

FOUR-LETTER WORD NETWORK UPDATE

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A word network is a set of words of a given length in which any two words differing by only one letter in a single position (such as **aunt** and **runt**, or **hire** and **hare**) are connected by a line. Using these lines, one can trace out a path leading from any word in a network to any other word in the same network. The terminal words, together with the intermediate words in the path, form a word ladder, well-known since the days of Lewis Carroll. This article updates a number of recent articles in *Word Ways* describing the properties of four-letter word networks and ladders.

Network Size and Span

In the February 1989 *Word Ways*, I stated that 3550 of the 3686 four-letter words in the Official Scrabble Players Dictionary are in a single network. This should be corrected to 3554; the quag-quai-quay-quey island can, in fact, be connected with the main network via quad-duad.

In the same article, I showed that the span of the main network (i.e., the number of steps needed to connect the two most distant words in the network to each other, using the shortest possible ladder) was 14. This can be compared with the 18-step span of the main network based on the 4060 words in Chambers Words:

```
stie-stir-sair-pair-pais-pats-oats-orts-ores-ures-urds-urde
stye
scye
                                     unde-unce
                                     |
                                     inro undo unco
                                     |
                                     onto-into==unto
                                     |
                                     otto info
```

The combined OSPD-Chambers list contains 4700 words; here is its 15-step span:

```
scye
stye-stie-stir-smir-amir-amis-anis-ants-ante-ance-unce-unco-unci
snye
                                     unto
                                     |
                                     inro-info-into
```

In order to solve various word problems, I have added a number of words from Webster's Second, Webster's Third and (mainly) the Oxford English Dictionary to the above list, for a total of 6060 words. The span of the 5979 words in the main network, 18, is diagrammed on the next page. Of the 81 words not in the main network, the only non-solitarities are **odic-otic** and **oboe-obol**, all in both the OSPD and Chambers. Of the 68 solitarities listed in the February 1989 article, 28 remain so:

abri ankh aqua asci awol ciao ecru elhi envy epee espy etna etui exam
 expo iffy isms jehu jeux meow ordo ossa ouzo ovum sybo upby upon weka

amok-atok-atop

stop-----step

coop=loop=noop=scoop-soup seep

coos=loos=noos-----sous sees

cots=lots=nots=====sots

aits=cits=lits=nits=====sits--sets

ants

ante-ance-once-onie-onix-onyx-oryx-eryx

Carrollian Word Ladders

In the November 1989 **Word Ways**, I presented word ladders joining evil-good and iron-lead requiring transposal links to do the job. With the expanded word list, transposals are no longer necessary:

EVIL-evel-ever-eyer-gyer-goer-goor-GOOD

IRON-tron-trod-trad-tead-LEAD

The same article showed a number of improvements of Carroll's word ladders using OSPD words; the May 1990 Colloquy shortened some of these using OSPD and Chambers words. Here are further improvements:

HARE-hore-sore-soue-SOUP

TREE-tred-toed-woed-WOOD

COMB-come-came-hame-haie-HAIR

BLUE-slue-siue-sine-pine-PINK

MINE-cine-cone-cont-coat-COAL

LOAF-leaf-lear-liar-lier-oier-over-OVEN

Some of the above ladders are examples of computer-human interaction discussed by several people in **Word Ways**. Finding minimum-length ladders is ideally suited for the computer, but searching a dictionary like the OED for usable words is not. However, when the computer finds a ladder that is only one or two steps longer than ideal, it is easy to see what word(s) are needed to shorten it, and (for four-letter words) OED is quite likely to have them. In fact, that approach is what has produced my hybrid list of 6060 words. Otherwise, perusing OED for four-letter words can be dreary indeed. With the computer, of course, there is a bonus; words found while searching for solution to one problem often turn up in solutions to another (see the next section).

Tours Through Subnetworks

In the August 1989 **Word Ways**, the editor and I discussed the problem of finding tours through subnetworks. Each subnetwork was defined as having words with common consonant-vowel patterns. The letter Y was considered a vowel except when in first position; thus, **year** and **fear** are in the same subnetwork.

Sixteen subnetworks are theoretically possible, but I do not have any all-vowel words (**yoyo**, for example, is defined as starting

with a consonant). A closed tour (Hamiltonian) of 16 nodes (vertices) on a hypercube is mathematically possible, but with one node absent the best possibilities are a 15-node open or a 14-node closed tour. Here are the best ones I was able to find:

```
swad-swld-sild-sile-ails-awls-awes-awee-awme-twme-twee-tyee-tyes-eyes
owes-ores
awes oras---bras---bias---aias---aits---alts---alto
|
awee---swee---swte---swth---sith-suth---suto---auto
|
site---siue
```

(The site-siue appendage illustrates how the fifteenth subnetwork (cvvv) can be joined to the closed loop of the other fourteen.)

WORD WAYS MONOGRAPH SERIES 2

In 1926, Newton B. Lovejoy, one of the premier anagrammists of the National Puzzlers' League, prepared a monograph containing approximately five thousand anagrams that had previously appeared in *The Enigma* (the official publication of the National Puzzlers' League) as well as in a wide variety of newspaper puzzle columns and privately-issued puzzle magazines of the past 50 years. 65 years later, *Word Ways* offers for sale in July 1991 the successor to Lovejoy's opus, *The New Anagrammasia*, containing approximately nine thousand anagrams and antigrams: a large fraction of the original never-published work, plus many more that have appeared in *The Enigma* since that time. It is offered in a limited edition as the second publication in the *Word Ways Monograph Series*, and includes anagrams appearing as recently as April 1991.

In order to assess the size of the printing, *Word Ways* solicits advance orders for this spiral-plastic-bound 8½"x11" book of approximately 170 pages: \$12.50 per copy if received prior to July 1, 1991, \$15 thereafter. (Ten per cent of each copy's price will be paid to the National Puzzlers' League, who have kindly granted permission to publish anagrams and antigrams from *The Enigma*.)

Word Ways Monograph Series 1, Satire: Veritas, a palindrome of 58,795 letters in 56 pages published in 1980, is still available at \$5 per copy.