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Sensors Aloft

"The greatest invention of the nineteenth century was the invention of the method of invention. . . . One element in the method is just the discovery of how to set about bridging the gap between the scientific ideas, and the ultimate product."

We know of no better illustration of the validity of Whitehead's statements (quoted above from *Science in the Modern World*) than that offered by the development of instruments to explore outer space. With satellites in orbit and the recent spectacular flight of the Pioneer in mind, it is hard to realize that the decision to attempt such launchings during the International Geophysical Year was made at a conference in Rome as recently as 1954 and that detailed plans for going ahead with a space program in this country were not formulated till 1955.

The designers of the satellites were faced with novel problems of propulsion, guidance, and communication. They had to design instruments to withstand rapid acceleration, wide temperature fluctuations, and periodic and random vibrations as well as unknown environmental variations. Moreover, the instruments had to be unprecedentedly light in weight. Rocket experiments, begun in a systematic way in 1946, had laid the groundwork for instrument design and had shown what kind of information about temperature, radiation, magnetic fields, and so on, might be procured by satellites, but these experiments had not been severely limited by the problem of weight. A rocket could carry 40 pounds or more of instruments into the upper atmosphere for a single experiment which might last only a few minutes. The satellite designers, on the other hand, had to plan to reduce the weight of the instruments to a few pounds at most and to provide enough power for them to operate for weeks rather than for minutes. They had to work against a severe time limit and had to have a superb confidence in their ability to bridge "the gap between scientific ideas, and the ultimate product." A choice had to be made, for example, between designing a transmitter with radio tubes or with transistors. The designers were certain at that time that tubes would give enough power, but uncertain about the performance of transistors. But transistors would be both lighter and more rugged than tubes, so they gambled upon their ability to improve them in time to meet the need. A similar choice had to be made between batteries and solar energy converters. In this case the Vanguard planners made a conservative choice and selected batteries for the first experiments, because unsolved problems of solar converters seemed to make their use too great a gamble. As an indication of the rapid progress in instrument design, a satellite now in orbit, the experimental Vanguard, which was launched last March, still faithfully transmits signals whenever it moves out of the earth's shadow and into the brilliant sunshine of interplanetary space. Had it depended upon storage batteries rather than solar energy for power, its voice would have long since been stilled.

The miles of magnetic tape now accumulating testify to the spectacular success of the designers in developing light-weight, rugged instrument systems for satellites and the moon probe. The whole point of the effort is of course to get sensing elements (or sensors, in the language of the space engineers) into space and to hook them to amplifying and transmitting systems that will get messages back to earth in an interpretable form. Already, as any attentive reader of the popular press knows, much has been discovered about the earth's magnetic field, ultraviolet radiation, the radiation belt of intense x-rays, and so on.

With the flight of the Pioneer more than one-fourth of the way to the moon, the second year of the Space Age is off to a promising start. Who can doubt that improvement in rocketry and instrumentation will lead to the further and further extension of man's knowledge of the universe?—G.DuS.