QUEEN'S-MOVE GRAPHING

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In chess, the queen is the most versatile piece, moving in any of eight directions; unlike the king, which is constrained to move only one square at a time, she can move in a straight line until another piece is encountered. Translated to logology, this means that any word whose separate letters can be placed on chessboard squares so that it can be spelled out by a king, will also be spelled out by a queen. Furthermore, there will exist some words that can only be spelled out by queen's moves.

Ascertaining necessary and sufficient conditions for queen's-move graphability is an extraordinarily difficult problem. An obvious necessary condition for a queen-graphable word is that no letter participates in more than eight bigrams. For example, CHOLEDOCHODUODENOSTOMIES cannot be queen-graphed because it contains nine different bigrams using O: HO,OL,DO,OC,UO,NO,OS,TO,OM. A somewhat less-obvious condition is that any pair of letters in a word must not share more than three other letters in bigrams. For example, ELECTROENCEPHALOGRAPHERS cannot be queen-graphed because it contains the bigrams EL,EP,HE and ER, sharing the letters L,H,R,P with the bigrams HA,AL,RA and AP.

Beyond these two, no simple rules are known. However, a useful technique for determining queen-graphability is to identify all bigram triads such as EN,EC,CN or AT,ET,EA that exist in a word. Bigram triads must be assembled in right-angled structures that have very little freedom to be adjusted, particularly when two or more bigram triads share a pair of letters. For example, it is easy to convince oneself that INSCIENCES is not queen-graphable; it contains the four triads

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 S      N      N      C                    NC  or   NS
CE     IE     SE     IN                   IES       IEC
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which cannot be simultaneously realized. The two diagrams at the right show how the first three triads can be assembled, but the fourth cannot be incorporated since C, N and I cannot be placed in a right-angled structure with full accessibility (in the second diagram, E blocks I from C).

Usually, it takes a bit more analysis to prove that a word is not queen-graphable. To illustrate, TETRAIODOPHENOLPHTHALEIN contains the triads OP,OL,LP as well as IO,NO,IN and EN,EI,IN. These can be assembled as in the diagram

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    I  or variations such as     IE or  EI .
  PONE                          LON     LON
   L                             P       P
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One should next look for possible short connections between letters such as P or L on the left, and E on the right. There are in fact two: PHE and LE. To achieve these, P and L must be extended outward:

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      H
    + + +
  + + + + T
+ + I + +
P + O N E
  + + +
    L
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T can be added on the right to accommodate the bigrams TE and TH, but A, which participates in HA, AI and AL, cannot be located anywhere in the grid. Experimentation with variant arrays also leads to dead ends.

There are probably only a few dozen Websterian words that cannot be queen-graphed, but no systematic survey of these has been made. One place to start is with words that cannot be king-graphed. Of nineteen 24-letter words so identified by Leonard Gordon, only five failed--the three already discussed, plus PANCREATICOGASTROSTOMIES and HEMATOSPECTROPHOTOMETERS. (In the second, O and E share M,T,R,P in bigrams.)

On page 4 of his February 1995 article "Introduction to Word Graphs", Leonard Gordon lists five 15-letter words that cannot be king-graphed. Of these, three fail queen-graphing as well: PROSCRIPTIONIST, OVERCONCENTRATE and UNCONSCIENTIOUS. The others, AURICULOCRANIAL and DIPLOSPONDYLISM, are queen-graphed below.

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  C + + O
I R U +
N A L
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    Y D
    + I
  + L P S M
N + + O
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Two other words in Gordon's article fail queen-graphing: PNEUMORETROPERITONEUM (O and E share P,N,T,R in bigrams) and VENTRICULOCISTERNOSTOMIES (after assembling the four triads RN,NT,TR, ST,OS,TO, EN,NT,TE and NT,TR,RN, there is no way that R, S and E, all of which must join I, can be placed in a straight line).

A word with five different letters is queen-graphable if it contains no more than eight of the ten possible bigrams of ten different letters. INSCIENCES, INTENSITIES and INTRATRINITARIAN, all having nine, are not. Similarly, a word with six different letters is queen-graphable if it contains no more than eleven of the fifteen possible bigrams of two different letters. No words that fail this requirement are known; a queen's-move graph of METASOMATOSES, with only nine different bigrams, is shown at the left.

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  M O
E   T
S A
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The shortest non-queen-graphable word is INSCIENCES, and the longest queen-graphable one is the Random House Unabridged DIAMINOPROPYLTETRAMETHYLENEDIAMINE. This is actually king-graphable, as shown by Leonard Gordon in the February 1995 **Word Ways**.