New York to Schenectady") to make a roughly consistent non-relativistic calculation along the above lines. Lamb and Kroll then made a relativistic calculation; as Lamb puts it, "we simply evaluated the expressions of Oppenheimer in 1930 allowing for the filled negative energy electron states". Their calculation could just as well have been made in the early 1930s, but there would have been no data to compare the result with, and no theoretician would have believed it. Even in Japan, Tomonaga had been striving to obtain finite results from quantum electrodynamics by the idea of compensation, introducing fields of unknown particles in such a way as to cancel the divergences obtained from the known interactions. However, he had realized the importance of covariant notations, and had developed methods of calculation; when news of the Lamb shift reached Japan, as a report in a weekly magazine, he was able to carry out at once the necessary relativistic calculations. In the end, it was the conservative theoreticians who proved to be correct, not the revolutionaries.

A large part of the symposium was concerned with the identification of Yukawa's meson. As Piccioni relates, a series of crucial experiments was necessary before it was realized that the penetrating particles observed in cosmic radiation did not have the strong interactions required by Yukawa. Marshak discusses the history of the two-meson hypothesis he and Bethe published in 1947 to resolve this discrepancy, namely that Yukawa's strongly-interacting meson is copiously produced in high-energy cosmic-ray interactions but decays to a lighter but weakly-interacting meson. In fact, the group of Powell and Occhialini at Bristol had already seen, and reported in *Nature* (May, 1947), the two-meson sequence $\pi^+ \rightarrow \mu^+$ in nuclear emulsion exposed to the cosmic radiation, although this was not known to Marshak at the time (June, 1947) when this idea first came to him. Communications were much slower in those days.

Brown and Hoddeson are to be congratulated on the success of their conference and on the unique contribution it has made to the history of particle physics. The recollections of the physicists involved come together in a most illuminating way, to give a vivid overview going beyond what any historian could deduce from the printed and manuscript evidence. At the time, and afterwards, probably no one had a clear picture of all that was going on. So this conference has put us further ahead, advancing our knowledge of the interrelationships of that era, providing source material for future historians and leading to a more global view of the early history of particle physics, even for those who took part in it. □

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Cybernetics in human affairs

Donald MacKay

Human Systems are Different.

By Geoffrey Vickers.

Harper & Row: 1983. Pp.188. Pbk £5.95, \$12.50.

THE publication of Norbert Wiener's *Cybernetics* in 1948 created ripples of interest right across the scientific spectrum and beyond. Although he did not coin the term (it was used by Ampère in 1838 to denote "the science of government"), Wiener was the first to popularize the idea that by analysing the flow of communication and control one could discern common scientific principles that applied equally to the self-regulation of steam engines and of human communities. In particular, one could identify in feedback loops common causes of instability and misregulation — though not always, alas, cure them.

Among those who recognized the relevance of cybernetic concepts to human affairs, none was better-balanced in his appreciation than Sir Geoffrey Vickers, who died in 1982 after a long life in the practice and analysis of administrative decision making. I first met his keen mind when reviewing a symposium on "Communication" in 1955, where for sheer intellectual quality his contribution stood out from all the rest. From then on he produced a remarkable series of books with such titles as *The Art of Judgment* (Chapman & Hall, 1965) and *Freedom in a Rocking Boat* (Penguin, 1970), in which he sought to elucidate key elements in the working of human systems, and to contrast human judgement with the type of calculation that can be mechanized in a computer.

In this his last book, published posthumously, Vickers has brought together some of his most penetrating insights into the nature of human systems and the special cybernetic problems they present. Systems are nets of relations sustained through time. Open systems, interdependent with their surroundings, can be kept in being only through mechanisms of self-regulation. The constraints of interdependence, however, set limits to the possibilities of organization, making it necessary to think in ecological terms as well as those of systems engineering if we are ever to understand the conditions for their stability. When we do this, according to Vickers, the crisis of our time appears in

● Routledge & Kegan Paul have issued in paperback John C. Eccles's *The Human Mystery: The Gifford Lectures of 1977-1978*. The book first appeared in 1979, published by Springer-Verlag, and was reviewed in *Nature* 282, 160. Price of the paperback is £5.95, \$10.95.

a new and ominous light. "The threats which face the world today", he claims, are all threats to the maintenance of systemic relations on which we depend. By a threat I mean that we are no longer maintaining these relations within tolerable limits and we have at present no means in sight for doing so [p.107].

Much of the book is devoted to spelling out the nature of the threats to stability thus identified, and the implications for our society. Technology, for example, has encouraged expectations of an increasing share for all.

Yet anyone familiar with the behaviour of systems should not need telling that they breed their own limitations and that ... the management of these limitations — not their evasion but their acceptance and management — is what politics will [soon] be all about [p.147].

Again, overemphasis on the value of equality has produced a mistrust of non-reciprocal relationships (parent/child, teacher/student, master/servant)

fatal to the effective performance of a role by either party and hence to the effective working of any organization, since all depends on the trust by each in the faithful role playing of all the others [p.84].

Himself no technologist, Vickers offers no formulae or heavy theoretical models, still less any easy recipes for the rescue of our human system. He strongly urges, however, that systemic thinking should be taught and practised in schools, so that young people might grow up knowing enough about feedback loops to take it for granted that constraints must be accepted as the price of enablements.

Human systems have become very difficult for human beings to maintain. They demand from whole populations levels of understanding and tolerance seldom before found even among the few [p.177].

There are two good reasons why we scientists in particular should read and ponder this book. The first is that it powerfully challenges the hopes placed in our profession by the dominant tradition of the past two centuries.

The ideology deriving from the Enlightenment ... has aspired to realize both liberty and equality ... by a self-regulating and self-exciting process, powered by technology and directed by human "reason". ... The contemporary outcome is the reverse of what the 19th century expected. An ever more scientific world was never less predictable. An ever more technological world was never less controllable [p.xxvii].

Secondly, if Vickers is right (or even if he is not) there is an obvious need for much more thinking along these lines by minds trained in the relevant sciences and ready for the frustrations of cross-disciplinary collaboration. If a few such are stirred to action by what he has written, we may all be the better for it. □

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