in the projects in increasing numbers. Engineers had been about for a long time but during the war physicists were exposed to technology, industry and engineering as never before. The first rash of synchro-cyclotrons and electron synchrotrons was followed by the giant facilities. As the accelerator theorists developed advanced systems of orbits the engineers and physicists developed apparatus to confine the orbits and industry supplied the means to fabricate the apparatus on a large scale. The specialized profession of builder began to appear distinctly as the problems of design and organization of large projects multiplied and were painfully solved, or at least suppressed.

The lens properties of axially symmetric fields were discovered by Busch about 1926. Twenty-six years later Courant, Livingston, and Snyder published the alternating gradient focusing principle. With these two methods of focusing, or stability, in hand and with advances in technology the triumphs of the second era were attained. Large circular and linear machines have been constructed and operated with gratifying success. Our work during the last few years makes some important general principles evident: economic and technological limits on energy of accelerators set in before scientific or technical limits; the choice of high energy or high intensity has lost much of its technical significance because a high energy machine can be built with high intensity; engineering improvements on pulsed synchrotrons make feasible duty cycles which approach continuous, or dc, output; storage rings can expand and extend the application of both linear and circular accelerators; and not least, it has been demonstrated that a well-planned accelerator can carry on several experiments simultaneously, and that a laboratory can serve a national or international community of users. I believe that now we can build a vast facility with high energy and high intensity and great utility for experimentation.

We are now entering the third era, the "Era of Tribulations", in which our technical skills apparently exceed our political skills. During the first two eras a staff would gather on a site and ask for a project they earnestly wanted to build. Now in this era we have seen a project searching for a site and a staff. The ingredients of disaster are present in the 200-GeV project, and in the unlikely event that anyone believes disaster cannot happen, let him examine carefully the projects of the last two decades. But we have an individual and collective responsibility to see that the 200-GeV project goes well. The matter of self-interest is self evident. A bad project will affect every builder and every user in the country and even beyond the borders. That is too narrow a view. The search for knowledge and the satisfaction of accomplishment may be reasons enough for us, but they are not enough for the public and the politicians — the body politic. In the regions of the particles and of the subparticles there may be reservoirs of energy, or of technology. If something is there we need to know it, and if something is not there we need to

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know it. The status of the United States as an advanced and scientific nation is involved, and for the body politic particle physics is a gamble, but a gamble that must be taken.

There are some specific things we and others can do now. We, the builders, can be less parochial and clannish. We can improve our publication – I should say non-publication – situation. If we will write significant and interesting papers we can bring pressure on the Journals to publish them. Perhaps the major benefits of these conferences are the Proceedings. At present the various conference proceedings are the only journal the accelerator builder has – and they should be recognized as such. The internal reports are with us to stay. I intend to make a strenuous effort to catalog the internal reports and to put them on microfilm. One of the first requirements of the 200-GeV project library will be a collection of accelerator reports which are not published, not available for sale, and not catalogued.

We can meet the users half way, and since we can talk their language, we can insist that they reciprocate. It is obviously ridiculous for the builders and users to diverge or to compete. We must insist that we be representated on boards and committees. The users have insisted, and they are represented. One important example of our under representation is the (URAI) board of trustees of the Universities Research Association, Inc.

The new laboratory will be a national laboratory for users. Why should it not also be a national laboratory for builders? The knowledge and experience possessed by the thousand individuals here needs in some way to be transferred to the new laboratory. That knowledge is not private property; it is community property. The new laboratory should not be the private concern of a few; it should be the concern of the community. In the process of providing the new laboratory with our knowledge and our experience let us make it a national laboratory for the builders, and representing all the builders.