THE ALPHABET CUBE

DAVID MORICE
Iowa City, Iowa

You've just bought an Alphabet Cube for $26 from K-Mart. It measures one foot long on each side, and it comes with a remote control panel displaying a course of buttons. A sign on the box says: "Operates on triple A batteries (included)." It's ready to work.

You take it out of the box and hold it in your hands. Viewing the front, you count 26 rows of 26 tiny spherical lights on a plane, with many more lights behind it. Looking closer, you notice that each light has 3 letters, a trigram, on it. The first row reads AAA, AAB, AAC, .. to AAZ; the second row, ABA to ABZ; and so on to the bottom row, AZA to AZZ. Checking the top, you see the structure in depth: there are 25 planes parallel to the front plane, and all of them are similarly lettered, except that the first letter in every trigram on each successive plane is different. The second plane has B's instead of A's - BAA, BAB... BAZ on down to BZA, BZB... BZZ. The third plane has C's. This order continues to the 26th plane with Z's, ending at ZZZ.

When you press the button marked PALINDROME, an entire plane radiates yellow like a shaft of sunlight, and one of its diagonals flashes bright as lightning. You punch the LETTERSHIFT button, and green sparks crackle diagonally downward from left to right. Then you tap the TRANSPOSAL button, and red triangles and blue hexagons zip rapidly from one plane to the other. You rotate the Cube to read the left plane, and you find it's a mirror image of the front. You're watching logogeometry in action.

Of course, the Cube exists only as a Platonic Ideal and not as a K-Mart Blue-Light Special. From the front, it's a 3-dimensional array of trigram points, alphabetized from AAA to ZZZ over 26 parallel planes. The segment in **Figure 1** is the top left front corner. Each of the Cube's 5 other faces begins a different set of 26 planes with the order of the trigrams rotated accordingly. You'll see that many logological forms operate in elegant harmony in this simplest of structures.

In discussing the Cube, some abbreviated notation is helpful. A line can be represented by its first and last trigrams separated by a dash: AAA-AAZ is the top line on the front face (and the bottom line on the top face). A 2-dimensional shape can be represented by more than two trigrams dashed together: AAA-AAZ-AZA is a right triangle on the front face composed of the top line, the right line, and one of the diagonals. A regular plane (one of the faces, or a plane parallel to a face) can be represented by the

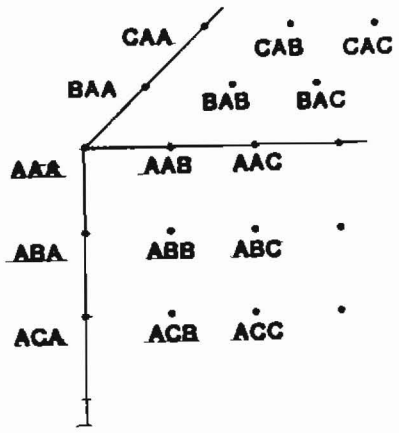

FIGURE 1

notation X--, -X-, or --X, which indicates the location and the identity of the only letter appearing in every trigram on the plane. For instance, the front plane is A--, the second plane is B--, and the left plane is --A. A plane can also be represented as a square composed of 4 trigrams: the front plane is AAA-AZA-AZZ-AAZ. Brackets around one or more trigrams signify a trigram set before a specific function is performed, such as "girder [ABC, DEF]" or "transposal hexagon [GHI]." The glossary at the end of this article gives definitions of the forms boldfaced in the text which follows.

Palindromes The Palindromic Plane, one of the most significant structures in the Alphabet Cube, contains all the palindromes. As shown in Figure 2, the Palindromic Plane, AAA-AZA-ZAZ-ZZZ, slices through the Cube from the front left column to the back right column. The Plane is a trigram square measuring 26x26. Geometrically, though, it's a rectangle, as are all trigram squares that are not parallel to one of the sides of the cube. The Lettershift Diagonal, another important structure, cuts through the Plane from AAA-ZZZ forming one-letter palindromic lettershifts. Every other line on the Plane going in the same direction as the Diagonal forms palindromic lettershifts.

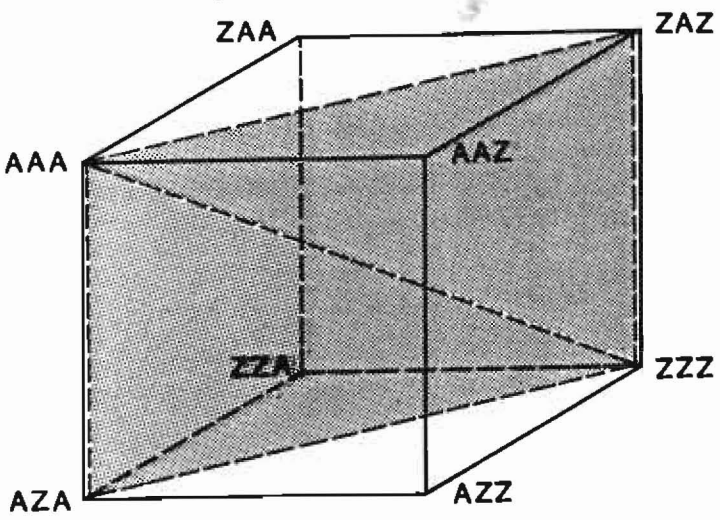

FIGURE 2

Lettershifts Throughout the Cube, all lines parallel to the Lettershift Diagonal form lettershifts. No lettershifts go in any other direction. Given any trigram, the total number of trigrams on its lettershift line can be calculated by the formula T = 26 - H - L, where T = number of trigrams, H = highest alphanumeric value of the 3 letters in the given trigram, and L = lowest value. Lettershift lines begin on the A-faces (A--, -A-, --A) and end on the Z-faces (Z--, -Z-, --Z). Trigrams on the 6 edge lines that don't have AAA or ZZZ as an endpoint are isolated from any lettershift partners, and the formula yields 1.

Reversals The left plane is a mirror reversal of the front plane. The positions of all the trigrams and the order of letters within them are reversed. The 26 regular planes viewed from the left face are mirror reversals of the 26 corresponding planes viewed from the front. This relationship holds true for the right and the back

right and the back views as well.

Crashing trigrams All trigrams that crash with a specific trigram are located on the three regular planes that intersect it. For instance, trigram PJV crashes only with the trigrams on planes P--, -J-, and --V. The words in a 3-letter network, as discussed in recent issues of **Word Ways**, can be connected by horizontal and vertical lines - that is, by the rook's move in a game of 3-dimensional chess.

Transposals A set of trigrams that are transposals of each other can be joined to make either an equilateral triangle or a hexagon that is an equilateral triangle with its vertices truncated equally. Triangles are derived from transposals of trigrams with two different letters ([AAB] = AAB, ABA, BAA), and hexagons from 3 different letters ([ABC] = ABC, ACB, BAC, BCA, CAB, CBA). **Figure 3** depicts the 2 Major Transposal Triangles, the largest in the Cube.

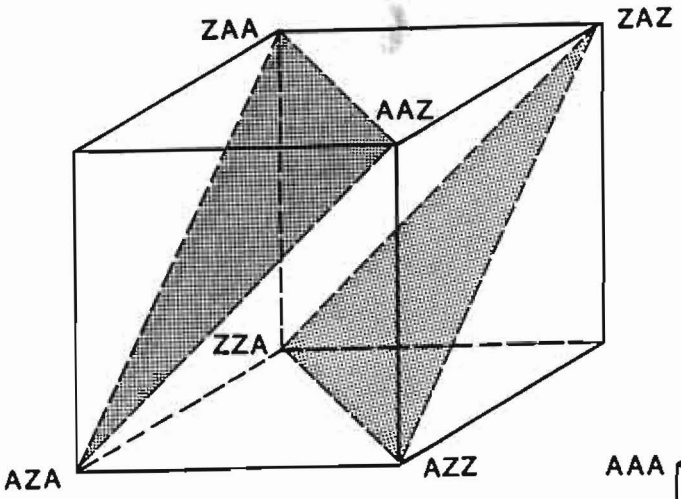

FIGURE 3

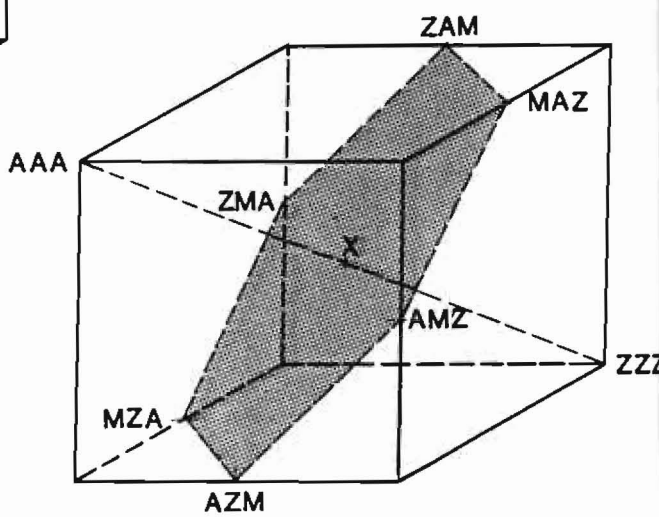

FIGURE 4

Triangle [AAZ] = AAZ-AZA-ZAA is composed of the diagonals of the A-faces, and [AZZ] = AZZ-ZAZ-ZZA is composed of the diagonals of the Z-faces. All of these shapes are parallel to each other, and the Lettershift Diagonal runs through the geometric center of each. **Figure 4** shows transposal hexagon [AMZ] intersected at its center (X) by the Lettershift Diagonal.

Girders The two trigrams forming a girder and the 2 other trigrams it generates can be connected to make a rectangle or square. All shapes derived from girders have their horizontal edges parallel to the top plane and their vertical edges perpendicular to it, but not all of these shapes are parallel to each other. Some are located on the Palindromic Plane: for instance, the square formed by girder [AAA, BBB] and the rectangle formed by girder [AAA, BCB]. Some of the shapes are parallel to the Palindromic Plane, but most are not. In Figure 5, girder square [ACE, KMO] is parallel, but girder rectangle [MAQ, XZT] is not. The Palindromic Plane itself can be generated by girder [AAA, ZZZ].

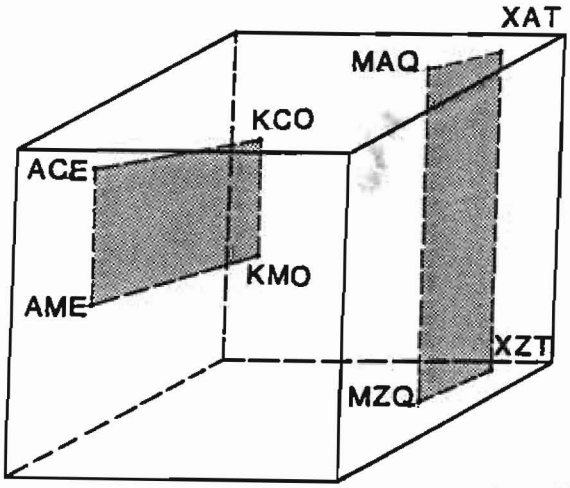

FIGURE 5

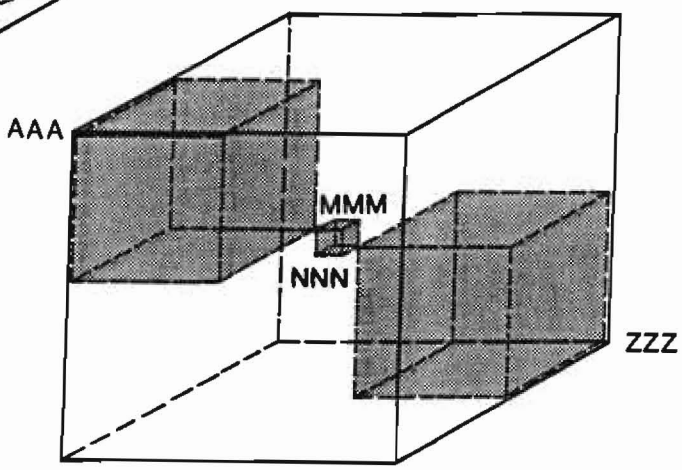

FIGURE 6

Garble Groups The 8 trigrams in a garble group can be connected to make a 6-sided solid whose sides are on regular planes. Such a shape may be designated by bracketing any two noncrashing trigrams in the garble group. Garble cube [XXX, YYY], for instance, is the shape whose vertices are marked by the group of 8 trigrams XXX, YYY, XXY, YYX, XYX, YXY, XYY, YXX. If any 2 of the trigrams in a garble group are lettershifts of each other, the shape is a cube; otherwise it is a rectangular solid. If there are only 2 different letters in the garble group, it is a cube with a diagonal lying on the Lettershift Diagonal. If the alphaposition-

al sum of the 2 different letters is 27, the cube is nested concentrically within the Alphabet Cube (except for [AAA, ZZZ], which is the Cube). The smallest of these 13 concentric cubes, the Center Cube [MMM, NNN], is nested precisely in the middle of the other 12, a box within a box within a box... Like the Alphabet Cube, every smaller cube has its own Major Transposal Triangles and Lettershift Diagonal.

Half-Alphabet Trigrams Trigram made of letters from the first half of the alphabet are located in garble cube [AAA, MMM] at the top left front eighth of the Alphabet Cube, and those from the last half are found in cube [NNN, ZZZ]at the bottom right back eighth. Bridging the two halves is the Center Cube [MMM, NNN]. As illustrated in **Figure 6**, the diagonals of these 3 cubes link together to form the Lettershift Diagonal.

Returning to the K-Mart metaphor, you haven't pressed all the buttons on the console yet. The forms discussed here can be explored in much greater detail. Other traditional forms, like word squares, as well as hybrid forms, like lettershift girders, remain untouched; and new forms become apparent while working the Cube. This is the introductory model. Advanced models come in higher dimensions to accommodate higher-order lettersets. The word ALPHABET, for instance, requires an 8-dimensional model. Even at 3 dimensions, the Alphabet Cube demonstrates many relationships among a diversity of forms.

Many thanks to my wife, Milagros Quijada, for her excellent drawings of the Cube.

GLOSSARY

Palindrome A word reading the same backwards as forwards: PUP.
Lettershifts Words whose corresponding letters are the same number of steps away from each other in a circular alphabet: SAP and WET are separated by four alphabetic steps SAP-TBQ-UCR-VDS-WET.
Reversal A word that spells the same word or a different word when it is read backwards: PUP; DOG-GOD. The palindrome is a specific type of reversal.
Crashing words Words with one or more letters in the same position in each word: LID-LIP; BIT-NOT.
Transposals Words derived by rearranging the letters of a word: EAT-ATE-TEA.
Girder Two non-crashing words whose alternating letters can be exchanged to form 2 different words: CAT, MOP to COT, MAP.
Garble group A group of 8 words with the property that any two noncrashing words in the group can exchange their corresponding letters to form the other six words: POT, CAD, COT, PAD, PAT, COD, POD, CAT.
Half-Alphabet word A word composed entirely of letters from either the first half or the last half of the alphabet: DIM; NOW.

These definitions can be generalized to words of other lengths.