Readers of *Word Ways* should be familiar with the concept of word patterns, exemplified by Jack Levine’s three-volume rearrangement of Webster’s Second and Third Editions into groups of words having the same pattern, such as EXCESS and BAMBOO. (Word patterns have even been discussed in large-circulation magazines; see physicist Sheldon Glashow’s “The Game of Bop” in the Sep/Oct 1992 issue of *Quantum*.) It is the object of this article to show how the concept of alphabetic patterns can be similarly codified.

The alphabetic pattern of a word is ascertained by writing the letters of the alphabet in a row on a slip of paper (in circular fashion, with Z followed by A), and sliding this strip back and forth underneath the word to identify letter-matches (crashes) with the letters of the word. For example, the letters of the word WRETCH match with four different alphabet-shifts, denoted by capital letters in the four alphabets below:

<table>
<thead>
<tr>
<th>Alphabet</th>
<th>u v W x y z a b c d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q-alphabet</td>
<td>o p q R s T v w x</td>
</tr>
<tr>
<td>C-alphabet</td>
<td>a b c d E f g H i j</td>
</tr>
<tr>
<td>Y-alphabet</td>
<td>w x y z a b C d e f</td>
</tr>
</tbody>
</table>

The crashing alphabets are, for convenience, identified by the letter corresponding to the first letter in the word. If a letter matches the A-alphabet, it is said to be invariant.

One can characterize the alphabetic pattern of a word by the identifiers of the crashing alphabets; thus, WRETCH has the alphabetic pattern WQCQYC, with two alphabets (W and Y) crashing once and two more (Q and C) crashing twice. Using this equivalence, one can classify all words in the dictionary by their alphabetic patterns, grouping together those (such as WQCQYC and PNDN-XD) whose alphabetic patterns are equivalent. For brevity, each group is identified by its first pattern, alphabetically speaking (ABCBDC). In turn, groups can be assembled into supergroups which are identified by the number of singly-, doubly-, etc. crashing alphabets (WRETCH, for example, has two single-crashes and two double-crashes, as does LANCES, with the different alphabetic pattern LZLZAN; both are in supergroup 2211).

These concepts can be illustrated by classifying the three-letter, four-letter and five-letter boldface words in the Merriam-Webster Pocket Dictionary according to their alphabetic patterns.
Three-Letter Words (547 words)

Supergroup 111 (498 words)
Supergroup 21 (49 words)
Pattern AAB 12 (deb den dew eft ope opt pro sty tub tug tun)
Pattern ABA 21 (arc bad bid bud cue egg ilk irk ink moo nap nip par per rat rot rut vex yea)
Pattern ABB 16 (cab cop dab elm fop gap hop jab lab lop mop nab ode sop tab top)

Four-Letter Words (1954 words)

Supergroup 1111 (1538 words)
Supergroup 211 (392 words)
Pattern AABC 68 (abbe abet able ably abut dead)
Pattern ABAC 70 (arch body chew clew crew doff)
Pattern ABCA 63 (acid amid arid avid auld awed)
Pattern ABCB 46 (alms anon baby chic chid chin)
Pattern ABCD 48 (ache acme acre acre ammo away)
Pattern ABCG 97 (aine Arab atop balm bast best)
Supergroup 31 (14 words)
Pattern AAB 6 (deft defy nope stub stud stun)
Pattern ABA 3 (bade bide bode chef clef)
Pattern ABA 2 (abed hick)
Pattern ABB 1 (first)
Supergroup 22 (10 words)
Pattern AAB 5 (hide high node stab stop)
Pattern ABA 2 (grit spur)
Pattern ABB 3 (babe shiv whiz)
Supergroup 4 (0 words)

Five-Letter Words (2808 words)

Supergroup 11111 (1860 words)
Supergroup 2111 (837 words)
Pattern AABCD 133 (aback abaft abash abbey abbot abeam)
Pattern ABACD 80 (ascot badge badly buddy budge cheap)
Pattern ABCAD 82 (baker baler bases beset betel bevel)
Pattern ABCDA 67 (acute adage adobe addle adore aerie)
Pattern ABCDB 82 (adap ansem aster astir befog)
Pattern ABCDC 83 (again along apart aport beige bland)
Pattern ABCDE 89 (althe Aztec beach beech belch bench)
Pattern ABCGD 97 (adder adopt annoy aphid aught balm)
Pattern ABCGH 63 (bawdy brick brink brisk burnt cache)
Pattern ABCDJ 75 (angst avast Bantu beanos beast blade)
Supergroup 31 (46 words)
Pattern AABAC 8 (defer stuck study stuff stump stung stunk stunt)
Pattern ABAAC 6 (bedew bided cleft eigh parse purse)
Pattern AABCA 8 (abase abate above abuse death depth straw strewn)
Pattern AABAC 4 (deign opera stave stew)
Pattern ABAHC 1 (squaw)
Pattern ABCAA 3 (aside brief dough)
Pattern BBAAB 0
Pattern ABBCB 8 (chick chink ravid shirk thick think toper whisk)
Pattern ABCCB 3 (llano neigh weigh)
Pattern ABCBG 5 (burst first verst worst wurst)
Supergroup 221 (61 words)
Pattern AABBC 1 (Norse)
Pattern ABABC 9 (glint grits lance links parch slung slunk spurn spurt)
Pattern ABBAC 2 (babel labor)
Pattern AABCB 3 (noway stick stink)
Pattern ABACB 6 (check cheek retch rotor shuck squat)
Pattern ABBCC 5 (boner borer bowser boxery)
Pattern ABCBA 7 (align alone clang cling clung plant screw)
Pattern ACABB 6 (chest grief grist guide squad sough)
Pattern ACBAB 1 (beret)
Pattern ACBBA 2 (ankle letup)
Pattern ABCCB 3 (aphis donor honor)

There seems no a priori reason to expect any alphabet-shift to be more prevalent than another. This hypothesis can be easily tested by a probabilistic model which assumes that alphabet shifts occur at random and independently with equal probabilities to form words. Thus, for example, the chance that a three-letter word will contain three different alphabetic patterns is equal to \( \frac{26}{26} \times \frac{25}{26} \times \frac{24}{26} = 0.888 \), or that it will contain two letters corresponding to one alphabetic pattern and the third to a different pattern is equal to \( 3 \times \frac{26}{26} \times \frac{1}{26} \times \frac{25}{26} = 0.111 \). The table below shows that the expected number of words in each supergroup closely matches the observed numbers.

<table>
<thead>
<tr>
<th>Supergroup</th>
<th>Obs</th>
<th>Exp</th>
<th>Supergroup</th>
<th>Obs</th>
<th>Exp</th>
</tr>
</thead>
<tbody>
<tr>
<td>111</td>
<td>498</td>
<td>486</td>
<td>11111</td>
<td>1861</td>
<td>1851</td>
</tr>
<tr>
<td>21</td>
<td>49</td>
<td>61</td>
<td>2111</td>
<td>837</td>
<td>848</td>
</tr>
<tr>
<td>1111</td>
<td>1538</td>
<td>1534</td>
<td>2211</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>31</td>
<td>14</td>
<td>11</td>
<td>311</td>
<td>61</td>
<td>56</td>
</tr>
<tr>
<td>22</td>
<td>10</td>
<td>8</td>
<td>312</td>
<td>1</td>
<td>1.4</td>
</tr>
</tbody>
</table>

However, when one looks at the numbers for individual patterns, there is somewhat more variability than the equiprobability model predicts. In particular, there are a larger-than-expected number of words with the alphabetic patterns AABCD and ABCC.

It would be of interest to use a computer to compile a type-collection of supergroups for words of six or more letters. The probability model enables one to decide the likelihood of finding one or more words in a given supergroup, given that a dictionary such as Webster's Second or Third is searched. For example, the Air Force list of Webster's Second (plus a few specialized dictionaries) contains 33,226 eight-letter words, and the probability of a word appearing in Supergroup 2222 is equal to \( 105(25 \cdot 24 \cdot 23)/26! = \)
0.00018; therefore, one may expect \((0.00018)(33226)\) such words to appear. In fact, WRETCHED, with the alphabetic pattern \(WQCQYW\), belongs to this supergroup. As another example, what is the longest word in which each letter has its own unique alphabetic shift (that is, belongs to a supergroup of form \(111\ldots 1\))? The table below suggests that a 17-letter word (maybe even an 18-letter one?) can be found.

<table>
<thead>
<tr>
<th>Word Length</th>
<th>Dictionary Size</th>
<th>Probability</th>
<th>Expected Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>23999</td>
<td>0.0285</td>
<td>1164</td>
</tr>
<tr>
<td>13</td>
<td>17723</td>
<td>0.0261</td>
<td>463</td>
</tr>
<tr>
<td>14</td>
<td>11910</td>
<td>0.0131</td>
<td>156</td>
</tr>
<tr>
<td>15</td>
<td>7438</td>
<td>0.00602</td>
<td>45</td>
</tr>
<tr>
<td>16</td>
<td>4380</td>
<td>0.00255</td>
<td>11</td>
</tr>
<tr>
<td>17</td>
<td>2504</td>
<td>0.00098</td>
<td>2.5</td>
</tr>
<tr>
<td>18</td>
<td>1289</td>
<td>0.00034</td>
<td>0.4</td>
</tr>
</tbody>
</table>

It should be a straightforward matter to program a computer to discover how many words with the requisite alphabetic patterns appear.

Certain aspects of alphabetic patterns have been touched on in earlier Word Ways; the subject was introduced in a Query in May 1972. Invariant letters ending words (A, oB, saC, leaD, staE, etc.) were explored by Darryl Francis in May 1971. Ed Wolpaw listed words having four crashes with a particular alphabet in February 1979. The words iNOPeRatIve and coOPeRatIveY both have six crashes with a single alphabet. Shiftwords (such as JOLLY to CHEER, or OHM to PIN) always have the same alphabetic pattern.

Alphabetical patterns are analogous to the word patterns alluded to at the beginning of this article; in fact, any question about one can be rephrased as a question about the other. The key is to visualize the alphabetic pattern as a "word" in its own right. Thus, the search for the longest word in which each letter has its own unique alphabetic shift (discussed above) corresponds to the search for the longest isogram (a word with no repeated letters), which happens to be the 15-letter word DERMATOGlyphics. Similarly, the search for the word with the most letters matching a single shift-alphabet translates to the search for the word with the most repetitions of a single letter, which happens to be hUmU-hUmUnUKUnUKUapUaa (among others) with nine. And what is the pattern word corresponding to the longest word with each shift-alphabet repeated twice (WRETCHED, noted earlier)? This is, in fact, a pair isogram; the longest example is SCINTILLeSCENT. Words such as undeRSTUDY or iMNOPhile have four consecutive letters in the same shift-alphabet; however, there are no Websterian words with a pattern of more than three consecutive identical letters (waLLLess, headmistreSSShip). No doubt Word Ways readers can discover other analogies.

Chris Cole has kindly supplied the author with a list of boldface uncapitalized unhyphenated words with six letters matching a single shift-alphabet. All can be found in one or more of three sources: the Unabridged, OPeRaTiVeY, and uncoOPeRatIveY. Here is the list:

1. nonfeSTiVeLy
2. aLoN, ArCh
3. AntiantHropo~
4. i b LeNess, nor

NOT ANNoY

Yes, adding the A-al aLoN, ArCh

Adding the A-al
6 such words WQCQYC—
what is the
[1 .... 1]? The
en an 18-let-

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computer to

touched on

a Query in a
lead, state, 

. Ed Wolpov
alphabet in an
atic patterns

alenned alumnation about. The key is s own right.
hter has correspon-
ding no repeated
ers matching the word with
be hﾑU—what is the
ach shift—This is, in
TILLESCENT.
consecutive to
16 Webstarian
dential letter-

fays readers

sources: the Second and Third Editions of the Merriam-Webster Unabridged, and the Random House Unabridged. By far the common-
est match is OPRTVY, illustrated by coOPeRaTiVeY, intraOPeRaTiVeY, OPeRaTiVeY, preOPeRaTiVeY, postOPeRaTiVeY, and uncoOPeRaTiVeY. NOPRTVY is found in noNOPeRaTiVe, NOPeRaTiVe.
ness, and noNOPeRaTiVe; NOPTUY, in iNOPorTUnelY and iNOPorTUnity; and NPRTUY, in noNSPiRiTUally and uNSPiRiTUally. Other matches are illustrated by DaughTerLiNesseS, DEFinItiveNesseS, gyMNO-
PlaST, nEiGHborLiNesseS, uNDEFendableNesseSn, bLaNOPlaSTy, and
ON nefStiVeY.

Here is the corresponding list of words with five letters matching the A-alphabet: ABuDEFduf, Agamma Globuli Nemias, ArChEnceph-
aloN, ArChEtypiCaL(y), syngEnesiQtraNsPlan Tation, AbadEnGo, AntiantHropoMorPhiSm, ApoDEictiCaL(y), ArChErsHlp, nonDEFens-
ibleNess, nonDEFensibleNess, nonDEFinItely, and nonDEFinItiveNess.

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NOT ANOTHER PALINDROME BOOK?

Yes, another ... but Go Hang a Salami, I'm a Lasagna Hog (Farrar, Straus, Giroux, 1991; $12.21) is certainly worth adding to the canon. John Agee's cartoons of the 56 palin-
dromes are generally clever, even when the original palindrome seems unpromising ("No, son" is uttered by a father reading a newspaper as his son, hiding behind the TV, prepares to light a fuse leading to a box of TNT on which his sister is tied). Others, of course, cry out for an apposite cartoon ("Not a banana baton" or "Pooh's hoop"). There's even one Cheater's Palindrome: a car, a man, a Maraca. Some care has been taken with the arrangement of the pages ("Yell alley" opposite "Yawn way", and "Dump mud" opposite "Emil's niece, in slime"). This book deserves a sequel, pre-
ferably before the year 2002.