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Chapter 13

Origins of the MOUSE Proposal*

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The concept of MOUSE [Minimum Orbital Unmanned Satellite of the Earth] seemed a natural outgrowth of high-altitude research using rockets, which began in 1946 at White Sands, New Mexico, with captured German V-2 rockets. The initial MOUSE design, as published in the *Journal of the British Interplanetary Society* in 1952, just forty years ago, visualized a spin-stabilized basketball-sized satellite carrying miniaturized instrumentation. The invention of the Bell Labs solar photovoltaic battery, in 1954, gave great impetus to the concept by solving the problem of a lightweight power supply. Still, the idea seemed strange to a public that believed in space travel, and in huge manned space stations, as described then in popular magazines. Many investigations followed from the MOUSE design, including the first calculations of orbital lifetime and of equilibrium temperature.

To me, the most gratifying outcome was the TIROS weather satellite, whose design incorporated many of the MOUSE features. I had the good fortune

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to be appointed, in 1962, to direct the conversion of TIROS into the U.S. operational meteorological system for weather forecasting and Earth observations.

Rocket Experiments

What we call space research had its origin in experiments carried in high altitude rockets. This "high altitude research" program started in 1946, in the United States, using captured V-2 rockets. Several groups prepared experiments, which were then launched at White Sands, New Mexico. My group was from the Applied Physics Laboratory (APL) of Johns Hopkins University, led at that time by a triumvirate of physicists: James Van Allen, Howard Tatel, and Richard Peterson. Their main goal was to measure the flux and other properties of primary cosmic radiation.

By 1948, other experiments were added. John Hopfield measured the vertical distribution of ozone, making use of its absorption of solar ultraviolet radiation. I became involved, also, in measuring magnetic field changes in the ionosphere, as indicators of electric currents flowing there. Jesse Greenstein of Cal Tech attempted to measure the solar spectrum at very short wavelengths. All of these experiments required that the instruments be carried to high altitudes, or at least above the absorbing atmosphere.

By 1950, our group had completed a latitude survey of primary cosmic rays, from the geomagnetic equator off the coast of Peru up to high latitudes in the Gulf of Alaska. These shipboard launches employed a much smaller rocket, the American-built Aerobee, which put a great premium on building lightweight instruments. From these measurements we were able to deduce the energy distribution of the primary radiation, using the Earth's magnetic field as a kind of magnetic spectrometer.

In the 1949 equatorial measurements, using a specially modified magnetometer mounted in an Aerobee rocket, we discovered the existence of a highly concentrated electric current in the lower ionosphere—the "equatorial electrojet."

Early Satellite Ideas

By 1950, after four years of intensive rocket experiments, one thing had become evident: we would lose the instrumentation every time the rocket impacted on the surface, and would then have to rebuild and retest a new package—a backbreaking job that consumed many evenings and weekends. Even the best rocket flights gave us only a few minutes of observations of cosmic rays above the atmosphere, not really enough time for anything but crude counting experiments. More sophisticated experiments would have required better statistics and, therefore, longer exposure times.

The idea of using a satellite to carry cosmic-ray instruments, and to gather data for truly long periods of time came in response to a request for a speech. By the fall of 1950, I was in London as a scientific liaison-officer, attached to the Office of Naval Research, London. Members of the British Interplanetary Society approached me about giving a talk on our rocket experiments, and to perhaps write a paper for the *Journal of the British Interplanetary Society*. The initial contacts involved Arthur Clarke, Val Cleaver, Les Shepherd and Len Carter. By then, having been wined and dined at the Players Club in London, I readily agreed to not only give a talk, but also to write a paper for the *Journal of the British Interplanetary Society*.

In preparing the talk, and in considering the audience, I thought it essential to mention, also, the possible use of artificial Earth satellites, as they were then referred to. I had, of course, been exposed to the concept of satellites by reading the popular press, but I had never made a study of the subject. In fact, I was quite put off by what I had read, particularly by the series on space stations, published in *Colliers* magazine. While I couldn't deny the scientific possibility of constructing such manned space stations, they seemed to me to have no purpose, and to represent a waste of resources. I have since changed my mind, but more of that later.

The lecture to the BIS was a smashing success, and the idea of putting miniature instruments into a miniature satellite weighing less than 100 pounds was well received. My years of rocket work had made me an expert on miniature instrumentation. I had, of course, sized the satellite to match what I was then aware of in terms of launchability. The main idea was that even such a minimal satellite could carry on worthwhile experiments. Anyway—and I don't remember all the details—I ended up with an acronym: MOUSE—a Minimum Orbital Unmanned Satellite of the Earth. The word "unmanned" was important, because it was a relatively new concept.

The great breakthrough in the development of the concept of small instrumented satellites was the 1954 symposium organized at the Hayden Planetarium in New York City by Arthur Clarke. It brought together, for the first time, a number of people who were seriously interested in instrumented, unmanned satellites, rather than the manned space station concept. It was at this symposium where I first met Dr. Harry Wexler, chief scientist of the U.S. Weather Bureau. His presentation on cloud observations from satellites made a great impression on me, and I resolved to include such studies into the MOUSE design. Years later, in 1961, it was Harry Wexler who engineered my appointment as the first director of the U.S. Weather Bureau's program on operational meteorological satellites.

Following the Hayden Symposium, I began to write detailed papers about scientific applications for a MOUSE satellite. Since the available propulsion seemed inadequate to boost such a satellite into an orbit much beyond 300 kilometers, it became important to study the lifetime of satellites as limited by atmospheric drag. Reversing this idea, I published not only on lifetime, but also on how to use the decay of the orbit to measure atmospheric densities in the Earth's exosphere. Another paper had to do with the equilibrium temperature of a satellite, taking into account the influence of outgoing Earth radiation on the satellite's radiation balance. From there it was but a small step to designing an instrument to measure back-scattered UV radiation to determine the distribution of ozone in the Earth's atmosphere—the SBUV/TOMS scheme now used by the Nimbus satellite.

But most of the papers dealt with scientific applications, some two dozen of these. In a review article, published in the 1956 volume of *Advances in Geophysics* (Academic Press, New York), I discussed satellite measurements of gravity, magnetic fields, ionospheric currents, ionospheric electron densities and radio wave propagation, atmospheric drag due to the exosphere and charged drag due to ions, and many more. The proposed measurements even included trapped particles in the Earth's magnetosphere and their role in magnetic storms. Trapped particles were observed two years later in the Explorer I satellite by James Van Allen.

In the meantime, the MOUSE concept had gotten some exposure in *Life* magazine and other popular publications. This forced me to think out the physical design of the satellite in more detail. I had decided on a sun-synchronous orbit as being useful for many applications. I planned to use spin stabilization and attitude control by magnetic torquing. Taking advantage of the spin, optical observations were made by scanning instruments.

By a fortunate coincidence, the Bell Telephone Laboratories had just developed the first solar batteries, reasonably efficient photovoltaic cells. Through the efforts of John Pierce of BTL, I was able to get one of the first sets of PV cells in 1954, and I used them in a model of the MOUSE which I was then building. This model is now in the National Air and Space Museum of the Smithsonian Institution.

By 1955, the concept of small instrumented satellites was gaining support and being taken seriously. President Dwight Eisenhower made a proclamation, announcing the intention of the United States to launch such satellites during the International Geophysical Year of 1957-58. Already in 1954, two major international organizations had passed resolutions favoring the launch of such satellites during the IGY. I had drafted these resolutions and advocated their passage, with the strong support of Lloyd Berkner and Athelstan Spilhaus, at the URSI (International Scientific Radio Union) in the Hague and at the IUGG (International Union of Geodesy and Geophysics) in Rome. There were opponents as well as supporters; among the latter was Joseph Kaplan, head of the U.S. IGY effort, who labeled satellites "long-playing rockets."

Things started to move faster when Wernher von Braun became actively involved in the small satellite program, and he proposed to use the Redstone/Jupiter rocket for Project Orbiter. It was Fred Durant and Commander George Hoover of the Office of Naval Research who brought us together. I was pleased to see that von Braun was not irrevocably wedded to the manned space station concept, but that he was quick to grasp that, with interesting scientific applications and with the help of the IGY science community, he would be able to advance Project Orbiter.

Unfortunately, there developed great rivalries between the U.S. Navy and the Army. The Navy had persuaded General Eisenhower that the U.S. should not use the military Jupiter rocket to launch satellites, but instead to develop the Vanguard as a successor to the Viking high-altitude research rocket of the Naval Research Lab. These rivalries also spread to the respective scientific communities, and they were carried over into the newly created National Aeronautics and Space Administration, which was initially staffed by NRL personnel.

Things began to move at top speed after the Russian Sputnik went into orbit in October 1957. Even though the United States lagged behind initially, and many of its satellites failed to reach orbit, there were some notable successes: the discovery of belts of magnetically trapped radiation in 1958, and the launch of the first weather satellite, TIROS, on April 1, 1960. Only two years later, by June 1962, I became the first director of the operational metsat office, later called the National Weather Satellite Center of the U.S. Weather Bureau—and now NESDIS of NOAA, the National Oceanographic and Atmospheric Administration.

We chose TIROS to become the prototype of the first operational series: it was simple, cheap, a spin-stabilized, magnetically torqued satellite, and in many ways a direct successor to the MOUSE concept.