Lysenkoist statements in the literature of the three fields in the late 1940's and early and even middle 1950's. However, on the one hand, these statements seem to be rapidly disappearing from present-day writings, and on the other, there is no evidence that in the fields under discussion the statements were ever anything more than formal lip-service, without significant relation to concrete research and practice.

10. J. B. Watson, *Behaviorism* (Norton, New York, 1924).

Communication Satellites

The entirely reasonable point of view expressed in your news note "Space communications" [*Science* **133**, 1812 (1961)] elicited from a Bell System executive, J. R. Pierce, a quite misleading criticism [*Science* **134**, 527 (1961)].

It is misleading to say, as Pierce has on several occasions, that to stop to consider the issue of who should own and control communication satellites implies delay in achieving the technological triumph of an operative communication satellite system. Granted that speed is essential, it happens that public ownership of communication satellites is consistent with the earliest and most urgent use of such satellites—that for national defense. The Advent program (a synchronous, equatorial system) for the military is just such a project, built by private contractors for government ownership and control. Surely the less urgent civilian uses of communication satellites will not be delayed if a similar ultimate ownership and control situation is considered while the satellites are being perfected under private contract.

Pierce asks, "Must the very first satellite communication system connect us with all the underdeveloped countries, where internal communication itself is poor? How long should we wait to make sure that these will be included? Until the Russians have satellite communication first?" This is typical of the misleading arguments on this issue advanced by Pierce and his associates.

If the highest priority communication satellite system now under development in this country—*and also in the Soviet Union*—namely, the Advent system, proves operational, it will permit but not require interconnection between points in any countries of the world. This includes all the underdeveloped countries as well as the United States and countries in Western Europe where the transoceanic communication facilities are presently overburdened and inadequate. Unlike the low-altitude satellite system which Pierce favors,

however, the synchronous satellite system does measure up to the second policy "requirement" stated by President Kennedy in his remarks on national policy on communication satellites, 24 July 1961: "Make the system global in coverage so as to provide efficient communication service throughout the whole world as soon as technically feasible, including service where individual portions of the coverage are not profitable." It also fits the concluding sentence of that policy statement, in which the President expressed his desire that "development of this new technology to bring the farthest corner of the globe within reach by voice and visual communication, fairly and equitably available for use, proceed with all possible promptness."

As against this, the low-altitude system which Pierce is developing is suited to a *limited* service. Because of their low altitude, between 40 and 50 satellites would be needed to link *by pairs* the major communication centers of the world. Because of the rapid revolution of these satellites around the earth, expensive tracking and movable-antenna equipment, in duplicate or triplicate, would be needed at each of the ground stations. The rigid barrier to multilateral global use of communication satellites which this Bell System plan would impose is evident from testimony by Herbert Trotter. He points out that with the low-altitude system, if each of only ten surface points were to be equipped to communicate *directly* with the other nine, more than 400 satellites and at least 180 large moving antennas and associated tracking equipment would be required.

Pierce, both in his letter in *Science* and in his article in the May issue of the *Bulletin of the Atomic Scientists*, tries to give the impression that technology gives a mandate to the Bell System to which the economic and political institutions of our world should render dutiful obeisance. "Non-technical obstacles," "political monsters," and the like lead to "embroilment" of scientists in "windy, empty, but terribly dangerous debate."

Thirty-five Congressmen, however, in their letter to the President of 24 August, have undercut this rather arrogant position. Noting that a number of different types of communication satellite systems are now in the research and development stage, they observe that we do not know which system can be put into use first or which will be most efficient. Given this technological uncertainty, the complicated issue of ownership and control is even more uncertain. Prudence, they urge, requires a further investigation of the broadest aspects of the ownership question. They support the conditions set forth in the Presidential policy statement and condemn the Federal Communications Commission's efforts to create a consortium, dominated by the Bell System, as "contrary to the policy established by you . . . [and] contrary to the principles of the antitrust laws." They request that no decisions concerning ultimate control be made until the entire system becomes fully operational. And they propose that during the interim, while all possible speed is made on research and development contracts, all possible questions of international agreement, cooperation, control, and ownership related to other nations and the United Nations be thoroughly explored. This proposal would seem to make good sense to anyone not blinded by the interests of private privilege.

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In the letter on which Dallas W. Smythe comments I criticized what seemed to me to be a rather misleading account of the satellite situation. Since Smythe has raised somewhat broader issues, I think it only fair that in reply I should state my views (which are not necessarily those of other Bell System employees).

The first step in satellite communication should be to meet real and pressing human needs by providing more circuits between our own country and other countries which have highly developed communication systems. An extension to less technologically advanced countries could follow quickly with either high or low satellites, despite the peculiar figures ascribed to Herbert Trotter, which are misleading if nothing else. Today, by means of Bell System and cooperating foreign facilities, you can call over 160 different political areas, and it seems to me ridiculous to believe that the Bell System would abandon this policy of widespread telephone communication if it were allowed to use satellites as well as cables and short-wave radio.

I favor any sort of satellite that can provide useful, practical communication first. We still have much to learn, and we may learn a great deal, not only through Advent but also through

NASA's Relay and Syncom satellites and the Bell System's Telstar I satellite, all to be launched in 1962. Certainly we'll have synchronous satellites, but lower-altitude satellites may come sooner, and according to W. Meckling [*Science* **133**, 1885 (1961)] they may even be more economical.

In regard to the use of satellites, the Bell System finds itself in a novel and peculiar position. In the past the Bell System has been able to use any new science and technology that would give better and cheaper communication. Sometimes the science and technology have been of Bell System origin (for example, the transistor and the negative-feedback amplifier) and sometimes of outside origin (the triode and the traveling-wave tube). In this way the communication provided by the Bell System has steadily improved, through such advances as automatic switching, multiplex transmission, coaxial cable, microwave radio relay, long- and short-wave transoceanic radio, and submarine telephone cables. It seems to me that it would be very unfortunate if the Bell System, which has shown itself very effective in improving communication through new science and technology, should be denied *any* new science and technology that could be used to improve its service, and I include the science and technology of space. I believe that thinking of a particular area such as space as in some way set apart from the rest of science and technology is wrong and a bar to progress.

The uncertainty as to whether or not telephone systems, here and abroad, will be allowed to incorporate satellites as well as short-wave radio and transoceanic cables into their pattern of international communication will, if it persists, discourage research and development of satellite communication by those most skilled in the art. And, if those who now provide international communication are not allowed to operate satellite communication systems, who will? I find it hard to believe that an entirely new organization, whether under the control of the United Nations or the Government of the United States (would the latter be acceptable to other nations?), can be brought quickly and harmoniously into operation. But perhaps 35 Congressmen can work miracles that are beyond the understanding of this one somewhat bewildered engineer.

J. R. PIERCE

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