The 2m Quad Project

Here's a great antenna project for your club!

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As the rainy season blew into Puget Sound, I was giving thought to the second semester of our electronics technology program at Sno-Isle Skills Center. During this semester I teach amateur radio to my junior and senior high school students ... a daily block of three hours of classroom lecture and lab. Each of my students builds an AM/FM superheterodyne receiver to give further understanding to my lectures on electronics theory. This gives these teenage intellects a break from the 30 minutes of dits and dahs of Mr. Morse's code.

December brought rain, rain and, when the sun was about to appear, more rain. January was just a little bit more of December: rain, rain and wind. What does this have to do with young high school students and amateur radio? A reason to demonstrate antenna theory in the classroom, and hope for sun in February—to be exact, on Groundhog Day. On February 2nd the sun did peek out to greet my birthday. Having spent over nine-tenths of my life as a ham radio operator, I felt that this was an appropriate time to take the class outside to test the antennas we'd made in the classroom.

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We'd made a half-wave dipole for 2 meters, 146.58 MHz, using the formula 468 divided by the frequency in MHz for a length of 38.5 inches. Devin Corbett KB7NKT cut the number 12 wire and installed a PIN diode and a Fluke 87 Digital Multimeter in series with the antenna to measure the current. Two meters gave us the compact size and also allowed me to demonstrate vertical and horizontal polarization.

Photo A. *Devin Corbett KB7NKT and Matt Chapsin checking the SWR.*

As I explained the half-wave dipole antenna to my students, their eyes began to glaze: "Like how can this work?" With our demonstration, some of these bright young minds opened up and started to ask questions: "How can a full wave fit into a half-wave length of wire?" My excitement increased with each question. I found *The ARRL Antenna Book* and started to look for a 2 meter quad antenna that we could make with little cost to the students.

Sno-Isle Skills Center is a vocational high school with 22 programs of instruction, from automotive technology to welding. The resources of the faculty and supplies are a ham's dream come true.

During the last week of January, it rained some more. This was an opportune time to build a single-element quad at home to illustrate a full-wave antenna to the students. The third quarter of instruction is communication electronics and the goal of each student is to pass the Technician Plus exam. The half-wave dipole and quad are both antennas that are covered in the exams. In my lectures on antennas the students calculated the length of each type of antenna needed to pass the exams. For quads, the length of the full-wave loop can be calculated by 1005 divided by the frequency in MHz. If multiple elements are used, the reflector should be five percent longer and the director(s) five percent shorter.

With my *Antenna Book* in hand, I went to the faculty lounge to discuss my quad antenna project with some of the staff. I showed Dan Minzel, our welding instructor, the drawings of a portable 144 MHz four-element quad. He had a large quantity of 1/8-inch diameter oxyacetylene welding wire that we could use for the loops. Al Urness N7QDC, our plastics instructor, had the PVC support (spreaders) and a Fiberglas™ boom. The machine trades instructor, Tom Clemans, suggested he have his students drill all of the holes needed in the PVC (spreaders) supports and boom. It's as exciting to have cooperative working groups on the staff as it is to teach in the classroom. It was a good beginning to the second semester.

The element spacing for quad antennas found in literature ranges from 0.14 to 0.25. Factors such as the number of elements in the array and the parameters to be optimized (F/B ratio, forward gain bandwidth, etc.) determine the optimum element spacing within this range. The four-element quad we constructed in class was cut for 146.58 kHz. We decided on a reflector length of 86 inches, with the driven element 81 inches and the directors 77 inches long.

Construction

We began with the 10 feet of 1/2-inch PVC for the booms that was provided by Al. It was cut to 42 inches in length, with allowances given for the two PVC tees, one for the reflector and one for the first director.

The reflector tee was glued to one end of the boom, 16 inches from the center of the driven element tee. This was the work of another classroom team led by Matt Watson. Matt made sure that the distance from the center of the reflector tee was 16 inches to the center of the driven element tee, and the second director tee was on center, 13 inches from the driven element. Finally, the first director measured 13 inches from the second, then all of the PVC tees were glued into place.

Construction of our first four-element quad began with 1/2-inch PVC spreaders. These elements were first assembled with the holes drilled for the 1/8-inch brazing rods. The reflector spreader was 22-1/2 inches long, with 1/8-inch holes drilled 10-3/4 inches from the center of the boom. The driven spreader was 21-1/4 inches long, with holes drilled 10-1/8 inches from the center of the boom, and the directors were 20-1/4 inches, with holes drilled 9-5/8 inches from the center of the boom.

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We used 1/2-inch PVC for the boom with PVC tees to install the spreaders; each spreader was cut in half, i.e. the reflector was cut at 11-1/4 inches, then each end was glued to the tee and in turn to the boom.

The rationale for using oxyacetylene welding wire for the elements was to keep the cost of our quad to $0, and also to improve the students' soldering skills. No. 8 aluminum ground wire will work just as well. The brazing rods cost around $2.26.

A 12-inch x 2-inch Plexiglas™ plate was used to support the feed point hardware and the feedline. The feed point support was epoxied to the boom. Using a heat gun, we bent the Plexiglas to meet the driven element. The ends of the brazing rods were 3/4 inch apart where they mounted on the Plexiglas plate. We left enough excess rod to bend a small loop for attachment to the coaxial feedline with stainless steel hardware.

For vertical polarization, we located the feed point in the center of one side of the driven element. In tests, we found that there was a 10 dB loss in the horizontal polarization when we tested with a local repeater.

We connected the coax to the bolts connected on the driven element support plate, and ran the RG-8 along the Plexiglas to the boom. From there the cable was routed directly to the mast and down. The antenna provided very good performance, with a reasonable SWR over the entire 144 MHz band. We used a Bird wattmeter to measure the reflected power and found that with 100 watts out, less than 1/2 watt was reflected.

The kids now know what a full-wave antenna is, compared to a half-wave antenna. Our next classroom project is to build a PVC 10 meter quad. We'll be looking for you on 10 meters. 73

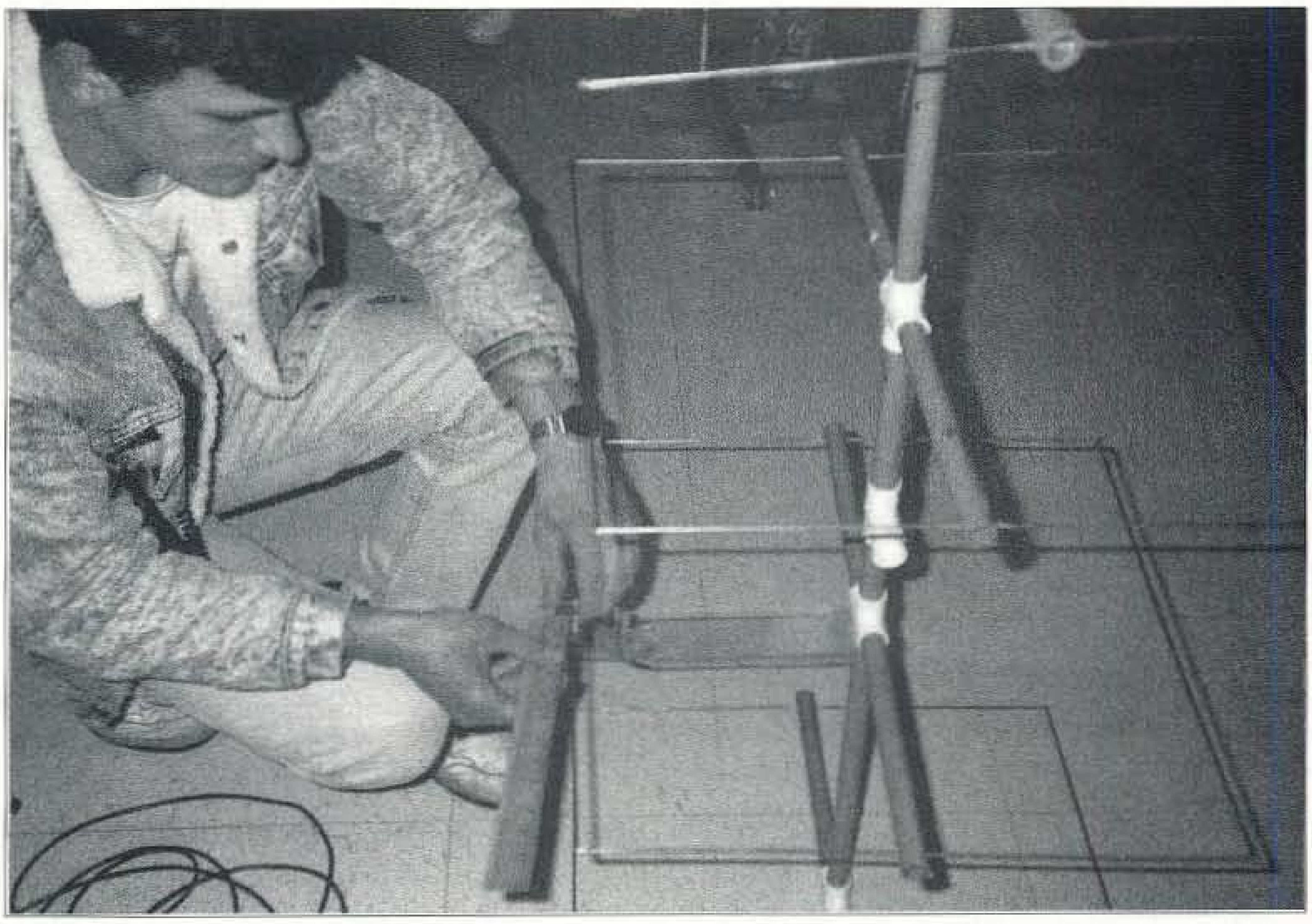

Photo B. *Devin Corbett KB7NKT measuring the spacing for the feedline.*