No, this is not about which one is better, but rather the unique construction considerations each offers and the relative ease of replicating results by home-brewers.

Narrowing The Debate

A Brief Look At Replication Requirements For Building Yagi and Quad Antennas

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The intention of this article is not to settle the long-standing debate between the virtues of HF quad and Yagi antennas. Rather, I have chosen to narrow the focus of discussion to overlooked characteristics of the two different designs and constructs and to show how these characteristics ultimately affect consistent performance from one builder to the next.

Anyone who has used the various Yagi design programs now available for the home PC knows that designing a Yagi antenna can be a complicated procedure. The conversion from computer-generated electrical to real-world mechanical dimensions must be closely adhered to. For those not familiar with the process, let me explain that the computer primarily models the antenna as though it were a single wire or cylinder. For those who build wire Yagi antennas, that's fine. However, most builders construct their antennas using various sizes of available aluminum tubing that change in diameter as they connect to form each element.

Once the builder decides upon the size and number of tubing sections for a given antenna design, the length and diameter of each section is run through a taper program which converts the electrical design length to real-world physical dimensions. This is an essential step of the process that must be closely adhered to because connecting several sections of different diameters and lengths affects the *overall* finished length.

For example: In the files of one of the programs used in researching this article I came across a design for a three-element 15 meter beam with a 12 foot boom (see Table I). The overall cylindrical length given for the reflector is 280 inches. By using Lew Gordon's program, Taper801, I converted the cylindrical dimension to a physical dimension. I told the program that the tubing I was using tapered from .875 to .625 inches in two sections for each element half. I also told it that the first section from the boom would be 75 inches long. The program then calculated the remaining .625 tubing section to be 67.84 inches in length. Thus, the overall physical dimension is 285.68 inches.

File: 315-12
Equiv. Cylindrical Reflector Length = 280
Equiv. Cylindrical Element Diameter = .54

Section #1	Length (in.)	Diameter (in.)
1	75.0	.875
2	67.84	.625

Total tapered element length end to end = 285.68
(Source: Taper801 by K4VX)

Table I– Using Taper801 with a design for a three-element 15 meter beam with a 12 foot boom. Taper801 is by Lew Gordon, K4VX.

Another consideration is the method of element to boom attachment. Does the element go through the boom? Does it attach by means of a plate, or is the element insulated from the boom? Each method has a different effect on the overall length. If the element is insulated from the boom, no compensation is necessary. But if a plate rather than an insulator is used, its length, width, and thickness must be entered into the program as a separate section of the element. If the element passes through the boom, proper compensation must be made with regard to the thickness of the boom.

Some Yagi designs are less tolerant of dimensional errors than others, especially modern designs with close-spaced elements. In the three-element design mentioned earlier, the elements are unevenly spaced with the driven element just 48 inches from the reflector. Table II shows the calculated gain and front to back ratio of this antenna when run through Yagimax.

Notice the decrease in gain from 7.43 dBi to 7.29 dBi when the reflector is lengthened 2.8 inches overall. This is an insignificant difference. However, the decrease in front to back is 8 dB, a much more noticeable difference.

Thus, it is easy to see that in order to convert the Yagi design to the real world, it is essential that all mechanical aspects just covered be closely monitored and adhered to. These variables apply to both computer and range designed Yagis. Regardless of the design, compensation must be made in order to duplicate the performance from one Yagi to the next if in fact the tubing sizes' element to boom attachments are different than the original antenna.

Armed with the Yagi information we now have, let's turn our attention to the quad antenna. The simplicity of the quad antenna is its strong point when it comes to design and replication. Because a single wire loop of a given gauge obviously will be continuous throughout its circumference, no mechanical tapering need be considered. In addition, there are no boom or element to plate dimensions to consider, as the elements of a quad normally are suspended on non-conductive fiberglass spreaders. Thus, only minor adjustments need to be done when applying the electrical dimensions to the physical construction. Far fewer variables to deal with when designing and constructing quad antennas results in a higher probability of matched results from one constructor to the next. In other words, the repeatability of design from one constructor to the next is more consistent and predictable.

In contrast, the repeatability of the quad design is far easier to copy. Without the need for computer modeling to compensate for construction variables, overall performance results can be much the same from one builder to the next. Simply put, the quad is a much more forgiving antenna, assuming the builder follows conventional quad construction. (Most quad constructors use number 12 and 14 wire and non-conductive fiberglass spreaders.)

There is yet one more aspect to consider. The Yagi antenna is designed on a half-wave principle, whereas the quad is based on a full wave. Therefore, a simple one inch error in measurement during construction may ad-

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Dimension	Gain (dbi)	F/B (dB)
280.00	7.43	32.34
282.80	7.29	24.26

(Source: Yagimax 3.23 by K4VX)

Table II– Figures for gain and f/b at 21.000.

versely affect the Yagi more than the quad. (A two inch error in the overall dimension of a 20 meter half wave is one half of one percent of the overall length. A two inch error in a full-wave loop is half that much, or one quarter of one percent.) This seemingly small error can lead to decreased performance in close-spaced Yagis as previously shown in Table II.

Not so many years ago when there were no personal computers and affordable antenna programs to go with them, average Yagi antenna builders were at the mercy of NBS design dimensions and those passed on to them by fellow amateurs. Many times, the result of their antenna projects was far less than hoped for if they failed to consider the mechanical variables present. Only if they used the exact same ...ing lengths and dimensions, boom width, ...d element to boom attachment would the performance of their antennas usually match that of their friends or that of the NBS predictions. If any one of the mentioned variables was ignored or altered, the results often fell far short of their hopes.

During the 1950s, '60s, and most of the '70s the average amateur had no access to computer modeling. Unless he was well versed in mathematics, he was unable to accurately compensate for the variables introduced in the construction of Yagis. The probability factor of the performance of a copied quad design versus a Yagi was therefore much higher, and the results more consistent. The advent of the PC has helped to reduce the inherent errors in Yagi design and construction, thus narrowing the debate between the Yagi and quad.

Without going into the electrical performance of each antenna, I have tried to show why the home-brew antenna builder may sometimes find the quad antenna to be a better performer than a Yagi, especially in those years prior to the home PC.

It is important that the builder recognize that ... quad and Yagi are two different antennas, the Yagi demanding special treatment. The debate here is not that one is better than the other, but that more care must be taken in the design and construction of the Yagi as opposed to the quad.

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Source for Tables I and II: Yagimax 3.23 and Taper801, software program by Lew Gordon, K4VX.