High Performance Cubical Quad Antennas 3rd Edition by John Koszeghy, K3BB: a Review

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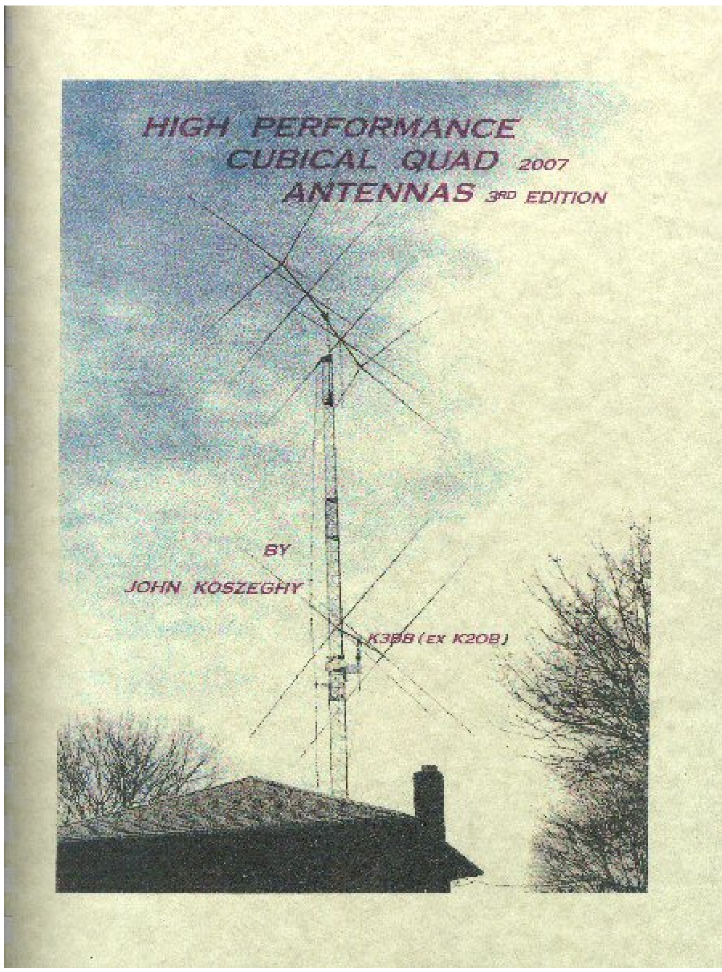
John Koszeghy, K3BB (ex-K2OB) has had a love affair with quad beams for 45 years. Indeed, he subtitles his latest volume with just those words. The first edition appeared in 1994, with a second in 1996. The latest volume might be called the sum of his very extensive work with all varieties of quad beam forms since he first fell in love in about 1960. Although the latest volume lists a modest 135 pages of text, the volume is almost twice that size. A good portion of the unnumbered pages consists of color photographs—in full 8.5" by 11" format—of quad beams and related materials.



If John had been interested only in the usual lot of quads used by the average amateur, the photos might not be as exciting as they are. 2-element quad beams in monoband or multi-band form are likely to lose reader interest. However, the photos include quads up to 8 elements. As well, there are quads for more than the usual upper HF range, with one being a monster quad beam for 80 meters. The photos alone are a worthwhile addition to the amateur bookshelf, since they provide a perspective on amateur antenna construction that we rarely see.

To understand the text of the book requires some insight into John's perspective on antenna design, perspective developed from long years as a test engineer for Grumman (now Northrup-Grumman). His work does not start with computer models, although you will find numerous post-facto models in the volume. Instead, it emerges from patient empirical design, construction, and test procedures. Indeed, part of his experience includes the evolution in testing procedures over the years, an evolution that has allowed him to refine his designs and to expand the designs with which he works.

In antenna labs, the use of scaled VHF and UHF antennas often serves as the fundamental test bed for antennas ultimately intended for HF use. John is intimately familiar with such techniques, but the bulk of his work has consisted in constructing—and reconstructing—full size antennas, with a primary focus on the 20-meter amateur band. His test notes beginning on page 122 provide specific details of his test procedures, along with results that include both numerical data and other results of specific interest to users of the antenna.

The first chapter traces the history of John's involvement with quad antennas, as he moved from initial 2-element box (square) and diamond designs to 3- and 4-element quads. In the process, he experimented with octagonal elements and also with quad stacks, as suggested by the cover photograph for his book. His most intensive period of design testing occurred in the late 1990s, with experiments on 11 full-size 20-meter monoband quad beams.

Chapter two contains many of the results that John obtained from his extensive building and testing efforts over the years. He discovered that "boom length translates into gain . . . until gain fold over occurs with excessive boom length." (page 7) Later in the chapter, the author provides tables and graphs of quad performance results that indicate a nearly linear growth of boom length from 2 to 7 elements of 0.2-λ up to 2.0-λ. The corresponding gain graph has a modest curve indicating that there is a practical limit to the addition of further elements.

One of the outcomes of John's continual experimentation is a set of recommendations for the size of the loops in quad beams ranging from 2 to 5 (and more) elements. For reader convenience, he summarizes these results in a series of formulas limited to AWG #12 through AWG #16 wire. He provides separate formulas for bare and insulated wire. Over the next two pages, I have reproduced these handy tables for calculating quad element loops. The quality of the reproductions suffers from using scanning methods to obtain them. In the book, they are very crisp and clear.

The loop-cutting tables apply to the element spacing values that John obtained from his long series of experiments in the 1990s. Through the 1980s, quad builders had tended to use a very limited set of 20-meter element spacing values, usually involving increments of 8' or 10' between elements in various combinations. John's work resulted in various non-standard combinations of spacing values, especially between the driver and the first director and again between the first and second directors. As he changed the spacing values, he adjusted the required loop sizes to obtain maximum gain from the array. The second chapter traces these experiments to provide the reader with a good idea of the methods used to obtain top performance from his arrays.

The chapter also includes a number of practical construction and operational recommendations. Among them is the preference for using 72-Ω matching sections between the driver loop and the main feedline in lieu of either wound coaxial chokes or balun devices. The latter two items he found could modify driver performance. At the end of the chapter, he provides some guidance for the newer amateur just entering the world of quad antennas. His own extensive operating experience suggests that approximately 11% of the DX operators around the world use quad beams.

FORMULAS

2 ELEMENT QUADS

(**WIRES**: Copper - Stranded or Solid # U.S. 12, 14, 16)

Reflector = 2% larger vs. Driven	12194 / f-Mhz	= LOOP in inches	30973 / f-Mhz	=	LOOP in CM
Driven =	11955 / f-Mhz	= LOOP in inches	30365 / f-Mhz	=	LOOP in CM

(**WIRES:** Aluminum, and the Mylar or Teflon covered # U.S. 12, 14, 16)

Reflector = 2% larger vs. Driven	12120 / f-Mhz	= LOOP in inches	30780 / f-Mhz	=	LOOP in CM
Driven =	11880 / f-Mhz	= LOOP in inches	30175 / f-Mhz	=	LOOP in CM

SAMPLE CALCULATIONS

WAVELENGTH IN METERS = 300 / FREQ Mhz
WAVELENGTH IN FEET = 984/ FREQ Mhz

EXAMPLE: 2 Element QUADS designed for 20 and 40 meters -

Boom Lengths (optimum) = 0.20 Wavelength

14.1 Mhz	=	(984 / 14.1) x 0.20 = 13.95 ft	or	13 feet, 11.5 inches
7.1 Mhz	=	(984 / 7.1) x 0.20 = 27.7 ft	or	27 feet, 8.5 inches

Element Lengths

14.1 Reflector =	12194 / 14.1 =	864.82 inches	=	72 feet, 7/8 inches
Driven =	11955 / 14.1 =	847.87 inches	=	70 feet, 7.87 inches
7.1 Reflector =	12194 / 7.1 =	1717.46 inches	=	143 feet, 1.46 inches
Driven =	11955 / 7.1 =	1683.8 inches	=	140 feet, 3.8 inches

Chapter 3 contains an interesting survey of the perennial quad-vs.-Yagi question. The survey includes the reports of a number of trusted hams who were able to compare directly quads and Yagis over long and short DX paths. Although John loves quads, he does not varnish the results to favor his preferred antenna. Instead, he lets the reports show that the debate has no definitive resolution. Although some claim that quads are quieter than Yagis, experience with rain static suggested that sometimes one, sometimes the other type of antenna excelled. A similar indecisive result appears with band openings and closings that early quad users claimed in favor of quads. Most of the reports involve well-designed and constructed monoband beams of both types. If any advantages emerged for beams of equal boom length, then the gain margin went to the quad, while the rearward performance went to the Yagi. Although this note seems to give away the chapter's theme, the details of the individual reports are of considerable interest for anyone who tracks the history of beam development.

FORMULAS

FOR

3, 4, 5, AND MORE ELEMENT CUBICAL QUAD ANTENNAS
(WIRES: Copper - Solid or Stranded # U.S. 12, 14, 16 **)**

Reflector = 2.25% Larger vs. Driven	12224/ f-Mhz = LOOP in inches	31048 / f-Mhz = LOOP IN CM
Reflector = 2.0% Larger vs. Driven	12194/ f-Mhz = LOOP in inches	30973/ f-Mhz = LOOP IN CM
Driven =	11955 / f-Mhz = LOOP in inches	30365 / f-Mhz = LOOP IN CM
Director -1 = 0.6% Shorter vs. Driven	11883/ f-Mhz = LOOP in inches	30183/ f-Mhz = LOOP IN CM
OR		
Director - 1 = 0.8% Shorter vs. Driven	11860 / f-Mhz = LOOP in inches	30123 / f-Mhz = LOOP IN CM
Director 2,3 = 1.13% Shorter vs. Driven	11820 / f-Mhz = LOOP in inches	30022/ f-Mhz = LOOP IN CM
Director 4,5 = 1.25% Shorter vs. Driven	11805 / f-Mhz = LOOP in inches	29985/ f-Mhz = LOOP IN CM

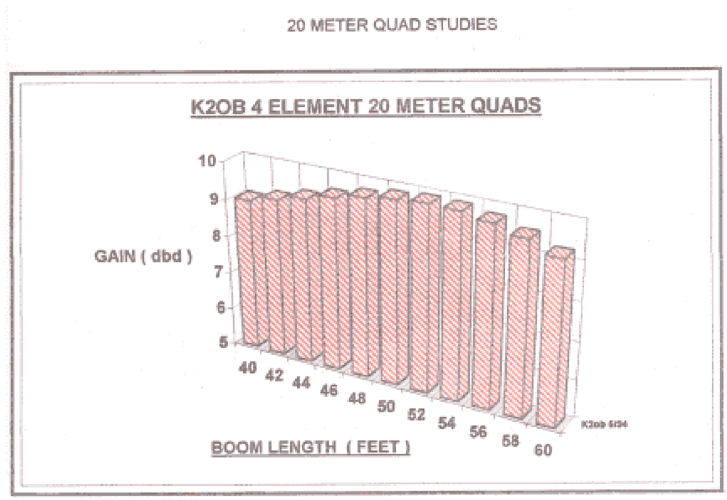
3, 4, 5, AND MORE ELEMENT CUBICAL QUAD ANTENNAS
(WIRES: Aluminum, and the Mylar or Teflon covered # U.S. 12, 14, 16 **)**

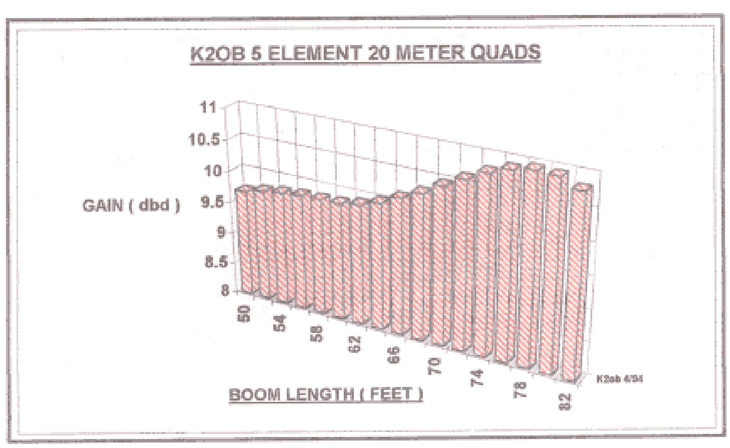
Reflector = 2.25% Larger vs. Driven	12106 / f-Mhz = LOOP in inches	30750/ f-Mhz = LOOP in CM
Reflector = 2.00% larger vs. Driven	12077 / f-Mhz = LOOP in inches	30675 / f-Mhz = LOOP in CM
Driven =	11840 / f-Mhz = LOOP in inches	30074/ f-Mhz = LOOP in CM
Director - 1 = 0.5% Shorter vs. Driven	11780 / f-Mhz = LOOP in inches	29923 / f-Mhz = LOOP in CM
OR		
Director - 1 = 0.6% Shorter vs. Driven	11769 / f-Mhz = LOOP in inches	29893 / f-Mhz = LOOP in CM
Directors 2, 3 = 0.8% Shorter vs. Driven	11745 / f-Mhz = LOOP in inches	29833 / f-Mhz = LOOP in CM
Directors 4, 5, etc. = 1.0% Shorter vs. Driven	11721 / f-Mhz = LOOP in inches	29773 / f-Mhz = LOOP in CM

Chapter 4 traces John's experiments with 80- and 40-meter quads and delta loops, beginning with single loops and progressing—through his own work and the work of equally enthusiastic DX quad lovers—to both quad beams and collinear forms of beams. His initial work has convinced John that box and diamond quad loops are superior on the lower bands to apex-up delta loops, although he would not for a moment discount the utility of even the simple sloper for the low bands.

The final two main chapters are devoted to the conclusions John has drawn since his earliest work in the 1960s up to the present. The 35 numbered conclusions, abetted by extensive graphical data, are too complex to note here, since they cover many basic and refined aspects of quad design and construction. After some basic facts, John addresses issues of antenna resonance (including multiple resonant points within a band) and HF pattern acquisition. Perhaps his penultimate conclusion—actually a recommendation—sums up his entire approach to quad antennas: “Experiment and try new concepts—in all cases, record your antenna dimensions, antenna height, weather conditions, the test instrumentation and the data.” (page 70) The shorter list of recommendations in Chapter 6 contains highly practical suggestions for successful quad building, whether one uses a box or diamond configuration. They include both fundamental structural issues and simple ideas for quad longevity, such as capping the ends of spreaders.

The remaining pages of the volume equal in number the main text. They contain practical notes and experimental results on a large variety of relevant quad questions on subjects like performance measurement techniques, quad phasing, and element wire questions. One section details the specifications for advanced quad design ranging from two to seven elements. The designs include element spacing values as well as loop dimensions and provide examples of the optimized values developed during John’s research. For example, one 5-element 20-meter design uses 10’ from reflector to driver, with 13 feet to director 1, 15 feet to director 2 and 20 feet to director 3 for a total boom length of 58 feet.

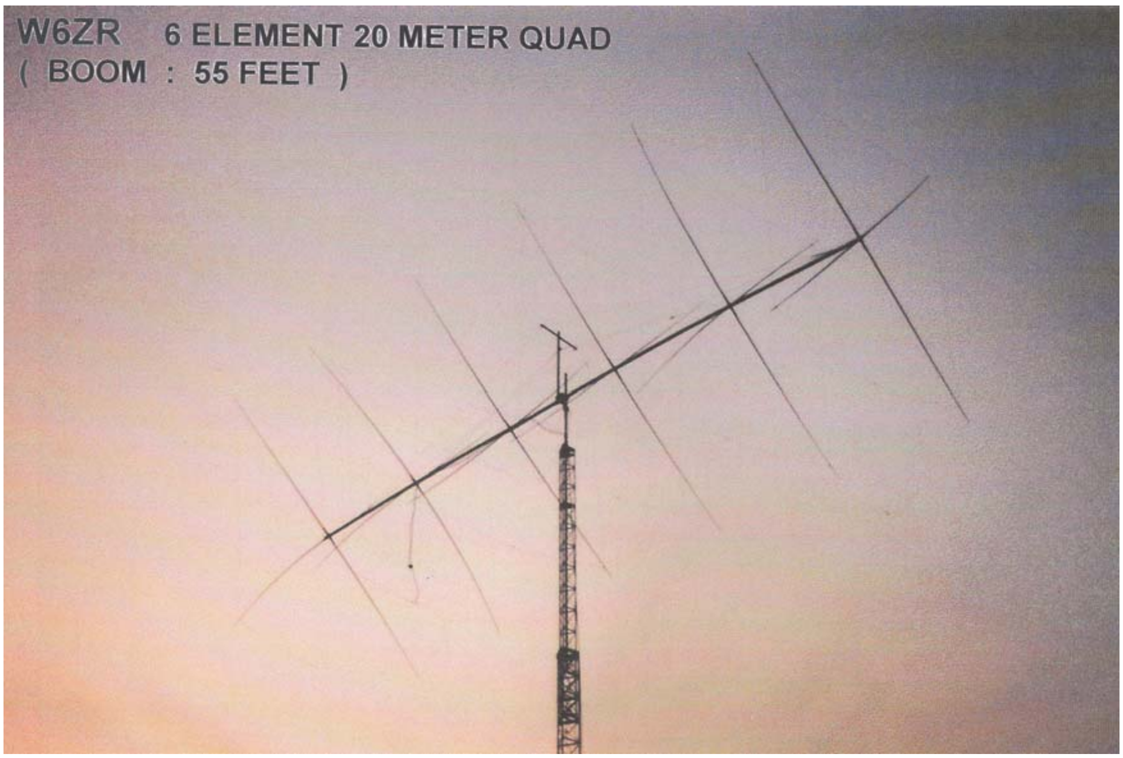




The next two sections of the appendix contain graphical data and text related to the extensive work John did with determining to optimal boom lengths for various numbers of quad elements. The sample graph is typical of the series and shows what John means by gain fold over when boom length becomes excessive. However, for most quad builders, the tendency is the opposite: to try to use too short a boom for the number of elements in the design and hence to loose significant gain potential from the array. (Again, scanning reduces the clarity of the graphic relative to its crispness in the volume.)

The appendices cover other topics, such as design comparisons, feed methods, and details of the test methods used by K3BB. The last especially is essential reading to frame properly the data and conclusion in the book.

The final section of the book is devoted to photos and sketches of antennas used by John and by a host of amateurs throughout the world. Beginning on page 135, this section of the book holds its own fascination for anyone who has admired complex antennas against the sky. A single sample will have to do to introduce this part of the volume.



I shall close this review with the observation that K3BB's Quad volume has preserved an important place in quad literature in its new and revised edition. However, to obtain a copy, you will have to contact John directly:

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Click for Biography of LB Cebik

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