REVERSIBLE WORD SQUARES

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Most people are familiar with reversible overcoats; by turning them inside out, one gets two garments for the price of one. The logical equivalent of this is the reversible word square, a square array of letters that contains words when read in normal left-to-right and top-to-bottom fashion (as in a crossword puzzle), but also contains words when read right-to-left and bottom-to-top.

Reversible squares come in several varieties. They can be either single word squares or double word squares, depending upon whether or not the row words are repeated as column words. Furthermore, palindromic word squares are special cases of reversible word squares. In a palindromic word square of size n, the ith and the \((n - i + 1)\)th row (or column) words are reversals of each other; if \(n\) is an odd number, the central row (or column) word is a palindrome.

To clarify ideas, let us look at examples of the four pure types of reversible word squares of size three: palindromic single, palindromic double, (non-palindromic) single, and (non-palindromic) double.

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<tr>
<th>A T E</th>
<th>D A B</th>
<th>P A T</th>
<th>P A R</th>
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<tr>
<td>T O T</td>
<td>E V E</td>
<td>A R E</td>
<td>I T A</td>
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<tr>
<td>E T A</td>
<td>B A D</td>
<td>T E N</td>
<td>N E T</td>
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Note that the number of different words, counting reversals, in these squares is 3, 6, 6 and 12, respectively; if the square is of size \(n\), these numbers are \(n\), \(2n\), \(2n\), and \(4n\). Not surprisingly, the difficulty of construction is related to the number of different words in the square. All words in these squares can be found in Webster's Collegiate Dictionary, with the exception of ITA and ATI. These are both Negrito peoples living in the Philippines -- one on the island of Luzon (in Zamboales, Papagana and Bataan provinces) and the other on the island of Panay.

Reversible squares of size three are so easy to construct that additional challenges have been formulated. In his 1925 book A Puzzle-Mine, H. E. Dudeney attempted to construct a (non-palindromic) double reversible word square of size three in which the two diagonals also formed words. (These squares are of somewhat less interest because of their lack of symmetry -- some letters enter into more words than others do.) Although Dudeney did not succeed in solving this problem, four readers of Martin Gardner's Mathematical Games...
The four types of reversible word squares have also been constructed for squares of size four and five:

<table>
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<tr>
<th>STEPS</th>
<th>SNAPSLAPSLAG</th>
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<tr>
<td>TIDE</td>
<td>LANA LANA NAVEL</td>
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<tr>
<td>EDIT</td>
<td>ANAL ANAN NATA</td>
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<td>PETS</td>
<td>PANS PANS PALS</td>
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<td>CARES</td>
<td>PALER KANAT LARES</td>
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<td>ANELE</td>
<td>ASALE ASANA ANELE</td>
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<td>REFER</td>
<td>CIVIC NAMER DIVIL</td>
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<tr>
<td>ELENA</td>
<td>ELASA ANELE ELASA</td>
</tr>
<tr>
<td>SERACRELAPTARED</td>
<td>DERAH</td>
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The first of the squares of size five was discovered by Doug McIlroy using a digital computer, and appeared in the November 1976 Word Ways; the second and fourth were discovered by Dmitri Borgmann, and appeared in his book Language on Vacation (Scribner's, 1965). Words not in Webster's Collegiate are:

- anan var. of anon, an interjection of surprise
- Anat the consort of Anu, a Babylonian sky god
- aval pertaining to a grandparent
- Evan male given name
- gals pl. of gal, a var. of girl
- Lana female given name
- Nana wife of hero of Aztec myth; nursemaid
- ste to move about stupidly or awkwardly
- tana Sumatran squirrel shrew
- asale for sale, on sale
- asile obs. var. of asylum
- asana a squash bug (Anasa tristis)
- asana a Philippine timber tree
- anele to anoint, as in extreme unction
- anile feeble, doddering
- derah Eritrean measure of length
- derat to rid of rats
- dedal var. of daedal, ingeniously formed
- divil var. of devil
- Elasa Biblical name (in Douay)
- Elena female given name
- Elina female given name
- Elisa var. of Elizabeth
- hared teased, worried
- kanat the wall of a tent
- laded loaded
- Laval a French commune
- namer one who names

column in Scientific American magazine did, using a variety of obscure words; the results can be found in the October 1964 issue.
When one turns to reversible squares of size six, the difficulties increase considerably. Even the simplest square, a palindrome, single word, appears to be impossible to construct without going beyond standard dictionaries for words (KRAMER, in the first square below which was devised by Dmitri Borgmann, is a surname). One must relax the requirements, and ask for a word square in which as many different words as possible appear. The second square below, devised by Jeff Grant of Hastings, New Zealand, contains 21 out of a possible 24 words; can Word Ways readers do any better?

These words are defined as follows:

- **adare** to escape by hiding from (OED)
- **eddar** dial. form of edder (English Dialect Dictionary)
- **detter** obs. form of debtor (OED)
- **dradde** obs. past tense of the verb dread (OED)
- **errats** obs. form of errata, errors (OED, 1654 quote)
- **essart** var. of assart, the act of clearing land for cultivation
- **nieres** var. of neers, kidneys
- **redrew** past tense of redraw
- **serein** a fine rain falling from a clear sky shortly after sunset
- **sneews** a Wexford dial. form of snows, snows (EDD)
- **starre** var. of star or stare (OED)
- **steer** a Somerset dial. form of start, bleak (EDD)
- **sweens** var. of sowens, a Scot.
- **retted** soaked or exposed to moisture
- **terr** var. of terret, a harness ring
- **tirret** a swivel or manacle depicted as a charge
- **trasse** obs. form of trash or trace (OED)
- **treets** dial. var. of treats
- **werder** meaning uncertain (OED, c1350 quote); comp. of weird, an obs. form of weird

All words but **revar** can be found in Webster’s Unabridged.