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Over the years Word Ways has displayed a varied logological corpus. In this column I revisit forgotten ideas, connect seemingly-disparate concepts, and suggest further investigations.

For me, logology has been a field full of surprises. I have never been sure where the frontier is—where logology imperceptibly shades into some other body of knowledge. Here are some of the outposts which have especially charmed and beguiled me during the past forty years.

Eodermdromes (Aug 1980) Place the different letters of a word on a sheet of paper and, without lifting pencil from paper, trace out a path linking each letter to its successor, spelling out the word. For a few words of thirteen or more letters such as MET ASO:M.A TOSES, it is impossible to trace such a path without crossing some previously-traced segment of the path joining two letters. A word such as this was christened an eodermdrome (the shortest possible letter pattern having this property) by computer scientists Gary Bloom, John Kennedy and Peter Wexler.

Eodermdromes are distinct from king's move words in which the different letters are placed on a chessboard and the word traced out by moves of a chess king, or queen's move words, traced out by moves of a chess queen. There exist words that are both eodermdromes and king's move, and others that have only one of these properties. Eodermdromes have been explained in terms of graph theory, but no corresponding theory has been developed for king's or queen's move words.

Word Worms (May 1993) Words can be characterized by a sequence of vectors in three-dimensional space, resembling a segmented worm. It is a fortunate circumstance that the 26 letters of the alphabet can be assigned directions corresponding to the 26 lines drawn from the interior cubelet of a 3x3x3 cube to its exterior cubelets. A complex taxonomy of words can be established based on the shapes of the worms; although short words often have identical worm shapes, ones with five or more letters are almost always unique. A few words form closed loops (swallow their own tail) such as AMITY, PARSNIP and NEWSPAPERWOMEN, but none form a knot while doing so, as Mike Keith demonstrated in the Feb 2001 issue. The original idea was due to Keith Jones (on the Jul 7 1992 IBM bulletin board “Words Forum”) and Grant Willson.

Directed Word Networks (Aug 1991) The concept of a word ladder, in which each word is changed to the next by altering a single letter, is an old one, dating back at least to Lewis Carroll. Collections of word ladders can be assembled into exceedingly-tangled word networks. The properties of such networks are worth exploring, particularly when the moves from one word to the next are one-directional, as in WAS-ASH-SHE-HER-ERA... or URDU-DUST-STAR-ARMY-MYNA... The single most important characteristic of a word network is its span, a measure of its extent. The minimum number of steps needed to join one word with another (four, from URDU to MYNA) can be calculated for every pair of words in the network; the span is the maximum value of these numbers, characterizing the most distant word pair in the network. Directed networks can be dissected into a core of insiders which are mutually accessible from each other, starters which cannot be reached by any other word, enders which have no successor words, preceders which join beginners to insiders in one or more steps, followers which join
insiders to enders in one or more steps, and bypassers of the core which join beginners or preceders to followers or enders in one or more steps.

Short words usually form a main network with a few small auxiliary ones; on the other hand, long words usually form a large number of independent small networks. The disadvantage is that word networks are restricted to words of a common length; this can be overcome by creating insertion-deletion networks in which one either adds or deletes a letter from a word to move to the next word. For even small dictionaries, these networks are extremely complicated; the span is hard to calculate.

Symmetric Crash Groups (Nov 1978, Feb 1999) Two words of the same length are said to crash if they have matching letters in one or more positions, such as roTuND and atTeND. In a symmetric crash group, each word crashes a times with each other word, every letter in the group participates in a crash, and every letter is used m times in a given position. For n=1 and m=2, PEN POT SET SON qualify as a symmetric crash group. The largest-known symmetric crash group in which the members single-crash has eight seven-letter words. Steve Root found 63 by computer, a typical one being BIOLOGY DEATHLY SLOshed BASTARD SELVAGE FISSILE DALLIES FLAVORS.

Self-Descriptive Number Names (Feb and May 1990) If A=1, B=2, ... Z=26, it is well known that no number name has a score equal to its value (although TWO HUNDRED NINETEEN is scored 218 and TWO HUNDRED FIFTY-THREE is scored 254). However, if one is allowed to rearrange the alphabet, Leonard Gordon showed that −ESIV-F-WR-Y-UD−H-TXOLG-N (where hyphens can be replaced by the missing nine letters in any order) enables 38 number names to equal their scores, from FIFTY (7+4+7+20+12) to TWO HUNDRED TWELVE. He also demonstrated that one can do even better by allowing each letter to take any value, yielding 74 self-descriptive names from ZERO (-359/2 +107+99/2+23) to NINETY-EIGHT.

Self-Descriptive Sentences (Nov 1971, Feb 1992) Howard Bergerson devised the following self-descriptive sentence at the word level:

In this sentence, the word AND occurs twice, the word EIGHT occurs twice, the word FOUR occurs twice, the word FOURTEEN occurs four times, the word IN occurs twice, the word OCCURS occurs fourteen times, the word SENTENCE occurs twice, the word SEVEN occurs twice, the word TIMES occurs seven times, the word TWICE occurs eight times, and the word WORD occurs fourteen times.

However, Lee Sallows in 1983 constructed a special-purpose analogue computer which created the following self-descriptive sentence at the letter level:

This pangram lists four As, one B, one C, two Ds, twenty-nine Es, eight Fs, three Gs, five Hs, eleven Is, one J, one K, three Ls, two Ms, twenty-two Ns, fifteen Os, one P, one Q, seven Rs, twenty-six Ts, nineteen Us, four Vs, nine Ws, two Xs, four Ys, and one Z.

Much trial and error was necessary, as only about one in every eight verbs (lists, has, totals, contains, numbers, embraces, harbours...) led to a true sentence. He even found two sentences identical save for the number of (some of) the letters in the sentence!

Alphabetical Patterns (Feb 1993) Words can be sorted by their patterns of repeated letters; EXCESS and BAMBOO have common letters in the first and fourth, and fifth and sixth
positions. One can analogously classify words by the way in which the individual letters match shifted alphabets. For example, the letters in WRETCH match four different alphabet shifts:

\[
\begin{align*}
W & \rightarrow \text{R} \\
R & \rightarrow \text{E} \\
E & \rightarrow \text{T} \\
T & \rightarrow \text{C} \\
C & \rightarrow \text{H} \\
\end{align*}
\]

This matching can be labeled by WQCQYC, which can be regarded as a “word” worthy of study in its own right. In particular, various properties of such “words” can be studied:

- The word coOPeRaTiVelY has the most letters corresponding to a single shifted alphabet (analogous to HUMUHUMUNUKUNUKUAPUAA, the word with most repeated letters)
- The word undeRSTUdy has the most consecutive letters corresponding to a single shifted alphabet (analogous to wallLess, the word with most consecutive identical letters)
- The word QUANTIFICATIONALLY is the longest word with a different shifted alphabet for each letter (analogous to DERMATOGLYHPILLCS, the longest word with all letters different)
- The word HUMlSTRA TAUs is the longest word consisting entirely of letter-pairs with the same shifted alphabet (H and second S, first U and A, M and second U, I and 0, first S and first T, R and second T) (analogous to SCINTILLESCENT, the longest pair isogram)

**Embedding Words in Pi** (May 2006) The number pi has been calculated to many millions of digits. Can one discover words in this sequence? There are at least two ways that words can be efficiently generated: In the first, set $2=0$, $A=1$, ..., $Y=25$ and sum a sequence of consecutive pi-digits modulo 26. Thus, $3.1=4$, a $D$; $415926=27=1$ mod 26, an $A$; and $535=13$, an $M$, to form the word DAM. In the second, reduce each sequence of consecutive pi-digits modulo 26. Thus, $141$ mod 26 equals 11, or $K$; $5$ becomes $E$; $92$ mod 26 equals 14, or $N$, to form the word KEN. Quite long words appear early: in the sum-the-digits method, COMPETITIVE appears in the first 65 digits of pi, and in the reduce-modulo-26 method, KINDHEARTED appears in 75. Mike Keith has calculated that the 129,629 letters of Shakespeare’s play Hamlet need only 3,359,924 digits of pi to do the job.

**Textual Convergence** (Aug 1998, Nov 1999) In *The Mysterious Precognitions of Swami Picanumba* Martin Gardner exhibited the following logological curiosity. Pick a word at random in running text. If it has $n$ letters, count to the $n$th word farther along in the text. Repeat this procedure until one has passed (say) 50 words. The next word (the target word) that one arrives at is almost independent of the starting word—that is, one would have arrived at the same target word if one had started at any earlier word instead.

Convergence occurs because there is always some probability that two or more words in the text will lead to the same successor. The most extreme situation of this nature occurs when one has a reverse rhopatic phrase, with the last word before the target one letter long, the next-to-last word one or two letters long, the third-to-last word one, two or three letters long, etc. This event occurs in running text with probability 0.006.

It would be interesting to examine a large corpus of text to ascertain the probability of full convergence (all words before the start word converge to the same target) as a function of the number of words from the start word to the target.