Appendix H
First Radar Echoes from an Artificial Satellite

In the flurry of curiosity and interest following the orbiting of Sputnik, SRI radio researchers became probably the first people outside the Soviet Union to make radar contact with an artificial satellite. The initial part of this account is taken directly from SRI Staff Notes, October 1957. The article (shown in italics) gives a flavor of SRI's reaction to the event, but because of several inaccuracies, a number of edits are interspersed in brackets. The main purpose for including this story is its reflection on the natural and competent curiosity of SRI staff and how that curiosity leads them into purely voluntary and collaborative explorations.[1]

> *Special Techniques Group Tracks Sputnik with Radar*
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> *Staff members from the Radio Systems Laboratory are picking up and recording the radio signals from the Russian, man-made satellite at regular intervals. This, of course, is no longer news. However, the enthusiasm with which staff members attacked the problem of tracking down the satellite is worthy of comment.*
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> *The satellite's first pass was observed and recorded at the SRI field site on Friday, October 4, at 7 p.m. Engineers working under Dr. Allen Peterson, head of the Communication and Special Techniques Groups, set up radio-receiving and direction-finding equipment and went to work plotting the orbit and recording the transmitted "beep" signal.*
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> *The reaction of the press was immediate, and, soon, staff members were besieged with calls. Working voluntarily on an around-the-clock basis, sleeping in between passes, the engineers from the Radio Systems Laboratory have been maintaining a constant vigil on "Sputnik." Lambert Dolphin, Ray Leadabrand, Ray Vincent, Bud Rorden, Rolf Dyce, Bob Rach, Roy Long, Ed Post, and other volunteers from the Engineering Division took turns at various operations.*[2] *Hurriedly assembled, functional equipment (including an "analogue computer" made from a globe, scotch tape, string, and a wire coat hanger) was put into play and, as Ray Vincent said, "A crude but very effective 'analog computer' resulted which was instrumental in establishing the orbit."* [With only a rough idea of the satellite's velocity and altitude (it was in an elliptical orbit), the early Doppler and directional data from the satellite's transmission gave imprecise satellite locations. But using orbital mechanics and slide rules the orbit was iteratively refined. The globe mentioned was merely a convenient but coarse three-dimensional plotting surface on which the satellite's inclination and orbital tracks could easily be visualized.]
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> *The activity up on the hill behind Stanford is now a fairly well coordinated operation. A few minutes before a "pass" staff members take their places. The radio direction finder is put into play and the operator reads observed bearings to a recording secretary at 10- to 15-second intervals. The recording equipment, tuned to the transmitting frequencies of the satellite, goes into action. Instruments scan, compute and record. Prior to this activity, the orbit has been accurately plotted on a giant plastic globe. Changes are made, new orbits are computed and, all the while, different voices are passing and periodically shouting instructions and observations which are plotted and fed to the computing center in the SRI bus, where Professor Leland E. Cunningham of the University of California works at orbit computation.* [Prof. Cunningham was actually in U.C.

[1] The refinement of the story came from email correspondence from three of the SRI participants, Ray Leadabrand (May 31, 2004), Bud Rorden (May 31, 2004), and Roy Long (June 2, 2004) and from a phone conversation with Walter Jaye on June 25, 2004.

[2] Among the other SRI staff members not mentioned in the article but who were part of the vigilant group included Walter Jaye, Frank Firth, Loren Dye, Ron Presnell, Myles Berg, Ron Panton, Ralph Evans, and Howard Zeidler.

Berkeley trying to get the software of his new IBM 704 to work and didn't apparently contribute to the early calculations, which were all done by hand.] *Many persons outside the Institute have provided valuable assistance in their activity. Members from the Propagation Lab at Stanford University have coordinated their efforts with those of the SRI staff.* [Don Weaver, a colleague at Montana State in Bozeman was measuring the same things, thus helping to pinpoint the orbit. Another site with whom SRI was in contact was MIT's Millstone Hill radar. SRI was one of perhaps only four sites outside the USSR that would have been able to get a radar return from Sputnik.]

A few hundred feet away, SRI's radar van, loaded with transmitting, receiving, and recording equipment, is also a beehive of activity as the radarscopes are scanned for echoes from the satellite. "She's coming in loud and clear," someone shouts. A few minutes of concentrated activity ensue, then quietness settles over the group as "Sputnik" fades into space.

Data taken to the SRI bus, which has been pressed into service as a temporary computing center and dormitory, are analyzed. Computations are made by other volunteers who predict the time and location of the next "pass." The crew then relaxes, provided equipment adjustments or changes are not required. They sit around and sip coffee and discuss the next "pass." A few may try to catnap, but, within the hour, the satellite will be zooming in from somewhere over the Pacific. So, peaceful sleep is out of the question.

Comments

The caption on an illustration from the above-referenced Staff Notes indicates that the dish antenna had but a 12° beamwidth and thus, with the satellite traveling about 18,000 mph at an altitude of 300 miles, it would be in the beam for only about 12 seconds. While the radar apparently had the degrees of freedom to track planetary objects, it could not be programmed to do so. This meant that the dish had to be prepositioned from estimated orbital data and then the satellite's distance and rough direction would be verified when it passed through the dish's beam. A short note in the November 1957 *Proceedings of the IRE* (Institute of Radio Engineers) by Allen Peterson describes the equipment set-up and data types in detail. The SRI radar dish was a 61-ft parabolic reflector. The procedure was to first learn Sputnik's orbit from Doppler and direction finding equipment, then predict when it would over-fly the Stanford field site, and finally position the dish so that the satellite would intersect its beam. Radar echoes were obtained when the 2-ft diameter satellite came within 700 miles of the site.

The SRI group was taking the above data on the satellite's signal approximately four hours after the Russians, at about 6 pm EST on October 4, announced it was in orbit. Promotional material on SRI's radar facilities indicated that the first radar returns were obtained 2 days after the launch. But the IRE paper states that the two radar returns detected on the morning of October 9 were from what was likely co-orbiting rocket staging equipment. Then, on the morning of October 10, 1957, a radar return from the satellite itself was obtained. According to Walter Jaye, the MIT Millstone Hill radar was down for maintenance at the time and therefore, in all likelihood, these self-initiated efforts resulted in the first such radar contacts with an artificial satellite, at least outside the USSR.[3,4]

The sheer existence of Sputnik brought a rapid change in the military posture and preparedness of the U.S., particularly the importance of space-directed radar systems. Radar programs that were on the verge of cancellation were hastily renewed, including some at SRI, and SRI was immediately given a contract from the Air Force to develop ways to more accurately track these new heavenly bodies.

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[3] Walter Jaye, personal communication, June 24, 2004.

[4] There is indication that the Millstone Hill radar was manually directed to also get skin reflections from Sputnik "within a few days" of Sputnik's injection. (*MIT Lincoln Laboratory–Technology in the National Interest*, edited by Eva G. Freeman, published by Lincoln Lab, 1995, pp. 111–112)