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ABSTRACT

The Amateur Radio Satellite Communications project had, as its goal, the assembly of an amateur radio satellite station in a high school physics classroom. Specific objectives were to provide: (1) a special source of interest as a motivator for attracting students and building public relations; (2) a center of interest as a motivator for the study of orbital mechanics, electronics, and space communications; (3) a model for accomplishment of a technical objective that utilizes many student skills; (4) a class project that would involve teams of students working to accomplish an objective; (5) future class or individual research projects; and (6) motivation for students to earn an FCC Amateur Radio license. These principal objectives were met. The station was successfully assembled with student involvement. Students are currently involved in some additional projects and the satellite station is serving as an ongoing source of interest and examples for specific topics in physics. It appears to be one of several factors attracting students to physics and to amateur radio. (JN)

AMATEUR RADIO SATELLITE COMMUNICATIONS

by

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1986

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(Submitted in partial fulfillment of requirements for the High School Grant program)

The Amateur Radio Satellite Communications project had, as its goal, the assembly of an amateur radio satellite station in my high school physics classroom. Specific objectives were:

1. To provide a special source of interest as a motivator for attracting pupils and building public relations.
2. To provide a center of interest as a motivator for the study of orbital mechanics, electronics, and space communications.
3. To provide a model for accomplishment of a technical objective that utilizes many pupil skills.
4. To provide a class project that will involve teams of pupils working together to accomplish an objective.
5. To provide future class or individual research topics.
6. To provide motivation for pupils to earn an FCC Amateur Radio license.

The radio station was designed to utilize the OSCAR 10 amateur radio satellite that is in a high altitude (4000 to 35000 km) orbit of approximately 0.59 eccentricity. The satellite moves relatively slowly near apogee. Therefore, we would not have to use azimuth and elevation rotators to track the satellite near apogee. A transponder on OSCAR 10 receives signals on the 435 MHz amateur band and retransmits them on the 145 MHz band. Two antennas were required.

A helical antenna design was chosen for two reasons. First was the relative ease with which the required circular polarization could be achieved. Second was the greater tolerance in construction permitted by that design compared to others.

On 19 March 1985 construction was begun on the 435 MHz uplink antenna (slides 1, 2, 3, 4, 6, 7, 9). On 29 April 1985 a tripod that allowed both azimuth and elevation rotation was completed (slides 10, 11). A frame for the 145 MHz antenna was completed on May 13th (slide 12). As the size was unmanageable by the previously constructed tripod, the helical design for the downlink antenna was abandoned in favor of a five-element quad design. Although the circular polarity is lacking in this antenna, it does not seem to pose much of a problem in reception.

During July 1985 I assembled the components of the antenna at my home (slides 14, 15, 16). During August the Space Shuttle Challenger was in orbit with astronaut Dr. Tony England, WØORE aboard. On orbit 84, between Ø251 and Ø259 UTC, August 3, we made voice contact with Dr. England aboard Challenger using our pupil-constructed 145 MHz antenna system (slide 18).

Prof. Richard Emmons had previously written a calculation program for a Commodore computer to predict the geocentric latitude and longitude of satellites. I added calculations for the azimuth and elevation angles, slant-range, phase, and a map to give us a program for our Atari computers that would aid us in aiming the antennas (slides 19, 2Ø, 21, 22, 23).

On September 8, 1985 a Ten-Tec Satellite Station was purchased. Unfortunately, a problem with the output stage, coupled with a malfunction of the Service Center's power output meter led to a two-month delay before we could make use of the station. Meanwhile, a receiver preamplifier, a power supply, and a 435 MHz amplifier were purchased using funds ($35Ø) donated by the Canton Amateur Radio Club (slides 24, 26, 26, 27, 28, 29, 3Ø). Finally, on November 14, 1985 we made our first OSCAR 1Ø contact during the first-period physics class. The contact was made with a radio amateur in Livermore, CA, WB6SYE. Since that time, contacts have been made from the Isle of Wight and Germany to Hawaii (with Katashi Nose). On December 19th the GaAsFET transistor in the receiver preamplifier failed. I was able to replace it on January 1Øth, and we plan to mount it at the antenna within a week or so.

Some possible pupil projects are measurement of the half-power beamwidth of the antennas, and construction of a UHF dummy load. Other projects or exercises may include Doppler shift measurements of the OSCAR or UOSAT satellites to determine period, approximate slant-range, position, and velocity. The satellites have been used as examples in the study of orbital mechanics, and I plan to eventually develop a unit on electronics with the satellite station as a focus of interest.

The project has received a fair amount of publicity in the community. Articles have appeared in the local newspapers beginning with the announcement of reception of the Grant. The contact with WØORE aboard Challenger generated further publicity, and our successful completion of contacts through OSCAR 1Ø this fall led to still more publicity in a school-to-parent newsletter.

The enrollment in physics at Hoover High School has continued to climb, and there was no indication that the satellite project, alone, was responsible for any increase. During 1983-84, 31.6 % of our seniors completed physics. During 1984-85, 32.3 % enrolled. This year 36.4 % of the seniors will have completed physics. A questionnaire revealed that, while many pupils had heard of the satellite project prior to enrollment in physics, none indicated that as a major factor in the decision to enroll in physics. Perhaps the publicity about that and other activities in the program contributes to the growing enrollment.

Over the last several years only one or two pupils per year have earned an amateur radio license, although many have been made aware of amateur radio. This year there are about four pupils who seem determined to learn the required Morse code and obtain a license.

In summary, principal objectives have been met in the project. The station has been successfully assembled with pupil involvement. Pupils are involved in some additional projects, and the satellite station is serving as an ongoing source of interest and examples for specific topics in physics. It appears to be one of several factors attracting pupils to physics and to amateur radio.