No. 46: The Persistent Vee-Beam Myth

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In a jigsaw puzzle, many pieces have similar shapes. You can force some pieces into the wrong places and end up with a messy and meaningless picture. The same rule applies to antenna work. Back in the 70s and 80s, backyard antenna builders created some interesting antennas and then made all sorts of miraculous claims for them. Since I receive numerous questions from folks reading old issues of ham magazines, a good number of them have focused on these miracle beams. One of the most persistent is the so-called Vee-beam.

Right at the start, we have the seeds for a misunderstanding. There is a very legitimate use of the term Vee-beam that indicates an array with good directivity and high gain. However, this traditional beam uses wire elements many wavelengths long. The Vee-beams of the more recent vintage are Yagi size, that is, with elements about ½ wavelength from end to end. However, it appears that the Vee-beam builders wanted to claim long-wire results for their short element antennas. So claims arose that a 2-element Vee-beam would give performance equal to or better than a 3-element Yagi with straight elements. (I still see such claims on the Internet.)

A second claim is that bending the elements forward will save space. If a standard Yagi is 16 to 17 feet wide, the Vee'd form will only be about 12 feet wide. So we have a seemingly compact antenna.

Let's evaluate these claims by making a series of comparisons among 3 2-element beams. All of the antennas will use 5/8" diameter elements for our modeling exercise. There is nothing in any of the designs that will even remotely approach the limits of antenna modeling software, so results will be reliable.

1. A standard Yagi: For the Yagi, I have selected a wide-band version having a natural feedpoint impedance in the vicinity of 50 Ohms. Hence, you do not need a matching network, such as a beta or gamma match. The reflector is 17.3' long, while the driver is 15.84' long. The elements are 5.5' apart. You can use closer spacing, but the lengths will change and the feedpoint impedance will go down. At 4.3' for the spacing, you will get 32 to 35 Ohms for the feedpoint impedance and need a matching network for your 50-Ohm coax cable feedline. The reduced spacing will give numerically detectable improvements in performance in modeling software, but not enough to be detectable in operation.

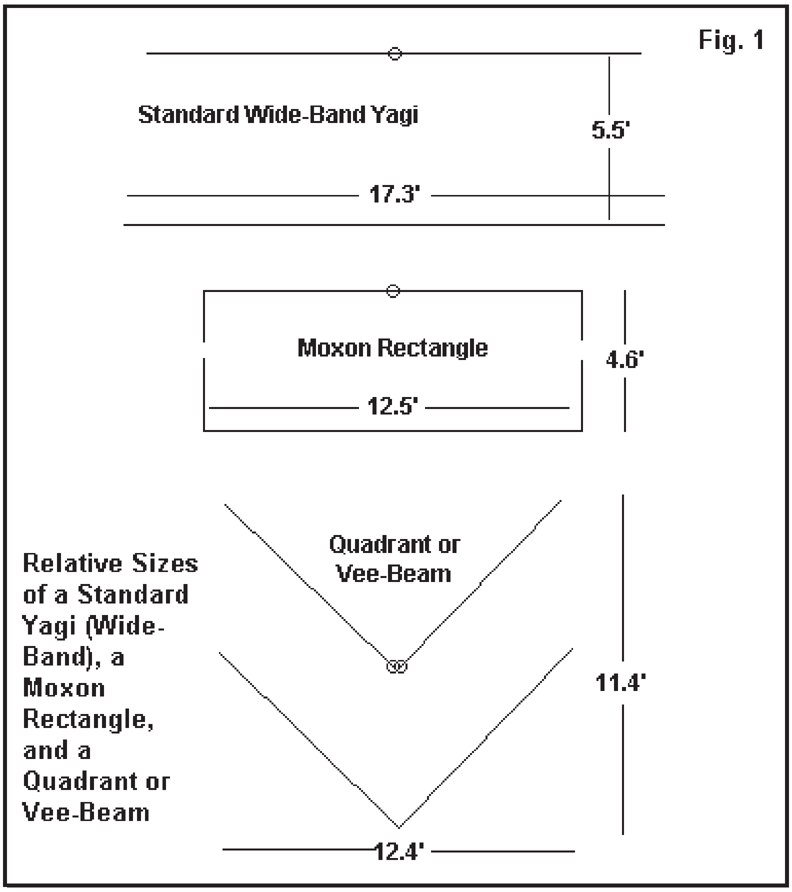
2. A Moxon Rectangle: The Moxon is a compact 2-element beam that uses standard Yagi parasitic coupling plus element end coupling. Its gain is almost as good as the Yagi gain. However, the front-to-back ratio is exceptionally better. At 28 and 29 MHz, you can have about 18 dB of front-to-back

ratio, compared to the 10-11-dB figure for a Yagi. More to the point is the size. The Moxon is only 12.5' side-to-side and 4.6' front-to-back. Like the wide-band Yagi, it has a natural 50-Ohm feedpoint impedance for direct connection to your coax cable.

Both the wide-band Yagi and the Moxon rectangle should use a means of "common-mode current" suppression at the feedpoint. For this purpose, you may use a bulky 1:1 balun. However, a simpler bead-type choke, as designed by W2DU and available from numerous vendors, is just as effective. Its advantage is a diameter not much larger than coax cable. Hence, you can tape it to the boom and not add significant weight to the antenna.

Structurally, the Yagi is larger overall. However, the Moxon requires a bit of extra fabrication effort. It needs 4 corners to the elements. So the space saving comes at a price, but one which many folks can pay without strain.

3. The third antenna is a 10-meter Vee-beam. Each element has a "quadrant" form, that is, a 90-degree overall bend. The open ends point in the desired signal direction on the premise that we shall get added gain from them. The bending results in an overall beam width of about 12.4'. Unfortunately, the forward bending increases the front-to-back dimension to about 11.4'. So now we have a nearly square array. **Fig. 1** shows the relative sizes of our 3 beams.



The next question for our comparison concerns how well the three antennas perform. We can break that question into 2 parts.

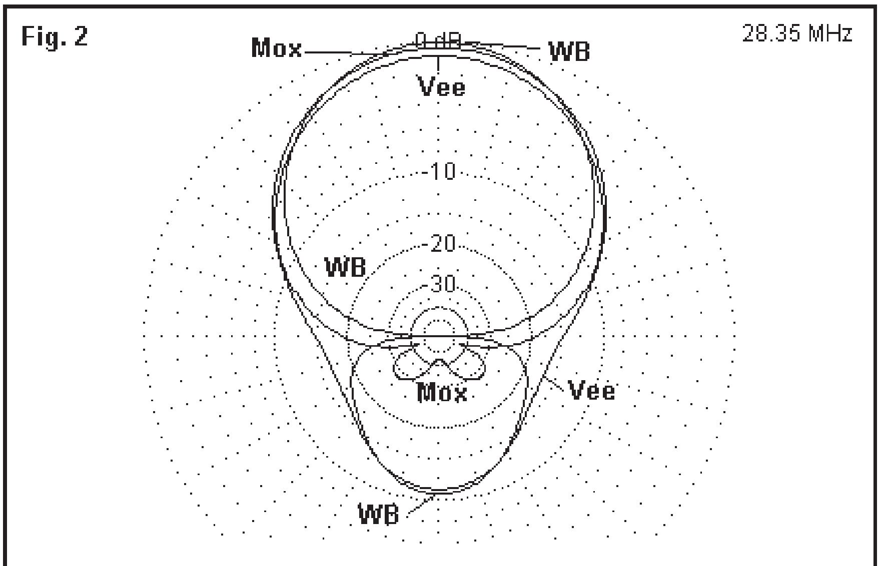
a. What kind of pattern do I get from each antenna?

b. What kind of operating bandwidth do I get from each antenna?

The pattern question is relatively easy to answer, if we break it down into parts. The Yagi provides the most gain--about 0.2 dB more than the Moxon and about 0.7 dB more than the Vee-beam.

The Moxon rectangle has the best front-to-back performance, as noted earlier. The Yagi comes next, with a modest 11 dB front-to-back ratio. Which value is better for your operation depends on your needs. For nets, I prefer the Yagi, since I can hear--although more weakly--stations from the rear. For contests, I prefer the Moxon that quells rearward QRM very effectively. The Vee-beam is slightly poorer than the Yagi in the front-to-back performance.

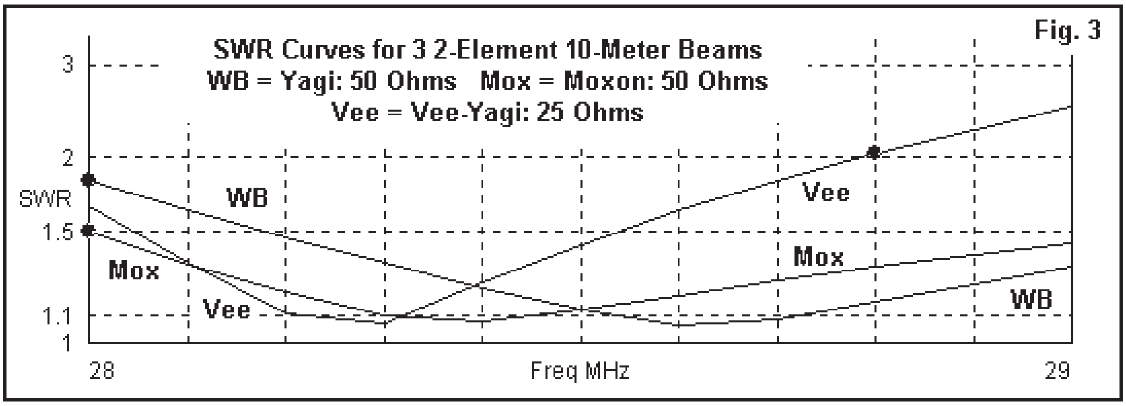
See **Fig. 2** for overlaid patterns for the 3 antennas to confirm these notes.



Comparative Azimuth Patterns for 3 2-Element 10-Meter Beams
WB = Wide-Band Yagi   Mox = Moxon Rectangle
Vee = Vee Yagi

The patterns reveal something else about what happens when you Vee and element horizontally. The front-to-side ratio goes way down, since each half element radiates some energy to the side.

We have noted that the Yagi and the Moxon have 50-Ohm feedpoint impedances. That number applies to the design frequency (28.35 MHz for all three antennas). But what about the band edges. For this performance specification, let's look at the SWR curves in **Fig. 3**.



The wide-band Yagi 50-Ohm SWR curve may start higher than the other two, but only because the antenna provides coverage of the entire 10-meter band from 28.0 to 29.7 MHz. You can lengthen the driver slightly to bring the minimum SWR value down in frequency.

In contrast, the Moxon rectangle provides a 50-Ohm SWR of 1.5:1 or less for the first full MHz of 10 meters. The rate of increase above the minimum point is slower than below the minimum point, so coverage extends to about 29.2 MHz or so before the SWR value reaches 2:1.

The Vee-beam shows an entirely different pattern. First, whenever you change a straight element into a Vee, no matter where the Vee ends point, you lower the single element impedance. Hence, a simple inverted-Vee has an impedance closer to 50 Ohms than to the straight dipole 70-Ohm value. Second, whenever you add a second element, such as a parasitic reflector, you further lower the feedpoint impedance. Straight element Yagis produce 30-50-Ohm impedances, compared to a dipole's 70 Ohms. Since a Vee'd dipole is already at a lower feedpoint impedance, adding a reflector lowers the impedance even further. Hence, the Vee-beam has a resonant driver impedance of only 25 Ohms. This value is not fatal, since we can always add a matching network to raise the impedance.

However, notice the overall SWR curve for the Vee-beam. Not only did we lower the impedance, but as well, we narrowed the 2:1 operating bandwidth. We have about 800 kHz of operating room, compared to the other beams. Although this value is adequate for most lower-end 10-meter activities, it does require that you tune the Vee-beam with great care and precision.

So the bottom line is that we do not get anything special from the Vee-beam configuration that we cannot get from simpler, smaller, or wider-band arrangements. My preference is always to keep these antenna notes on the positive side. However, the Vee-beam myth has persisted for so long that I felt compelled to provide some legitimate comparisons. May the Vee-Yagi rest in peace beside Vee'd LPDAs and other members of the family. There are better ways to meet your 10-meter small beam needs.